VALUE ADDED PRODUCTS FROM SHORT AND / OR NARROW LENGTHS OF TIMBER: THE SOUTH EAST QUEENSLAND HARDWOOD TIMBER INDUSTRY AND THE CHANGING ROLE OF THE DESIGNER WITHIN A GROWING SUSTAINABILITY IMPERATIVE.

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I would like to acknowledge the contribution to this study made by the industry representatives from all sections of the supply chain who so willingly shared their knowledge and expertise. Thank you.

Please note:

Although I was based at the Department of Primary Industries and Fisheries for this study, this thesis represents my own ideas and opinions and does not claim to represent the opinion of the Department of Primary Industries and Fisheries.

Signed declaration

This thesis contains no material which has been accepted for award of any other degree or diploma, except where due to reference is made in the text of thesis. To the best of my knowledge, this thesis contains no material previously published or written by another person except where due reference is made in the text of thesis.

Signed

Date

(front cover - offcuts produced at Hurford Hardwood, Lismore. Photo taken by Loy 2005)
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Study partners:

CRC Wood Innovations.
Innovative Forest Products Section, Horticulture and Forestry Science, Department of Primary Industries and Fisheries, Faculty of Design, Swinburne University of Technology.

Jennifer Loy is a scholarship student with the Department of Primary Industries and Fisheries in Brisbane. Her work forms part of a major seven year government and industry funded research project undertaken in conjunction with the Co-operative Research Centre for Wood Innovations in Melbourne, and the Faculty of Design at Swinburne University of Technology. Specifically, it forms part of a research project into the improved utilisation of timber led by Dr Michael Kennedy, Head of the Innovative Forest Products section of the Department of Primary Industries and Fisheries, Brisbane.

Publications from PhD:


Exhibited designs and research pieces developed as part of the PhD:

- Loy, J 2005, Spiral, demonstrating the value in timber off cuts exhibited at the International Union of Forestry Research Organisations, Brisbane.
- Loy, J 2007, Stems, Zonta exhibition, Montville winner Craft award, winner Packers award.
- Loy, J 2007 Curved stems, Cooloola Shire art exhibition, winner sculpture award, judged by the curator for International Art, Gallery of Modern Art, Brisbane.
- Loy, J 2008, Valuing the raw material, nine design research pieces to be exhibited at the Department of Natural Resources, Brisbane, May to September 2008.

Presentations from PhD:

- Loy, J 2005, Poster outlining the direction for the project, displayed at the CRC meeting of industry partners and academics members, Creswick, Victoria.
- Loy, J 2006, Presentation to CRC industry partners and academic members at the CRC meeting held in Swinburne, Prahran, Victoria.
- Loy, J 2006, Presentation to Industry representatives and Department of Primary Industries representatives on direction and proposed solutions, Indooroopilly, Queensland.
• Loy, J 2007, Presentation on improving the utilisation of timber through education on specification at the CRC meeting for industry representatives and academic members, Creswick, Victoria.
• Loy, J 2008, Short outline of conclusions of research, at CRC meeting with industry representatives and academic members, Melbourne, Victoria.

Title of research:

‘Value Added Products from Small and or Narrow Pieces of Timber’

Abstract:

This thesis is presented as a study for product design educators in respect to addressing a gap in knowledge on the changing role of the designer in the face of changes in attitude, and innovations in production, needed to initiate sustainable practice. Within this context it provides an industrial designer’s response to the issues and specific problems raised by the project ‘designing value added products from small and / or narrow pieces of timber’ for the hardwood timber industry in south east Queensland, Australia. In doing so, it also addresses a research gap on maximising the use of hardwood in value added products. The research is located primarily in the construction and manufacturing industries in south east Queensland and northern New South Wales but also in the development of design practice in response to the global sustainability imperative that has become a significant driver for the project. It provides practical direction, recommendations and examples for both industry and education.

Within the context of responsible design thinking, corporate responsibility and triple bottom line accounting (economic, social and environmental), there is much discussion in current journals on how the needs of the economy, environment and people can be met and how innovation can be stimulated by restrictive parameters, such as environmental ones, and produce new ways of
working. However, it is argued in the study that there are designers and architects who still appear to focus on the short term perceived needs of the individual client over the environmental and social aspects of their design decisions. Whilst it can be suggested that legislation needs to continue to be developed to ensure intergenerational responsibility, design students also need to be given practical examples of how they can assess the brief they are set and influence the outcomes of their projects to ensure that they are providing their clients with the financial benefits of long term, triple bottom line based thinking, and the rest of us with environmentally and socially responsible products.

Within the Forestry sector, these issues are particularly at the forefront of current research and debate. Policy, production practices and adherence to Australian standards are considered in relation to a broader context by this study, forming the basis for recommendations on changing practice. By suggesting ways to improve recovery rates for value added applications, this study provides a contribution to the ‘whole material’ lifecycle response to this increasingly high profile issue of sustainable production that the industry must make in order that timber can compete with other building and manufacturing materials in the future.

**Project books:**
There are three project books showing sketch work and project development to accompany this written thesis, available on request.

**Photographs:**
Unless otherwise stated, all photographs of work and drawings are by the author.
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Introduction.

This thesis is presented as a study for product design educators in respect to addressing a gap in knowledge on the changing role of the designer in the face of changes in attitude, and innovations in production, needed to initiate sustainable practice. Within this context it provides an industrial designer's response to the issues and specific problems raised by the project ‘designing value added products from small and / or narrow pieces of timber’ for the hardwood timber industry in south east Queensland, Australia. In doing so, it also addresses a research gap on maximising the use of hardwood in value added products.

The research is located primarily in the construction and manufacturing industries in south east Queensland and northern New South Wales but also in the development of design practice in response to the global sustainability imperative that has become a significant driver for the project. It provides practical direction, recommendations and examples for both industry and education. The contributions to new knowledge that will be made are in:

- Challenging the role of the proximate designer, providing suggestions and discussion points for design educators in response to the developing sustainability imperative.
- Providing an important aspect of the ‘whole material’ lifecycle response to this increasingly high profile issue in order that timber can compete with other building materials in the future.
- Finding ways to improve current practice in the supply chain to respond to the issue and improve recovery rates for value added applications.
- Providing design direction for the briefs for new equipment to improve recovery rates for value added applications.
- Providing examples of value added designs for small and / or narrow pieces of timber through case studies and projects.
- Providing a review of the use of technology that could help to address the problem of recovery rates and new design
opportunities for the Australian timber industry using small and/or narrow pieces of timber.

The literature reviewed as part of the initial sections of this work supports the methodology for the project. The basis for the approach is that design decisions are important for even the smallest of projects because of the unknown consequentiality of our work and the cumulative effect of the impact of designed products. In making design decisions, the designer is not autonomous to work within the immediate needs of the client, but subject to society. Because of our increased understanding of the power our decisions make globally both on society and the environment, it is essential that designers develop a responsible design methodology. The working of this project demonstrates in a practical way how that imperative impacts on the designer and the outcomes of the project initially set by the client. The starting title of this particular project ‘designing value added products from small and or narrow pieces of timber’, set by the Queensland Forestry Research Institute, now the Innovative Forest Products Section of Horticulture and Forestry Science in the Department of Primary Industries and Fisheries in Brisbane, Australia, provides the opportunity to explore this issue as part of an interesting, pertinent example.

Within the context of responsible design thinking, corporate responsibility and triple bottom line accounting (economic, social and environmental), there is much discussion in current journals on how the needs of the economy, environment and people can be met and how innovation can be stimulated by restrictive parameters, such as environmental ones, and produce new ways of working. However, it is argued in the study that there are designers and architects who still appear to focus on the short term perceived needs of the individual client over the environmental and social aspects of their design decisions. Whilst it can be suggested that legislation needs to continue to be developed to ensure intergenerational responsibility, design students also need to be given practical examples of how they can assess the brief they are set and influence the outcomes of their projects to ensure that they are providing their clients with the financial benefits of long term, triple bottom line
based thinking, and the rest of us with environmentally and socially responsible products.

Within the hardwood Forestry sector, these issues are particularly at the forefront of current research and debate. Global concerns and government policy have shaped the development of this project. In Australia policy, production practice and adherence to current standards have created the need for this project and are important to review within the broader, global context, forming the basis for the recommendations on changing practice made by this study. For the product design outcomes of the project, and suggestions for the direction for related design briefs, a thorough understanding of all related aspects of production and supply was necessary before informed briefs could be developed.
Chapter 1: Designing within context.

According to the design education article by Dr Mariano Ramirez Jr\textsuperscript{1} there is a lack of consensus on teaching methodology that considers the impact of design decisions beyond those of the immediate client, in particular with regards sustainable design practice. It is my proposal that the fragmented rhetoric on design methodology over the last seven years needs to give way to clearer guidelines on the responsibilities of an industrial designer in 2008, in an effort to provide a united front for the discipline, and therefore support for the individual designer, on their essential role in the face of the challenges of the current global environmental and social crisis.

Twenty years ago I graduated into a hedonistic designer's world. Fresh from the radical design of the visiting Sottsass exhibition\textsuperscript{2} excited by the opportunity to exhibit at the aptly named ‘Style’ exhibition in London; the heady delights of Designer Saturday at that time epitomised the pleasures of being one of the fortunate elite spoilt by a building boom, ridiculous budgets and the general consensus that employing a design consultancy was good for business, and that design, regardless of the efforts of Olins' book ‘Corporate Personality’\textsuperscript{3} to give it more depth, was unashamedly fashionable (and often self indulgent).

Makepeace describes design as a ‘snapshot of our time’\textsuperscript{4}. My first design work in the mid eighties was for an Oxford Street accessories department based on a Country Garden (for no particular reason I can remember) and an office furniture system for a Canadian company to capture the ‘English look’, complete with horse blankets. Successful designs in their time, they would be inappropriate now in my portfolio, but why?

The design historian, Adrian Forty\textsuperscript{5} argues that design is a product of the processes of society, which is along the same lines as the Makepeace observation, and my excuse for those first projects. He rejects the idea of personalities, such as Sottsass or Starck, effecting design changes or that
there is some kind of ‘law of natural or mechanical selection to propel artefacts in the direction of progress’.\textsuperscript{6} He emphasises the economic drivers for design (and the role of the client in brief setting and final approval) and the expression of society’s ideologies by the success or failure of a product in the market. Important points, he says, that have been largely ignored in design literature:

\begin{quote}
“Most of the literature from the last fifty years would have us suppose that the main function of design is to make things beautiful. A few studies suggest that it is a special method of solving problems, but only occasionally has design been shown to have something to do with profit, and even more rarely has it been seen as being concerned with the transmission of ideas.” \textsuperscript{7}
\end{quote}

If I, as a designer, am a product of the processes of society, then I need to understand what those processes are, how they will affect the brief for my work, the expectations of the client and my responsibilities to those involved in production, the end user and society as a whole. Will the experiences and attitudes of the individual designer commissioned affect the design outcome? Employing me, rather than another designer could change the approach. Is that true? Should that be true? Or is context the defining criteria? If so, what expectations in terms of approach, scope and ideology can a client expect on a project such as this in 2008?

Sparke, in her book published the following year to Forty’s ‘Object’s of Desire.’, titled ‘Design in Context\textsuperscript{8}, places the designer and various movements, such as De Stijl, feminism (discussed in more detail another of her books ‘As long as it’s pink\textsuperscript{9}) and the Bauhaus, within their social context. Her final chapter discusses design after modernism. The post-modern condition, a reaction to an age dominated by science and progress, was described by the French Philosopher Jean-Francois Lyotard as a ‘relativistic age with no absolute values’ \textsuperscript{10}. Perhaps the ideology of London in the mid eighties? Certainly, the excesses of disposable consumerism wore even my youthful enthusiasm down as I found myself on a carousel of restyling retail
spaces when the use by dates on the products they sold were probably still valid.

In my experience, rather than profit and ideology, profit and personalities did dominate in the eighties in the UK. There were not only individual personalities, but the projected personalities of design consultancies\textsuperscript{11} that were high profile and influential, such as Fitch and Michael Peters, who, for a few years, employed large numbers of designers. However, the scale of the design consultancies at that time was only possible because of economic and political developments in that society and therefore supports Forty’s preoccupation with context. The large scale London consultancies collapsed in the face of economic recession and have had to reinvent themselves.

There was another face to design. Papanek had not long released the second edition of ‘Design for the Real World’\textsuperscript{12}. The first edition, written between 1963 and 1970, attempted to define a social and ethical role for design. It was rejected by several publishers and the ideas ‘derided, made fun of, or savagely attacked by the design establishment’\textsuperscript{13} He was asked by his design colleagues to resign from the United States professional design organisation of which he was a member and they then threatened to boycott an exhibition of American industrial design at the Centre Georges Pompidou if his work was included. Papanek’s book is now translated into twenty two languages\textsuperscript{14} and is the most widely read book on design in the world. Twenty years have certainly seen dramatic changes in the design rhetoric.

After being given three hours to design a colour scheme for Marks and Spencer’s Oxford Street Food Court, I quit. Mass production held more promise of problem solving design and I moved into contract work for manufacturing. For a contract, I would join a manufacturer for between three months and a year to work on a broad spectrum of industrial design work. My first experience of Australia was on contract as an industrial designer for Sebel Furniture in Sydney\textsuperscript{15}. The company had bought an expanded-polyurethane machine and employed workers, but had no designs. I worked there for seven months and produced a range of upholstered chairs and
setttees for the contract market (hotels, restaurants). The work was fascinating because the manufacturing technique allowed me to ‘float’ anchor points for the upholstery anywhere within the mould which altered the traditional way of working in upholstery. I was very interested in new production techniques and was not alone. Influential books published at that time included the Mel Byars series\textsuperscript{16} which gave a break down of how a particular product was manufactured, rather than just photographs of the final pieces.

In the late eighties, Donald Norman wrote ‘The Design of Everyday Things’\textsuperscript{17} in which he called for a user-centered approach to design, a:

“Design philosophy based on the needs and interests of users, with an emphasis on making products usable and understandable”\textsuperscript{18}

The study of ergonomics gained importance and, combined with the growing interest in broadening a designer’s responsibility towards designing for processing, steered design away from the individual towards design choices based on action research and process planning.

Despite this, a designer’s design style was still presented as distinct from the effects of society by some publications throughout the nineties (and still now\textsuperscript{19}), such as ‘The Illustrated Dictionary of Twentieth Century Designers – Key Personalities in Design and the Applied Arts’\textsuperscript{20}, by Peter Dormer 1991, and ‘The Look of the Century’\textsuperscript{21} by Michael Tambini, 1998. However, two years after his book on design personalities, Dormer offered a very different perspective, arguing that design specialisms were challenging the way designers saw themselves and their role. Dormer says:

“Whenever the marketplace changes – as it has in Europe, for example, from black austerity to green concern – then the designer changes with it. The designer is a chameleon: he or she can, as needed, be a stylist, a corporate image strategist, an ergonomist or an environmentalist.”
“...this book offers a viewpoint that is based on an understanding of the
designer as a member of a team. Design, subservient to
manufacturing, the market and the consumer, is seen as an
evolutionary process rather than a series of inspirations. This is not to
deny the role of the individual as a driving force in design, but it is to
dilute the importance of 'self-expression'.”

I worked for large and small scale (batch production) manufacturers and the
design focus I experienced in the late eighties and early nineties during a
recession, was on designing for added value through the use of common
components across ranges, efficiency in manufacturing systems using ideas
such as JIT (Just in Time – supplying materials and components only as
needed), designing to allow for the deskilling and increased technocentricity of
factories. Taylorism was in. Investment in system mechanisation was the
dominant strategy. The Bauhaus, ‘Form follows function’ dominated as the
ideology and that function was defined by the production path as much as by
end use. Profit and innovation through technology was the ethos. Sohrab
Vossoughi, the President of ZIBA Design Inc., in the forward to ‘Innovation,
Award Winning Industrial Design 1991-1993 observes:

“Designers are going beyond product appearance to become more
involved in function and process......yesterday, designers were asked
to create image. Today we are expected to create value.”

This series published by the Industrial Designers Society of America,
compared to, for example, the series of International Design Yearbooks published by Laurence King, illustrated a dichotomy in what those design
values might be that emerged through the nineties. ‘Innovation’ celebrated
‘design solutions’ for need as opposed to design concepts as communication
and although Starck, as editor of the 1997 International Design Yearbook claimed that design should be ‘led not by aesthetics but by content’ and
mentions ‘new technology, the importance of reuse and the challenges of
designing for the mass market’ 27, he gives an ambivalent observation on the role of design and the designer for industry:

“I am not interested in the object as a thing in itself, but as communicating the sum of its signs, even though this communication takes, for the moment, a wholly material form. The total image allows people to understand their own position, their way of life and their modes of thought. It helps them to identify themselves. The image and the work of a designer empowers people to define themselves, by accepting or rejecting what is offered, and so deciding which groups or tendencies they are linked to. The image is practical in the context of an industrial society, in which a designer’s reputation can be the basis for justifying investment and getting a return. It offers a guarantee to the industrialist, giving him confidence to invest more in technology and so creating progress. And finally, the industrialist has to take the project on trust from the designer, so reducing the risk of bastardizing the final design.” 28

The mention of design for reuse heralds the emerging design specialisms of the nineties. Starck groups his design choices under different headings; the artists, who pursue an individual vision; those interested in recycling and re-use (my italics); the technologists; the naturalists interested in the honest treatment of materials; the minimalists and the reductionists. He also talks about ‘les anonymous plus’, or ‘anonymity with attitude’ which he describes as designs that recognise that people move around more than they used to and that design has moved away from the bold statements of a few years earlier, towards a more measured consideration of needs, materials and processes.

“This is in part the cautious response of an industry putting its head over the parapet of recession, and in part a genuine professional reaction against design extremes and indulgence.” 29
“Beauty is now an obsolete concept...Beauty is only of use or interest in a period of luxury. That is not the case now: beauty has become dangerous”

Starck argues that towards the end of the Century, the ‘indulgent, all-consuming, self-regarding design of a few years ago is no longer relevant at all’ in the face of a political, social and environmental crisis. Interestingly though, his chosen examples of design including Sottsass’s Chinese Vase series (figure 1.1), Melchers’ and Panza’s endeavour to ‘bring precious stones back into interior design’ (figure 1.2) and Rohringer’s porcelain teapot (figure 1.3) are hard to reconcile with that statement.
Technocentric manufacturing began to lose its appeal during the mid-nineties. Todd Cherkasky, in his article “Design Style: Changing Dominant Design Practice”\textsuperscript{31}, illustrates the experience through his description of the changing practice of large-scale bakeries in America. From an initial aim to mechanise production to the point of ‘lights out’,\textsuperscript{32} a fully mechanised system, the reality of high capital costs for the large scale machines required and the resultant pressures of continuous throughput and lack of flexibility of product it was possible to make, forced companies to either rethink their work systems or close down.

“Throughout the 1990s, the dominant management strategy in industrial bakeries was to replace aging capital equipment with increasingly integrated manufacturing control systems. In the early part of the decade, several prominent baking companies spent millions of dollars to implement fully computerised production facilities. When they lost their expected savings to degraded quality, high levels of waste and increasing costs, they went bankrupt or were acquired by competitors.” \textsuperscript{33}

Todd Cherkasky says that automation is ‘a road to failure – to pumping out poor quality products, faster, with more waste.’\textsuperscript{34}. He advocates a skill-based approach for a high performance work system. In this system, the skills and knowledge of workers become paramount, with investment in training rather than technology. The advantages include shorter runs, higher product variety and improved quality control.

Addressing this issue of improved quality control on assembly line production was my first experience of problems inherent in a technocentric approach. I was employed by a mass production, furniture manufacturing plant in Brighton, UK, that I had an ongoing design relationship with. In response to a dramatic rise in the rejection rate of finished products following the introduction of technocentric systems manufacturing, the management had employed more quality control inspectors and attempted to further de-skill and mechanise production wherever possible, but the slide in quality continued.
A crisis team was formed, of which I was part, and we reviewed the products and processes. We tracked the products through the plant and found that because the processes had been reduced to such simple operations, none of the workers felt they had a stake in production. If a worker was attaching handles and he noticed that the joints on the drawer were faulty, he did not see it as his responsibility. He was paid to attach handles and had a quota to fill. It made no difference to his quota if the unit was rejected by quality control at the end of the assembly line because of a problem with the joints. Therefore, small faults occurring at the beginning of the assembly line became costly faults by the end of the line as more costs were attached to it. The more mechanised the processes, the less ongoing preventative management for quality control occurred.

Eventually, after much consultation with the workers, assembly was reorganised into cells. Each cell was responsible for full products that they signed off. The interest, challenge and accountability in the work made a dramatic difference to the attitude of the workers. Investment in training was needed in some cases to allow the workers to complete the pieces in teams and that also highlighted interesting opportunities to add value as we exploited skills in the work force, such as the combining of technology and crafts skills with hand carvers adding finishing to computerised routered detailing. It was the first time I appreciated that design decisions had a direct effect on the work experience of those who made the products. Without the revolutionary zeal of Todd Cherkasky, I still radically altered my design focus.

“Our design decisions were decisions about who did what work, and how that work was done. I use the term “revolutionary”….to reinforce the idea that the design of common tools, machines and artefacts is a political act.” 35

If design is a political act, then the design politics a designer subscribes to, will affect design decisions and certainly design approach. How aware are clients of design philosophy, should the responsibilities currently faced be left
to individual designers, will social context be enough to make them rise to the challenge?

References and endnotes:


2. As a final year student, I visited the touring Sottsass exhibition in London in 1984. Sottsass, Branzi, de Lucchi and others were part of a radical group of furniture designers known as ‘Memphis’ when I saw their work (previously known as Alchymia). Their pieces were all about image and, to me, made reference of the work of Venturi. Non-symmetrical, brightly coloured, uncomfortable but startlingly dramatic. They were a challenge to form follows function as they were all about image and their timing – or perhaps the consumers’ willingness to embrace the ideas at that time - in the mid eighties was perfect.


5. Forty, A 1986, Objects of desire, design and society since 1750, Thames and Hudson, London.


7. ibid. p. 6.


13. ibid., preface.

14. ibid., preface.
15. Sebel Furniture, Bankstown Sydney. Design Manager, Denise Sheridan.
16. Byars, M 1990s, series: 50 Chairs, 50 Tables, 50 Lights, 50 Products, innovations in design and materials, Rotovision, Switzerland.
18. ibid., p. 42.
20. Dormer, P 1991, The illustrated dictionary of twentieth century designers key personalities in design and the applied arts, Quarto, London.
23. Taylor, F 1911, Scientific management, Haper and Brothers, New York. Taylor’s ideas on simplifying processes were applied by Ford in his creation of the first assembly line. Although the system worked on the face of it, making the Model T cheap enough to mass produce, Ford’s production was plagued with high staff turnover.
27. ibid., p.9.
28. ibid., p.15.
29. ibid., p.123.
30. ibid., p.123.
32. ‘Lights out’ referred to the idea of mechanisation to such a degree that lights would not be necessary, even for twenty-four hour production as there would be no people on site.


34. Ibid., p.25.

35. Ibid., p.25.
1.2: Design as a political act.

“Design must become an innovative, highly creative, cross-disciplinary tool responsive to the true needs of men. It must be more research oriented, and we must stop defiling the earth itself with poorly designed objects and structures.”

The emergence of design research as a discipline has seen a growing body of work on the role of the designer. Facilitating design decisions through the application of a design philosophy when approaching the work has been the subject of much debate. Designing is a political act. In deciding which projects to undertake, defining the limits of a demographic, specifying materials and processes and balancing the relationship between responsibility to the stakeholders and a wider responsibility to society, the designer is making decisions that affect ‘forms of life’, alter the balance of power between social groups, and have long term impacts on world resources.

Design research debate over the past five years has focused on defining the responsibilities of designers. Design methodologies forcing proximate designers to think more broadly have been advocated to address the needs and concerns of society from different stand points. In his essay ‘The Challenge of Responsible Design’, Jesse Tatum voices his opinion on the necessity of a ‘vigorous grasp’ of consequentiality for individual designers. He argues that even designers who feel they are designing ‘innocuous, insignificant products’ must understand that their work can have far reaching consequences. He argues that our design choices shape us and our behaviour, giving as an example how the humble garage door opener affected the interaction of neighbours in a community and therefore changed behaviour.

“There is, perhaps, no more powerful mechanism in our grasp for shaping the choice of a way of life than the accumulated increments of design (technology) that progressively and selectively underwrite certain patterns at the relative expense of others.”
If this is the case, then it is essential to approach each and every design project, however small or seemingly localised, with a design philosophy and methodology in place that stands up to scrutiny.

“The client-focused, one product-at-a-time marketed approach also means that designers tend to assume that any given design has little effect on other design, so negative synergisms can be ignored. A corollary assumption is that each new design is politically neutral, so how it is used rather than how it is designed determines whether the effects are for good or for ill. Among other implications, this means that there is no need to design for social equality or for any other public outcome.”

Examples of social design methodology include participatory and universal design. Participatory design has been the push to include, as far as possible, those affected by design in the decision making process. This has been directed on two fronts. Firstly, those who are being designed for: participatory design provides the opportunity for users to have a genuine input into the decision making process. This, fraught with practical difficulties in collecting information, theoretically has the benefit of providing the designer with a genuine, rather than imagined view from the user, although I have found that the ability to promote a sense of ownership in the user through participatory design is more valuable in improving the likelihood of acceptance of the product by the client and the market. This is also true of the second front, those who are affected by the production of the design. This is aimed at the lives of the workers who are affected by the design decisions made. Designing for a skill centred approach will be very different to designing for a technocentric approach. Participatory design as a philosophy ensures the best interests of the workers are included in the design process by consultation and an examination of the impact on the day to day lives of those producing the products. The challenges of this approach are in providing the knowledge to the representatives necessary for them to make an informed
contribution to debate without undermining the benefits of a lay approach to give genuine feedback.

“Participatory designers argue that if designers accounted for workers’ perspectives in their design process – instead of wholly and systematically with management – they would arrive at fairer, more satisfying, even more effective design outcomes. Building on these roots, participatory design has developed into a well-articulated, well-justified methodology for user participation in design processes, so that “people destined to use the system play a critical role in designing it”. While “imagined users, model users or surrogate users, stand in for those who will actually work with the technology” in dominant design practices, participatory design has a ‘central and abiding concern for direct and continuous interaction with those who are the ultimate arbiters of system adequacy; namely those who will use the technology in their everyday lives and work.” ¹⁰

Nieusma states that although participatory design began in workplace information technologies, its methodologies and motivations are now just as important in architecture and product design¹¹.

Universal design as a design philosophy looks at the issue of target marketing design, to the detriment of those who use a product or service but were not originally catered for in the design demographic. It began as an initiative at promoting inclusion in design for public spaces and had its roots in the accessibility movement ¹², but has broadened to include non-traditional definitions of marginalised groups (in design terms), such as women with children and seniors. Universal design theorists also want designers to think systematically about ‘inclusion’ and broaden their narrow notion of who users are in considering the cultural referencing of products and the built environment.
“Universal design theorists argue that inclusion applies not only to access, but also to psychosocial aspects of people’s interactions with the built world.” 13

Elizbieta Kazmierczak explores this semiotic interface14 in the article ‘Design as meaning making: from making things to the design of thinking’15. In it she proposes:

“that all designs be regarded as diagrams of mental maps of individual and collective cultures.” 16

Part of the difficulty in working with this methodology is the complexity of effectively taking into account social groups and the challenge of avoiding bland, compromise solutions. As in studies of global sustainability (e.g RMIT on-line module in Gobal Sustainability 2007), encompassing human rights and long term resource issues, it is difficult to expand our thinking of a product to the extent that we are considering it from the point of view of the universality of stakeholders throughout the world. Yet, ideally sustainable design thinking attempts this challenge. For any products made from timber, it is impossible to consider sustainable design practice without taking into account the world wide effects of deforestation. Even if locally owned forests are well managed, the overall history of forestry, both nationally and internationally will affect society attitudes to timber. This is evident in, for example, the Ecospecifier web site, (www.ecospecificier.org) which warns that timber products may not come from an approved source and should be treated with caution.

Participatory design and universal design are examples of methods that contribute to providing the capability to fulfil Papanek’s proposed integrated design approach in the search for a more ‘durable kind of design thinking entails seeing the product….as a meaningful link between man and environment.’ (17)

“We must see man, his tools, environment and ways of thinking and planning, as a nonlinear, simultaneous, integrated, comprehensive
whole. This approach is integrated design. It deals with the specialised extensions of man that make it possible for him to remain a generalist. All man’s functions – breathing, balancing, walking, perceiving, consuming, symbol-making, society-generating – are interrelated and interdependent. If we wish to relate the human environment to the psychophysical wholeness of the human being, our goal will be to replan and redesign both function and structure of all the tools, products, shelters, and settlements of man into an integrated living environment, an environment capable of growth, change, mutation, adaptation, regeneration, in response to man’s needs.”  

Up until now, the choice to adhere to any design philosophy has been that of the individual and, in my experience, rarely discussed with a client. I have only once in an interview been asked about my design philosophy. That was with a kitchen manufacturer in Liverpool, UK. I was asked how I could reconcile a concern for the environment, and in particular forestry, with working on their product. If I chose to act as a proximate designer and create product with no consideration of the implications of my design decisions on anyone other than the narrow band of my client and their target demographic for that product, I could separate the two. That approach should no longer be an option. For the first time, external directives brought about by the seriousness of the global environmental crisis we are facing are imposing an ecological design methodology. I suggest that for the future, designers’ work will be increasingly guided by legislation that will directly or indirectly affect our decision making process. This is certainly already happening in the timber industry in Australia and the project that forms the basis for this thesis is a direct result of such legislation.

References and endnotes:

2. DDR4 (Designing Design Research 4) March 20th 2004, Event Review and Reflections summarises a meeting held at the Royal College of Art in London to debate the emerging themes in design research.

3. Two examples of papers that discuss this issue are:
   Cherkasky, T 2004 *Design style: changing dominant design practice* Massachusetts Institute of Technology: Design Issues, Volume 20, Number 3 Summer p.25 and
   Tatum, J 2004 *The challenge of responsible design* Massachusetts Institute of Technology: Design Issues, Volume 20, Number 3 Summer, p.74.

4. ibid., p.25, notations, refers to the work of Langdon Winner (*The whale and the reactor: a search for limits in an age of high technology*. 1986 Chicago: The University of Chicago Press) in which Winner relates technology to the affect it has on how we live, our ‘form of life’.

5. Nieusma, D  2004 *Alternative design scholarship: working toward appropriate design* Massachusetts Institute of Technology: Design Issues, Volume 20, Number 3 Summer, p.14

6. ‘Proximate designers’ is a term coined to differentiate between professional designers and the ‘context and incentive structures largely shaped by others’ that influence design decisions.


8. ibid., p.72.


11. ibid., p.17.


13. ibid., p.15.
14. Semiotics is the study of signs and symbols.


16. ibid., p.45.


18. ibid., p.293.

19. See later sections on Forestry and Timber Industry.
1.3: Imposing a design methodology through legislation.

The Industrial revolution that began in England between 1790 and 1850 and the development of design as a profession has been well documented by many writers (e.g. Sparke, Forty, McKenzie and Braungart). The industrial designer’s role in the creation of built-in obsolescence in response to the American government’s desire to stimulate their country’s economy in the fifties has also been documented in books such as Vance Packard’s, ‘The Waste Makers’. With the devastating long term consequences of the industrial revolution on the environment through development of industry and consumerism both environmentally and in terms of global equality (with 20% of the world’s population consuming 86% of the world’s natural resources) being published in books such as ‘Limits to Growth’ and ‘Silent Spring’, Papanek, writing around that time, insisted Industrial designers take a significant share of responsibility.

“While the reasons for our poisoned air and polluted streams and lakes are fairly complex, industrial designers and industry in general are certainly co-responsible with others for this appalling state of affairs.”

“The designer-planner shares responsibility for nearly all of our products and tools and hence nearly all of our environmental mistakes. He is responsible either through bad design or by default; by having thrown away his responsible creative abilities, by ‘not getting involved’ or by ‘muddling through.’”

In the 1970s, environmentalism was ‘regarded as an activity for the radical fringe’ of design. By the 1990s, product design education was including environmental design in its curriculum, and there was growing interest from industry and government, as demonstrated by Tony Blair, the UK Prime Minister, supporting initiatives in design thinking in schools. The second edition of Dorothy Mackenzie’s book ‘Green Design, Design for the Environment’ was published in 1997, six years after the first edition and there
had been changes in attitudes between the two. In the introduction, Mackenzie says:

“As a result of dramatic scientific evidence of ozone depletion and new scientific agreement about the impending problems of global warming a new sense of urgency has arisen.”

“The contribution that design can make to improving environmental performance is increasingly being recognised. Over the last few years many companies have made considerable progress in improving the environmental performance of their manufacturing operations, but in many industries the major impact comes from their products in use, or when disposed of. Improving the environmental performance of products, is now a major focus of interest.”

However, she also points out that the “vast majority of new buildings remain largely untouched by concern such as energy efficiency or the avoidance of toxic materials”. The pace of change has been such that by 2005, only eight years later, the American Government had spent $15 million on ‘demonstrating’ the benefits of wood over concrete in the Life Cycle Assessment of building materials for environmental impact during the production of the materials, their use through the life time of the house and final disposal.


“The 1990s will long be remembered as a decade of accomplishment…..for humankind’s relocation of social mores. The re-enchantment of everything takes a distant back row seat to an
expanded awareness of the environment, the ascendance of diversity (both cultural and biological) and the recognition of the critical significance of sustainability to both organisms and living systems.”

The practical progress in manufacturing was initially impeded because of conflicting interests between capitalist economies and the idea of producing less.

“Classical economics generally had little to say about the social and environmental costs of capitalism.”

In the article ‘Altruism as Design Methodology’, Stairs describes the work of Dr David Korten, economist and author of ‘The Post-Corporate World’ and ‘When Corporations Rule the World’, as it relates to design. His call for ‘people-centred development’ to attain sustainable improvements in quality of life is aimed at designers as well as policy makers.

“A globalised economic system has an inherent bias in favour of the large, the global, the competitive, the resource extractive, and the short-term. Our challenge is to create a global system that is biased toward the small, the local, the cooperative, the resource-conserving, and the long-term.”

Korten criticises capitalism for deliberately eliminating regulations that would protect the environment and social equality for short term gain. He insists that regulations, such as heavy taxes on advertising, are required to break the competitive advantage that global businesses have.

On the face of that statement, businesses could feel justifiably concerned. How would it be possible to produce more value and maintain any kind of economic growth without producing more goods and processing more materials?
“Traditionally, new products have been introduced mainly through technological innovation, but the rapid development and merging of technologies is making it increasingly difficult to predict the future. In order to stay in business large companies such as Sony, Philips and IDEO, as well as smaller concerns, like Tangerine, ……have also been forced to recognise that technological innovation for its own sake is no longer acceptable. They recognise that products and services will have to come closer to meeting human needs and desires. Design will have to reflect the increasingly complex relationship between people and technology.”

“Until now the twentieth century’s obsession with the future has focused on images of high tech and the power of the machine. The emergence of ethical and ecological concerns now challenge this vision. In the twenty-first century it will be interesting to see how the interplay between high-tech and sustainable low-tech shapes the next generations predictions of the future.” 18

With the suggestion that sustainable equalled low-tech; environmental designers were luddites who would not support profitable enterprise, and economists were out to downsize their businesses, it is reassuring that so many companies did, in fact, respond voluntarily to the environmental design challenge, proving that sustainable design practice and competition were compatible, as proposed by the early work of Amory and Hunter Lovins in the mid-nineties, for example in their work with von Weizsacker 19.

‘Natural Capitalism, The Next Industrial Revolution’ 20 by Paul Hawkin and Amory and Hunter Lovins provided an alternative view of a growth economy based on a ‘green’ service economy. In the book, they described examples of highly successful industry initiatives that responded to the idea of companies being more environmental responsible from which the companies themselves benefited from financially. The aim of the book was to promote ‘the opportunities offered by the resource productivity revolution and the other principles of natural capitalism’ 21. Interface, in Atlanta 22 is perhaps the most
regularly quoted example of such an initiative and features in a follow up in ‘EcoLogic, Creating a Sustainable Future’ by Sandra McEwen in 2004.  Interface is the world’s largest manufacturer of modular carpets. With over 2 billion kilograms of Interface carpet in landfills with an expected degrade time of 20,000 years, the Chairman Ray Anderson moved the company from selling carpets to providing a ‘floor covering service’ by launching the ‘Evergreen Lease’. Founded in 1973, it changed its focus in 1995 in response to the “extended producer responsibility” policy based on Karl-Henrik Robert’s Natural Step principles established in 1989:

“Natural Step principles:

Developed by Karl-Henrik Robert, a Swedish Oncologist, in response to the increasing numbers of childhood leukaemia cases due to toxins in the environment. The principles guide thinking and acting in relation to the earth’s natural cycles and consider whole systems.

1. Materials mined from the Earth’s crust must not be allowed to build up on the earth’s surface or in the atmosphere faster than they can be redeposited. This includes waste from fossil fuels and other minerals.

2. Human-made materials must not be produced at a faster pace than they can be broken down and reabsorbed by natural cycles. This means that we should recycle materials in ‘old stuff’ to make the ‘new stuff’ we want. Alternatively we can make things out of materials that break down quickly.

3. We must not diminish the quality or quantity of natural ecosystems. This means only using resources from well-managed ecosystems.

4. All human needs must be met by a fair and efficient use of natural resources. This includes needs of people all over the world, and those who will inherit the Earth in the future.”

The carpet tiles are now made from ‘Solenium’ that can be completely remanufactured with no loss of embodied value and Interface monitor the tiles monthly, replacing any that are worn. In six years Interface saved $185
million in materials that it no longer wasted, reduced its water consumption by 26% and reduced by 18% its consumption of power from non-renewable resources. With no capital outlay and ongoing quality of product, the customer is happy, whilst the competitive advantage and reorganised production has dramatically increased profits for the company. Yet the initial shift in thinking, and investment in change, was radical. Ryan, in his 2004 book Digital Eco Sense: Sustainability and ICT – A New Terrain for Innovation observed:

“The idea that sustainable development will mean a major shift in current patterns of production and consumption, and in patterns of living (a shift every bit as significant as previous periods of social and economic realignment referred to as ‘industrial revolutions’), is increasingly evident in statements from governments, development agencies, industry bodies and research institutions.”  

By the time the World Summit on Sustainable Development took place in Johannesburg in 2002 the issue of ‘sustainability’ had become fundamental to political and industrial agendas throughout the world. It was recognised that an environmental crisis point had been reached that required ‘revolutionary’ thinking to respond to the time frame.

“We don’t have 100 years to figure out how to avoid ecological catastrophe…at best we have decades.”

Design (architecture and product) is now at the forefront of debate on the new industrial revolution. Innovation in design and in particular in the use of technology, is seen as vital to respond beyond merely reducing, reusing and recycling.

“Innovation is at the core of creating a sustainable human society. As a society, we will not succeed in creating a sustainable world if we focus merely on doing more efficiently what we currently do.”
In 2002 Green peace activists McDonough and Braungart reinforced the message of Natural Capitalism and took it further to completely reject the cradle to grave ‘reduce, reuse and recycle’ product lifecycle mantra of the late nineties in favour of only closed-loop industrial practice.

“Resources are extracted, shaped into products, sold, and eventually disposed of in a ‘grave’ of some kind, usually a landfill or incinerator.”  

“the product itself contains on average only 5% of the raw materials involved in the process of making and delivering it.”

McDonough and Braungart’s argument is that recycling is only delaying the eventual loss of the resource to landfill and that the materials that are being recycled are currently mostly downgraded during the process or used inappropriately, even dangerously, in product the original material was never intended for (e.g. recycled plastic used in clothing and upholstery). McDonough and Braungart propose ‘Cradle to Cradle’ thinking, where, instead of being downcycled or disposed of, materials can be circulated back into production as ‘technical nutrients’ in order to achieve genuine sustainability that will demonstrate ‘intergenerational responsibility’. The idea of closed-loop industrial cycles picks up on the lessons described in ‘Biomimicry’ by Janine Benyus. Advocating the study of natural systems in order to work with nature rather than trying to control it, Benyus’s book demonstrates how it is necessary to rethink basic assumptions on production systems in order to develop sustainable systems.

Sustainable development was defined as intergenerational responsibility by the Bruntland Commission (The World Commission on Environment and Development, 1987), as the ability to meet the needs of the current generation without compromising the potential of future generations to meet their own needs. McKenzie said that the implication was that in order for development to be truly sustainable, it must ‘take account not just of economic factors, but also environmental and social factors, and must assess long-term consequences of actions as well as short-term’. This is echoed in the
promotion of eco-effectiveness over eco-efficiency advocated by McDonough and Braungart 36.

If not all companies and designers responded voluntarily, as the carpet company Interface did, to the guidelines outlined by the Natural Step organisation, they will have to respond to the increasing legislation designed to force them into improved practices. As Korten in 1999 called for economic incentives to force change, so good design practice can be enforced through government intervention for the long term public good as individual designers have not yet demonstrated they can all be relied upon to make the seriousness of the current environmental crisis their priority, nor the desire for design for society enough of a focus to assume responsibility. When leading designers were asked to give their ‘vision for the future of design’ when designing for the twenty-first century to the Fiells37, their responses were such that even the authors themselves felt obliged to comment on the lack of consideration of the environment in the designers’ work and philosophy and said there was a need for designers to better understand their role as stakeholders in production and the environmental impact of the lifecycle of their work:

“The deliberation among the included designers on the appropriateness of individualistic versus universal solutions may well account for the relative absence of hypothesis on a unifying theory or new moral-philosophic basis for design. While many discuss the desirability of catering to the perceived need for greater individualism in design, for example, few comment on the future sustainability of such an approach, with its implications for increased waste production.”38

In 1987, the Montreal Protocol was introduced phasing out the use of ozone depleting chemicals following the discovery of a 40% decrease in the ozone layer over Antarctica 39. Although companies initially protested, alternative propellants were quickly designed. It was a good illustrative example of how legislation could kick start innovation. America had already phased out the
propellants and found that although scientists had not chosen before to tackle the issue, once they were obliged to, they found the task relatively easy.

Eco-labelling\textsuperscript{40}, such as the German Blue Angel scheme, and the Nordic Swan scheme provide consumers with the information to influence their buying choices. Meanwhile, legislation introduced since the Montreal Protocol in Europe, North America and Australia has focused attention on the lifecycle of products by ensuring accountability and therefore responsibility at each stage. A ‘polluter pays’ policy not only affects by-products, but also the end-of-life of the product. The concept of design for disassembly has been one of the responses. The BMW 3 series is easier to dismantle, repair and recycle than before\textsuperscript{41} and Herman Miller’s Aeron chair\textsuperscript{42} has been designed specifically for disassembly to ensure parts can be reused or recycled.

Life Cycle Assessment is a system of providing data on the environmental impact of all stages of the resourcing, manufacture, use and disposal of a product (or combination of products, such as a house). Work on lifecycle thinking (the term for recognising the contribution of all stages of the lifecycle of a product or system product to the overall consideration of the product, including transportation of materials, by-products, waste etc) is intensive at this time in order to provide a basis for government environmental policy.

Australian Architects have demonstrated a significant interest in lifecycle assessment. During a series of seminars given by architects of various backgrounds not necessarily sustainable design specialists, at the 2005 DesignBuild Exhibition in Sydney, the McDonough and Braungart text ‘Cradle to Cradle’ and lifecycle thinking was mentioned by almost everyone. To read, meanwhile, ‘Designing for the 21\textsuperscript{st} Century’\textsuperscript{43} and find no mention of it among the texts of the product designers featured is disappointing. Fortunately, there are many designers, who do not feature in the Fiell and Fiell Taschen publication, who are working to provide products that are in accordance with the current needs of society suggested by the increased legislation in the area. Fuad-Luke’s 2004 Eco-Design Handbook\textsuperscript{44} illustrates the success of mainstream products in a field that is no longer the domain of the radical
fringe and should be fundamental to all design work. His definition of eco-
pluralistic design methodology provides guidelines that I feel combine all the
areas of responsibility and list preferred directions, such as the design of a
service rather than product.

References and endnotes:

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   environmental design option and projects with a focus on an
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10. Puettman, M from the Consortium for Research on Renewable
    Industrial Materials (Corrim) at Oregon State University,
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    Press, Chicago.
12. Stairs, D 2005, Altruism as design methodology, *Massachusetts
    Institute of Technology: design issues, vol. 21 spring, number 2*, p. 6.
13. ibid.,


21. ibid., p.317.

22. ibid., p.139.


26. ibid., p.9.


30. ibid., p. 27
31. ibid., p.28.
32. ibid., p.185. The original call for ‘intergenerational responsibility” came from Thomas Jefferson in 1789.
35. ibid., p.10.
38. Fiell, C & Fiell, P 2005, *Designing the 21st century*, Taschen, Bonn p.19. An example of the designer’s quotes in the book include “Moving to an emotional supermarket”, Stefano Giovannoni, p.92, “My pieces are the essence of the time, of abilities and colour.”, Robert Wettstein, p.332, “We are here to create an environment of love, live with passion and make our most exciting dreams come true”, Marcel Wanders, p.326, “My role as a designer is to provoke change”, Jean-Pierre Vitrac, p.316, “I approach design in a fairly subliminal way, which is lucky because I don’t have time to think about it too much…”, Marc Newson, p.210.
41. ibid., p. 77.
42. ibid., p.81.
Chapter 2: Forestry research.

Why use a designer? Forestry has long been the domain of science based research, so why is it appropriate to bring in a researcher from a different discipline at this time? Will the methodologies based on developments in design thinking conflict with current (and proposed) research methodologies for Forestry?

Ten years ago the focus for research and development in forestry\(^1\) was on scientific forestry management, genetics, and certification, controlling and managing die-back, air pollution and biodiversity. Today, research and development reflects the global concern over the environment with research into the effects of climate change, carbon sequestration, plantations, the role of Forestry in addressing poverty, the sustainable use of wood and non-wood forest products and international forest restoration. During the 2005 International Union of Forestry Research Organisations opening address, Ariel Lugo, Director of the USDA Forest Service, International Institute of Tropical Forestry, Puerto Rico, raised the following research directions as the most important facing tropical forestry globally:

1. How to improve community forest management?
2. What is the functional role of biodiversity? How much biodiversity do we need?
3. How can we restore forests and overcome poverty?
4. How much will climate change affect the previous three?

Lugo emphasised the need to support the forest as a dynamic and resilient system with a realistic recognition of human interaction and local dependence on it\(^2\), not as a museum as was advocated in the 1990s. He said it must be allowed to evolve. In doing so, Lugo advocated increased socioeconomic policy research over the dominant biophysical research of the previous ten years. The importance of a transdisciplinary\(^3\) approach suggests a potential for the development of relationships such as those between industrial design
research and scientific research, as does a call, according to Lugo, by other stakeholders for the translation of scientific research into applied research projects.

The idea of a cross-disciplinary paradigm “in order to transcend the limitation of traditional disciplinary thinking” was raised by Hickey and Nitschke in their 2005 paper “Crossing disciplinary boundaries in forest research: An international Challenge”. There has been an increased call in the late 1990s and early 2000s for collaboration between disciplines in addressing the complex issues facing Forestry. To achieve a transdisciplinary approach, rather than an interdisciplinary approach requires re-evaluating the area of study and working across the disciplines, much as reframing the brief to encourage a situational design approach over a derivative design approach. This involves working back from the original project heading, looking at the overall context that the project lies within and allowing for the provision of solutions that may be practice rather than product based. Education leading to changes in attitude and behaviour in the interaction of the different stakeholders in supply, production, marketing, specification and consumption may result from this project as well as the potential of product. If products are produced, they will be justified within the context of these broadened study parameters.

Innes (2005), advocates a participatory approach to forestry, which suggests a similar consideration for the design methodology, to address the recognition (emphasised by Lugo) of the importance of meeting the needs of people with forestry research and the need for a wider range of skills.

“Foresters and forest scientists are poorly equipped to deal with this change, which is necessitating [the implementation of] a much broader knowledge than has been previously required.”

Traditionally scientists with specialist expertise have been valued over those scientists with a broader based knowledge. Designers, on the other hand, are expected to maintain a broad based knowledge. This difference in approach
and values was discussed by Edward de Bono as described in depth by Hepton.\textsuperscript{11}

Just as sustainable design implies a holistic and intergenerational responsibility, so does the concept of Sustainable Forest Management (SFM\textsuperscript{12}). The Canadian Sustainable Forest Management Network, established more than ten years ago, is an example of the Forestry research pushing to combine ecological, environmental and social research in a way that echoes the work of McDonough and Braungart.\textsuperscript{13} According to MacNab,\textsuperscript{14} for SFM to be successful, it cannot be restricted to forestry scientists:

> “SFM is an interdisciplinary concept. Research that is designed to provide options for moving forward SFM, or to measure progress towards SFM has to involve researchers from many disciplines.”\textsuperscript{15}

In terms of policy to support sustainable forest management, many governments have begun to implement change,\textsuperscript{16} although there are broad fronts on which they have to act.

> “Climate change, illegal logging and biodiversity are just a few issues which show the huge challenges that the state faces in guaranteeing sustainable forests.”\textsuperscript{17}

Even so, reforestation programmes and others have been effective - for example – there has been an encouraging reduction in poverty through improvements in eco-labelling.\textsuperscript{18} Scientific research in Forestry is working to provide the necessary information for the development of additional legislation, but it is a substantial task:

> “Research on the causes of tropical deforestation and the transition to sustainable forestry has not yet produced effective instruments for policy implementation.”\textsuperscript{19}
According to Peter Mayer, the Executive Secretary of the International Union of Forest Research Organisations\(^\text{20}\), during the president’s discussion on ‘research to cope with global change’ at the 2005 world congress, future research and development focus will still include the adaptation to climate change, landscape and restoration, but will fundamentally move to the consideration of the human element in forestry (particularly in terms of poverty); agro forestry, reduced impact logging and the social aspects of forestry will be high profile. The use of water will also be an issue. Mayer gave as significant drivers: scientific evidence; government legislation; and pressure from stakeholders that included global markets, public opinion and pressure groups.

Forestry marketing experts agree on the growing importance of responding to the needs of consumers. In their address to the 2005 congress, ‘Marketing of forest products in a changing world’\(^\text{21}\), Finish designers Hansen, and Joslin gave a clear outline of the direction they felt that Forest Products marketing – and by default, designing for forest products - needed to go to respond to the same global drivers of global markets, public opinion and pressure groups. Hansen and Joslin advocated an integrated model of marketing that allowed for ‘evolving into ecological orientation’\(^\text{22}\) that is particularly relevant to the task of defining the role of the designer and to whom he is responsible in the face of the current environmental crisis. Their argument was that manufacturers, wholesalers and the industrial customer all had different values regarding the environment to that of the consumer and that the producers had to learn to listen to their market. This must be taken into account when constructing a design brief.

The growing concern of consumers for the environment has certainly had an impact on retailers and forced producers to respond. Examples include Home Depot, a significant retailer in America, introducing a certified products purchasing policy, where producers were forced to ensure their products were formally certified as being from raw materials that were sustainably sourced, and other high profile campaigns such as ‘Boycott the Gap’\(^\text{23}\), “Save the Redwoods”\(^\text{24}\) and “Boise the Dinosaur”\(^\text{25}\) that were all successful in changing
the market. Through this kind of action, the global interconnectedness of specification and resourcing was shown. German publishing decisions affected Swedish wood supplies. Targeting one company at a time has been an effective strategy for environmental. Even one large corporation changing its buying policy can make a difference, for example Victoria’s Secret reviewed the production of its catalogue and now includes a high post consumer content in its paper. With over one million catalogues produced each day, the effects are significant.

The development of forestry research in the face of environmental issues relates to corresponding developments in design methodology research. Increased consideration of the human experience, a holistic approach to methodology and the need for sustainability in practice are common to both. The identification of transdisciplinary research as the way forward for Forestry research, and the need for broad based knowledge has allowed for the opportunity to propose an industrial designer as part of a team for a forestry project, or as a contributor to work on a particular area of research in forestry, as long as he works with an integrated design approach to ensure that he is not working in isolation27. There has been a shift in both disciplines towards a strong cautionary approach28 and the development of flexible solutions that allow both for change and for localised, rather than one size fits all, solutions. The addition of an industrial designer to forestry research seems, therefore, a possibility.

References and end notes:

1. Mayer, P The Executive Secretary of the International Union of Forest Research Organisations whilst addressing the 2005 World congress during the president’s discussion on research to cope with global change.

2. This was in response to the actions of many countries in locking up natural forests to prevent logging, and the resultant rise in poverty of those who formerly made a living from non-wood forest products.


6. ibid., p.322.

7. Refers to writing an open design brief from the starting point of a situation, rather than a traditional product, such as a chair.

8. Innes, J 2005 Multidisciplinarity, interdisciplinarity and training in forestry and forest research Forestry Chronicles Vol. 81, No. 3 Canadian Institute of Forestry.

9. Lugo, A 8/8/05 Conservation Challenges to Tropical Forestry. Director USDA Forest Services, International Institute of Tropical Forestry, presentation at the IUFRO Congress in Brisbane.

10. Innes, J 2005 Multidisciplinarity, interdisciplinarity and training in forestry and forest research Forestry Chronicles Vol. 81, No. 3 Canadian Institute of Forestry. p.324.

11. Hepton, B 1998 North West Arts Board. www.artscouncil.org.uk/regions/councilphp?rid=5 5.01.08

12. The Canadian Sustainable Forest Management Network.


15. ibid., p.344.

16. e.g. Strimbu, B & Hickey, G & Strimbu, V May / June 2005 Forest conditions and management under rapid legislation change in Romania Forestry Chronicles Vol. 81, No. 3 Canadian Institute of Forestry, p.350.


19. Contribution to poverty reduction through eco-labelled products with the ultimate goal of sustainable development.

20. Palo, M 2005 *A theoretical framework for transitions into sustainable forestry* METLA, Finland and CATIE, Turriabla, Costa Rica, proceeding of the IUFRO Congress.

21. IUFRO is a non-profit, non-governmental international network of forest scientists that aims to promote forestry research worldwide. The five yearly, XXII IUFRO World Congress was the most important forestry research event of 2005 with around 1000 seminars delivered during the week, and 1000 scientific posters on display.


23. A system of marketing that was consumer led, rather than manufacturing led in response to growing consumer concern over the environment.


26. Boise the Dinosaur campaign against The Boise Cascade Timber Company


27. MacNab, B *Challenges, achievements and impacts from interdisciplinary research and training: The Sustainable Forest Management Network, Separate Strands, working concurrently in isolation defined as a ‘Multidisciplinary approach’.*

28. Howard, J 2004 *Toward Participatory Ecological Design of Technological Systems* Massachusetts Institute of Technology:

   Design Issues, Vol.20, Number 3, Summer, p.47.
2.1: What about Australia?

Australia contains 4% of the world’s forests at 154,539,000 hectares and, of the ten most forested countries in the world, has the highest forest area per capita with forest covering 21% of the continent. Relative to other countries, Australia has a smaller percentage of plantations. For example, Australia has three-fifth’s the forest that the United States has, yet only 1,043,000 hectares are plantation, as opposed to the US figure of 16,238,000. In comparison, the Russian Federation has the largest area of forest at 851,392,000 hectares, but China has the largest area of plantation at 45,083,000.

Approximately 1% of Australia’s total workforce is employed in Forestry: around 91,400 people, and the contribution of Forestry to GDP is 1%. Total wood exports for 2003/2004 reached $2.06 billion and there is an estimated 10,500 million tonnes of carbon currently in the forests. Any changes in policy, any recommendations by global Forestry research, such as through IUFRO, are significant political issues here in Australia. Land clearing and logging have been actively supported by government in the past 100 years, and it has been difficult to change that mind set.

“In Western Australia it was recognised back in 1917 by scientists W.E. Wood and John Patterson in their recommendations to the Royal Commission in to the Development of the Esperance and Mallee Belt that 30 per cent of the land was at risk of becoming saline if cleared. The response from the commissioners was “We will not let scientific prejudice get in the way of opening up our Mallee lands.”

By the 1930s most states in Australia had set up soil conservation services to reduce soil erosion, and yet at the same time, the state and federal governments were actively encouraging farmers to clear land with Crown grants and leases that made it a condition that the land had to be cleared. By the 1940s, the links between land clearing, salinity and erosion were scientifically established, but still ignored because the full effects took decades to show (many farmers are dealing with it now as documented in the
Australian book, Vision Splendid\textsuperscript{10}). In the 1950s and 1960s in particular, the rate of clearing increased. The National Heritage Trust was set up in 1997 to try to conserve Australia’s environment, but the rates of land clearing actually accelerated between 1995 and 2002\textsuperscript{11}. By 2002, Queensland was clearing an average of 500,000 hectares per year for agriculture and pasture, one of the highest rates of clearing on the planet. Soil degradation, salinity and erosion have been the result\textsuperscript{12}. Only in the last ten years has the role of trees in sustainable land farming practices been recognised and formally addressed\textsuperscript{13}. Yet the previous ten years had seen Australia’s government introduce gradual reform to try to improve sustainability.

“Government actions also began to reflect changing attitudes to the environment. In 1992 the Council of Australian Governments adopted a National strategy for Ecologically Sustainable development (NSESD). It provides a framework to guide government decision making so that a co-ordinated and cooperative approach can be taken to ecologically sustainable development. The NSESD identified and incorporated five key principles of ecological sustainability:

1. Economic and environmental goals must be integrated in policies and activities.
2. Environmental assets must be properly valued.
3. Equity must be provided for within and between generations.
4. Risk and irreversibility must be dealt with cautiously.
5. The global dimension must be recognised.

During the 1990s, the state and territory governments first produced their State of the Environment reports describing actions being taken to reduce pressures on the environment. These reports indicate a growing nationwide awareness of the importance of sustainability.”\textsuperscript{14}

In the 2005 Annual Hawke Lecture at the University of South Australia, Greg Bourne, CEO of WWF suggested in his presentation that gradual change was not enough in the face of the current crisis and called for a ‘monumental shift’
in the way the economy was organised towards supporting sustainability. McEwen, in her book ‘Ecologic, creating a sustainable future’\textsuperscript{16}, describes this shift as involving a redesign of ‘almost every aspect of industry and society to reduce pollution and use fewer resources, and, most crucially, it will require a complete rethinking of what we value in life…. (providing) an unparalleled opportunity to develop new technologies and systems that will improve our quality of life’\textsuperscript{17}.

The WWF’s Living Planet Report\textsuperscript{18} provides an ‘ecological footprint’ for each country by showing how much land is required to support each resident at their current lifestyle. In order to support the Earth’s six billion people equally, there are 1.8 hectares of land to provide the natural resources for that person\textsuperscript{19}. Australians currently use 7.7 hectares. In the last forty years, humanity’s footprint has increased two and a half times, exceeding Earth’s biological capacity by 20 per cent. The Kyoto Protocol\textsuperscript{20} was one example of attempts to bring about changes, in this case in reducing ozone depletion. Australia has so far chosen not to take part because of perceived economic disadvantages. In 2005 the Prime Minister, John Howard, explained his decision:

“Until such time as the major polluters of the world – including the United States and China – are made part of the Kyoto regime, it is next to useless and indeed harmful for a country such as Australia to sign up.”\textsuperscript{21}

Meanwhile, the United Nations Environmental Programme published the ‘Millennium Ecosystem Assessment Synthesis Report’ in New York in 2005 suggested that 60\% of the ecosystem services that support life on earth were being degraded or used unsustainably. According to figures produced by the Organisation for Economic Co-operation and Development\textsuperscript{22}, the previous year Australia had the highest per capita greenhouse emissions in the developed world, and was the second highest producer of waste per head behind the USA and consumed more water per head than every other
populated continent except North America. Of the 142 countries in the OECD, Australia ranked 23:

- 128th in reducing air pollution
- 125th in conserving biodiversity
- 105th in eco-efficiency
- 134th in efforts to reduce greenhouse gas emissions

On a more positive note, just as individual companies have taken the initiative abroad and joined voluntarily schemes to address environmental concerns, so there are examples here in Australia. In line with developments overseas, the federal government established the National Packaging Covenant in 1999 to increase manufacturers’ responsibility for packaging waste. As members, the manufacturers must make efforts to reduce packaging, produce more recyclable packaging and pay a levy towards recycling systems. Just as described in the examples in ‘Natural Capitalism’ 24, companies that chose to embrace the initiative have found the experience beneficial financially as well as ethically 25. The introduction of the Green Bag to supermarkets is another example of the impact individual initiatives can have, but compulsory legislation could take that further (the Australian Government intends to phase out the use of plastic bags within five years). In 2002, the Irish government placed a surcharge of 25c on every plastic bag taken from the supermarket and demand dropped by 90% in a few months 26.

The Intergovernmental Panel on Climate Change (IPCC) report of February 2007 had a major impact on attitudes in Australia. Australia is slowly introducing life-cycle thinking, as demonstrated for example by the expanding use of life cycle software such as Accurate. To respond, the timber industry and industrial designers here, as abroad, need to understand the implications of Life-Cycle Assessment 28 (LCA), which provides data on the environmental impacts of all stages of resourcing, production, use and disposal of a product, on the specification of their products and, ideally, depending on which of the many systems being developed is used, the social costs of production. LCA provides the opportunity for comparisons between different products and, in order to satisfy the requirements of a life cycle inventory, the timber industry
needs to be able to supply supporting data for their products and address all aspects of resourcing, conversion, manufacturing, use and disposal (including recycling and final disposal) to show that in the current social climate, in response to the environmental imperative, specifying their product is a responsible act. Competition from concrete, steel, masonry and engineered products is strong. To be competitive the timber industry has to convince specifiers (architects and builders) and the general public that wood is being managed as a renewable resource, that certification is reliable (an outcome not helped by the current conflict between the two main systems of certification currently used in Australia²⁹), and that the LCA of timber products is competitive. Just as $15 million has been invested in this project in America, so investment needs to be made in Australia to avoid the timber industry being left behind. Without reliable data for a life cycle inventory, architects may increasingly avoid specifying wood³⁰.

Environmental architects such as Gabriel Poole³¹ and Tone Wheeler³² are prominent in Australia, with major corporations such as Lend Lease also taking the initiative³³ to meet, and surpass green building guidelines. Individual councils have commissioned projects to explore sustainable building, for example, Kogarah Council in Sydney creating a town centre that was self sufficient for power and water, and in 2005, Australian building initiatives include GreenSmart training and accreditation for builders (www.greenhouse.gov.au 10.10.05). Workshops on marketing sustainable design run by the Building Design Association of Australia have had over 700 members have attended. Any commercial construction work undertaken now needs to take into account LCA and take into account the social and environmental impact of the specification of timber and other construction materials.

References and end notes:

1. Australian Government Bureau of Rural Sciences, 2005 Australia’s forests at a glance Commonwealth of Australia, Canberra p.64.
2. ibid., p.10.
3. ibid., p.64.
4. ibid., p.3 / p.35.
5. ibid., p.3.
9. ibid., p.38. This practice of linking land grants to clearance persisted until the 1980s.
10. The effects are being felt by farmers throughout Australia. This was documented in the book by Ryan, S *A Vision Splendid, the greening of Australia*.
17. ibid., p.2.
18. [www.wwf.org.au](http://www.wwf.org.au) 14.06.06.
19. To calculate the ecological footprint, the earth’s 11.3 billion hectares of productive land and sea space is dived by the number of people, currently 6.1 billion.
20. The 1998 Kyoto Protocol is an agreement between 166 governments to reduce emissions of greenhouse gases to slow down global warming.


22. www.oecd.org 04.02.08.


26. ibid., p.28.

27. Ryan, C 2004 Digital Eco-sense: Sustainability and ICT – a new terrain for innovation, lab 3000 Carlton, Victoria p.34.

28. Two systems of labelling in forestry certification: FSC and PEFC.


30. Hyatt, P 2000 Local Heroes, Architects of the Sunshine Coast Craftsman House, Victoria p.60. The Queensland architect Gabriel Poole has been awarded the Royal Australian Institute of Architects’ Gold Medal for lifetime achievement. He provides architectural solutions that are ‘sustainable and eco-friendly’.

31. Tone Wheeler is the lead architect for Environ Architects in Sydney and a voluble spokesperson for sustainable design. He is a regular presenter on the ABC ‘New Inventors’, and tour guide for the Australian Architecture Association.

32. The Lend Lease Bond Building in Sydney addresses the issue of LCA in its specification of materials and design. Bamboo flooring (which is cupping already) is used and a small amount of Hoop Pine. The
project manager echoed the architects at DesignBuild as he said there were too many uncertainties in terms of LCA when specifying timber so he tended to avoid it, but if he had to then he would try to specify fast grown or plantation timber. For Australian green building practices [www.greenhouse.gov.au/buildings/practices.html](http://www.greenhouse.gov.au/buildings/practices.html) 11.02.06
2.2. Changing resource.

This study was based in Queensland, in partnership with the Department of Primary Industries and Fisheries, Horticulture and Forestry Science, Innovative Forest Products section\(^1\). It has been initiated as a result of the radical restructuring of the timber supply for sawmills in Queensland. The focus of the study is spotted gum because of the investment the state government has made in hardwood, spotted gum\(^2\) plantations.

Forestry Industry news (Australian Timberman\(^3\) May to October) in 1999 was dominated by heated debate on the Directions Report; the Queensland timber industry’s proposal for a Regional Forest Agreement released for public comment on April 20\(^{th}\). The Regional Forest Development Plan, formulated by the Queensland Timber Board in conjunction with the Forest Protection Society and the Australian Workers Union, proposed moving from the utilisation of Crown land for harvesting to the development and logging of plantation hardwoods. Biodiversity could be maintained in the forests while the plantations could cater for the 900,000 cubic metres of sawn timber consumed by sawmills in Queensland each year. In the report, the proposal to increase the development and production of value added products was cited as an opportunity in the creation of new industry jobs, and this was echoed by the Australian Timberman report on Timber Asia Pacific which stated

"Australia and New Zealand are poised to harness new export opportunities for both softwoods and hardwoods, particularly value-added products for furniture, panelling, flooring and other feature components."

Significantly, the Australian Timber and Forestry Conference was informed that just over half the value of exports through the 1990’s was in woodchips, reaching a record $646 million in 1997-1998. Sawnwood, roundwood and wood based panels and paper products accounted for the remainder. Japan was the largest importer of sawn timber, roundwood and timber products and
was the largest market for Australia and New Zealand, importing about 95% of Australia's wood exports.

On September 16th 1999, the South East Queensland Forest Agreement was signed by the State Government, the timber industry and conservationists. Cited outcomes included: increasing the native forest protected from logging by 425,000 hectares, the planting of 10 million trees in managed plantations, an end to all logging in state owned native forests by 2024 and a promised increase of 350 extra jobs.

With the exception of three timber mills, all mills using crown land would have a guaranteed supply for 25 years. In the meantime, it was expected that plantation timber would be developed in the private sector through incentives to support the major effort of planting hardwoods in the government plantations. An investment commitment of $10 million was also made to encourage the development of value-added products for hardwood including retooling and kiln drying facilities.

In 2007, there have been significant improvements in changing practices in sawmill operations in South East Queensland and Northern New South Wales. Retooling for increased recovery from logs and investment in kiln drying combined with the development of value added products has begun. By comparison $56 million has been committed to similar changes in Tasmania.

On the negative side, the expected privately developed plantation pockets have not been the success hoped for. In addition, the hardwoods planted five years ago in response to the initiative have inherent challenges to their use, as the twenty year timeframe left for the plantation timbers to be developed in order to take over from crown land logging means that the wood harvested will include higher proportions of juvenile wood for the species planted and consist of smaller diameter logs when compared to the traditional 40 – 60 year old trees that millers prefer to harvest.
2.2.1 Juvenile as opposed to mature wood.

To understand this project, it is important to summarise the changing nature of the wood resource for the sawmills as the implementation of the South East Queensland Forest Agreement comes into effect. Essentially, the main species of hardwood being grown in South East Queensland on the public plantations is *Corymbia* spp. (common name spotted gum) and the most significant issue is that the trees are to be harvested at twenty five years (when they are not considered fully mature) and the sawn timber will therefore consist of relatively high proportions of juvenile wood. This is a problem in terms of the density of the timber, the necessity of retooling for smaller diameter logs and also defects caused by growth stresses which have to be cut out, causing the production of more short lengths that are difficult to use in high value products.

“In general, the denser the species the greater the mechanical properties of its clear material. In practice the position is complicated by variable susceptibility to growth defects; in addition, young trees may often have a significant amount of wood in their central core which is much lower than the normal density of the species.”

“Until recent years most eucalypt logs used for the production of sawn, structural timber have come from mature stands whose timbers are relatively free of growth stresses. Such stands have been greatly depleted in many districts so sawmillers are now faced with the different set of problems presented by the smaller diameter regrowth logs. Though easier to fell, transport and handle physically they are likely not only to suffer from excessive end splitting but also to have a bow or spring on sawing which may be double that experienced with the mature trees in the past. Sawmilling equipment which was very suitable for the large mature logs is usually far from suitable for the satisfactory conversion of the regrowth, thus creating a dilemma for the miller. The smaller diameter is likely to lead to a lower recovery of high
quality material, probably in association with a lower production rate and a higher cost of conversion.\textsuperscript{6}

“A considerable amount of stress can be present in the tree. It can lead to end splitting of the log soon after felling, the distortion of freshly sawn timber in the form of excessive bow and spring, and sometimes the formation of a brittle central core due to excessive compressive stresses. Severe growth stresses are not common in conifers but can present a serious problem in the milling of hardwood, especially eucalypts….stresses are greatest in rapidly growing young trees.”\textsuperscript{7}

Although Bootle was referring to regrowth hardwoods in natural forests, these observations apply to plantation eucalypts as well. Sub-tropical hardwoods have always been more difficult to convert from log to sawn timber because they have traditionally varied more in diameter in comparison to, for example, \textit{Pinus elliottii}, common name slash pine and \textit{Pinus caribaea}, Caribbean pine; the dominant softwood plantations grown in the area, and may also have a large central pipe that cannot be used and must be sawn around. The position of the log has to be altered during processing to maximise recovery and allow for the separation of the wood: low grade knotted wood from clear; and sound areas from decay. In sub-tropical Australia, back sawing is favoured\textsuperscript{8} for eucalypts as it produces a higher recovery rate than quarter sawing with knots, ring shakes, gum pockets and resin pockets being able to be cut in one board rather than affecting a number\textsuperscript{9}. As the new resource is introduced, it is important that sawmills are retooled for smaller diameter timbers and explore more flexible and innovative cutting practices in order to recover the maximum possible from the log. Inevitably, recovered pieces of timber will become shorter and narrower as the log is maximised, costs will rise and the issue of value-added products become more significant.

With government subsidies following the 1999 South East Queensland Forestry Agreement, companies are retooling for small diameter logs and higher recovery rates, e.g. Wondai Saw and Planing, Grants sawmilling and Hyne, although the widespread introduction of log scanners and sawing
pattern software\textsuperscript{10} would take this further. Sawmillers are reconsidering their products to cater for small pieces, e.g., Ausgum furniture, Notarus parquetry, and flooring sawmillers, such as Hurford Hardwoods are keen to use off cuts from their standard production, but currently have to supply to standard pack sizes of 500 mm and 1000 mm (better than Japan 1000 mm, but worse than Europe). The use of CNC computerised routers to cut shapes or batch production could broaden the scope for extending the standard product range and it would be possible to create standard construction products such as window frames from joined small pieces, even with the problems of gluing some hardwoods, but for all products that build large pieces out of smaller ones, the cost will always be uncompetitive because of the additional processing expenses involved in using short lengths. Short lengths require more handling, which means increased costs, and can be impossible to run through traditional machinery.

In order to justify additional processing costs, it is necessary to create products that have added value and to create designs that exploit the characteristics of small pieces of timber in preference to using large ones as a starting resource. In doing so, it is also necessary to take into account installation costs and the level of skill required for each stage of production and fitting. However, with the relative costs of materials versus labour, the prospect is essentially unrealistic unless other drivers are taken into account that will affect the economics for the companies concerned. Based on the proposed methodology for this project, a sustainable practice approach needs to be applied in order for the design work to reflect the design needs of 2008. This requires a holistic thinking approach to the whole of the supply chain in order to achieve the desired outcome which was more value added product from the raw material available – and soon to be available – and resulted in recommendations for changes in practice and investment in technology, as well as product design.
References and end notes:

1. 80 Meiers Road, Indooroopilly, Brisbane.
6. ibid., p.74.
7. ibid., p.73.
8. In Victoria and Tasmania quarter sawing is used to minimise drying degrade.
10. The potential of Finnish sawing pattern software is considered later as part of this study.
2.3. Changing resources, changing attitudes.

At a 2007 meeting of the South East Queensland Construction and Demolition Waste Working Group\(^1\), dedicated to reducing the material sent to landfill and committed to building markets for salvaged construction materials, a vote took place to change its name to include the term resource recovery instead. This shift in emphasis reflects a major change in attitude that is happening not only in Australia but throughout the world. At a talk given by the CEO of the American Green Council, Rick Fadrizzi\(^2\), described how he had fought for ten years to capture the interest of the construction industry in LEED, (Leadership in Energy and Environmental Design). However, in 2006 there was suddenly an upsurge in interest that saw not only companies in America joining the Green Council, but whole cities.

In Australia, it took the publishing in February 2007 of the fourth report by the United Nations’ Intergovernmental Panel on Climate Change (IPCC), stating that the evidence of a human role in observed warming is now “unequivocal”\(^3\) for the Australian government to react, and the November 2007 vote for Labour will hopefully initiate practical changes in policy. With climate change a reality, legislation must be introduced to combat its effects. Developers like Lend Lease\(^4\), with its flagship eco-design building on Bond Street in Sydney demonstrated a sudden interest in sustainable materials and development practices. In 2006 / 2007 conferences and workshops on sustainable materials and on site practices dominated the agenda of the Australian construction industry.

2.3.1 Case for timber, worldwide.

At the Sustainable Building Materials conference held in February 2007 in Melbourne UN representative gave a talk about the need to use carbon neutral materials for the future of the environment. Tempered with concern for forest management, timber was recommended for the construction industry. At the Australian Timber Design Workshops in Brisbane in July 2007, a two day workshop designed to ‘cover the sustainable use of timber in
engineering, architecture and building\textsuperscript{5}, a presentation from the CRC for Greenhouse Accounting detailed the uptake and release of carbon in timber\textsuperscript{6}. It stated that contrary to previous speculation, research had found that even when timber is buried in landfill, the carbon in it remains stored. Timber was described as the only carbon neutral construction material.

The timber industry would seem to be in an ideal situation to take advantage of being a sustainable material and in fact, this does seem to be the case worldwide, with attitudes towards forestation changing. In India, for example, a million trees were recently planted as part of a reforestation initiative. In a presentation given by the American researcher from the Oregan State University, Maureen Puettman\textsuperscript{7}, certainly the American timber industry is well placed to be seen as sustainable. Fifteen million dollars have been invested by the industry in a program run by the Oregan State University to ensure that their life cycle statistics are shown along side steel and concrete. Their plantations are generations old, biodiverse, well managed. Carbon trading would seem to be the icing on the cake.

2.3.2 Australian challenges.

Carbon trading has been introduced in New Zealand and is currently being developed in Australia. Dr David Brand of New Forests Organisation\textsuperscript{8}, a company dedicated to carbon offset initiatives, says that Australia has the potential to become a major resource in terms of carbon stores and wildlife sanctuaries. An 2008 article in the Australian\textsuperscript{9} by Matthew Warren on the recent Garnaut Climate Change Review\textsuperscript{10}, which pushes for incentives for businesses to capture and store greenhouse gases, points out that there have already been investments in large scale forest plantations across Australia by companies such as QANTAS, Woodside and Origin in anticipation that forestry carbon sinks will be included in a future trading scheme. And yet there are issues….

The Australian situation is very different to the North American situation. The rapid urbanisation, then ruralisation of Australia in less than two hundred
years means that long term sustainable systems have not developed. Historical plantations that have been managed for hundreds of years such as those in America simply do not exist. The infrastructure and government controls on development and use were not in place in time to prevent abuse and even now the logging of old growth forests and the use of old growth forests for pulp mills in southern states has damaged public perception of the Australian timber industry. An additional Gunns pulp mill, proposed for northern Tasmania will be initially heavily reliant on native forest supplies, and whilst the group Timber Communities Australia claim that Tasmanian production forests save 4.7 million tonnes of emissions each year, the equivalent of the emissions from two million cars, the 2008 Tasmanian Premier, Paul Lennon, flagged potential reform of the forestry industry there in response to climate change.

Clearly there is still confusion, and so distrust. Although Australian architects demonstrate a keen interest in sustainable practice (The Caloundra Community Climate Change response group 4CRG and the Royal Australian Architects Association organised an event called ‘Sustainable Practice’ in October 2007 in the regional Sunshine Coast area in Queensland and 140 people attended) there is a marked reluctance to specify timber: at the Sustainable Materials Conference in Melbourne, the timber industry was not represented, and during discussion all the comments made from the floor in relation to wood were about the importance of not specifying timber. It is not enough for the material itself to be promoted as a renewable resource, given the history of the Australian Timber industry the handling of the material at each stage of the supply chain must be seen to be based on sustainable practice for it to be considered a sustainable choice. In order to respond to the sustainability imperative which, according to Rick Fadrizzi (2007), will increasingly drive the construction industry, the Australian timber industry will need to be able to demonstrate the following:

- Perpetual supply that does not compromise biodiversity or long term soil quality.
- Maximised use of raw material in conversion, specification and installation.
• Value added products that maximise the value of the raw material.
• Effective resource recovery, pre and post consumer.
• An integrated supply chain, with social and environmental impacts accounted for, that is the basis for a positive Life Cycle inventory.

Clearly the timber industry needs to change its thinking to embrace – and be seen to embrace – sustainable practice throughout each stage of the supply chain in order for this renewable material source to be able to claim to be, and to be able to prove itself to be, a material that can be confidently specified in the future. Without serious change, in my opinion, it will remain marginalised, and for good reason. The change in attitude that has occurred in the Construction and Demolition Resource Recovery Committee needs to occur throughout the hardwood timber industry in Australia. Every sector needs to be revisited and thought of as an integrated whole within the current context and changed parameters. This project, based as it is on the changing nature of the resource is itself due to changed legislation as a result of political pressure. As such, the project provides the opportunity to explore the application of a sustainable practice design methodology. The conclusions could then contribute to a positive response for the timber industry to the new thinking needed for timber, and in particular hardwood, to be able to be truly considered a renewable material.

References and end notes:

1. Submission to the Productivity Commission on construction waste and resource recovery.


Chapter 3: Methodology.

This study is based in a ‘real world’ project. In the introduction of his 2002 book, Real World Research\(^1\), Colin Robson describes research as enquiry. He describes real world studies as evaluations, ‘trying to provide information about how some intervention, procedure, system, or whatever, is functioning; and how it might be improved’. Whilst all enquiry aims to contribute to new knowledge, he describes real world enquiry as being characterised by seeking a potential usefulness in relation to current practice. The focus for this enquiry is the experience of industrial designers working within a changing sustainability paradigm. This is considered within the framework of a real world system (the supply chain of the Australian hardwood timber industry in South East Queensland) and a real world application (developments in thinking about sustainable practices).

Based on classifications detailed by Robson, the purpose of this particular enquiry is ‘exploratory’\(^2\).

- To find out what is happening.
- To seek new insights.
- To ask questions.
- To assess phenomena in a new light.
- To generate ideas and hypotheses for future research.
- Almost exclusively of flexible design

This thesis is presented as a study for product design educators in respect to addressing a gap in knowledge on the changing role of the designer in the face of changes in attitude, and innovations in production, needed to initiate sustainable practice. Within this context it provides an industrial designer’s response to the issues and specific problems raised by the project ‘designing value added products from small and / or narrow pieces of timber’ for the hardwood timber industry in south east Queensland, Australia. In doing so, it also addresses a research gap on maximising the use of hardwood in value added products. The research is located primarily in the construction and
manufacturing industries in south east Queensland and northern New South Wales but also in the development of design practice in response to the global sustainability imperative that has become a significant driver for the project. It provides practical direction, recommendations and examples for both industry and education.

Research question: How will the response to a design brief addressing a need in the south east Queensland hardwood timber industry change with a paradigm shift for industrial designers in relation to sustainable practices?

The research strategies used were based on the overall exploratory classification of the project. The project was divided into four phases. The first was an initial finding out phase, where an overview was built up of the context of the project. This was followed by initial research to inform the scope of the enquiry. This was followed by directed research, both in terms of the supply chain practice, and the design work (as practitioner-researcher) and finally through the testing of ideas and understandings through case studies on design and practice. The specific research methods used were:

- **Direct observation of current practice throughout the supply chain.**
  During the exploratory phase this observation was in an unstructured form, to find out the mechanics of the operations before framing specifics which would then have to be further explored. Information from direct observation can be used to verify stated practice by interview participants and highlight discrepancies. Robson suggests it is a particularly appropriate technique for real world situations. As much of the observation was of workers on the shop floor (who were often not told of the purpose of visits) of different organisations involved in the supply chain, but interviews with representatives were often with management, it is unlikely that the behaviours on the shop floor were altered by observation.

- **Interviewing representatives from throughout the supply chain:** King (1994) suggests qualitative research interviews are suitable where individual historical accounts are required to learn how a particular system developed. This is appropriate because of the different
perspectives of the participants in the supply chain, which can lead to personal impressions being given, rather than just facts. Semi-structured and unstructured interviews were used, where a general area of interest is raised by the interviewer but the conversation will develop depending on the experiences of the participant. This was considered suitable as the interviewer could not have the extensive expertise in every area of the supply chain practice that would be needed in order to frame fully structured interviews.

- Participant observation by addressing the design aspects of the project and involvement in workshop practice to experience directly the practicalities of using the off cuts.
- Accretion measures (waste as indicator) by tracking processing and production.
- Content analysis of artefacts produced by craftsmen and manufacturers whose method of construction, or social commentary (such as in the work of the One Tree artists) could be used to inform the research.
- Document analysis: literature review and a review of trade publications to provide a wider context for the work and identify the boundaries of current knowledge on the specifics of the subject.
- Case studies: A case study focuses on the study of a specific case. For this study, examples relating to specification and design illustrate the issues in real world situations with qualitative and quantitative data being collected to provide sufficient detail.

These strategies translated into:

- An understanding of the resource from the growing and harvesting (forest) stage, through the conversion and production of solid wood and engineered product, including end of life.
- Research for product design directions (see project books).
- Contact with stakeholders from each stage of the timber supply chain through visits and attending conferences and seminars relevant to the issue, the building of an overview, as well as finding out individual concerns from representative industry stakeholders.
• Workshop practice: working with small and narrow pieces of spotted gum off cuts to understand the difficulties of working with the material and of reprocessing.
• Maintaining a watching brief on global responses to the issue.
• The study of a specific example of how specification for a commercial interior can affect the utilisation of the raw material, and the study of a particular example for the issues in relation to design for manufacturing.
• The start of research into recent technological advances in Australia that could be utilised for this issue, and relevant technology abroad that could be imported.
• The beginnings of a direction for an Australian hardwood industry response to accountability with regards to off cuts.

This study uses mixed qualitative methods research in that more than one approach is used to provide a holistic perspective (as discussed by Patton, in his work ‘Qualitative evaluation and research methods’). This involves tracking the supply chain from forestry, through conversion and production to use and end of life. An ethnographic view gained through information gathering on the sub-cultures of the timber industry based on discussions with representative stakeholders, attendance at industry meetings, observation and relevant reading of current and past theory, is developed in consideration of the hardwood timber industry in south east Queensland. This gives an overview that forms the basis for inquiry through personal contact and insight during workshop and project book research through design. Two case studies were chosen as paradigmatic case studies because of features specifically relevant to the issues being considered. This information-oriented sampling for the case studies is justified because cases which are not average, but bias towards the issues in question tend to reveal more information than average cases do. A new sustainability paradigm is suggested for the industry and conclusions are developed based on the application for this paradigm.
The initial title for this project was ‘Value added products from small and or narrow pieces of timber’. It was based in South East Queensland, and the project was set by the Department of Horticulture and Forestry Science, Innovative Forest Products section. Product for the construction industry, in particular flooring, was suggested as a starting point for consideration. Spotted gum (*Corymbia* spp.) was the main timber of interest.

As discussed in earlier chapters, my approach to the project was influenced by my background as a designer for mass production, and the expectations of the broader design society at this time, resulting in an eco-pluralistic rationale. In practical terms this has meant applying a sustainable practice paradigm to the client’s original brief. I began by finding out as much about the context of the issue as possible, rather than focussing on the narrow confines of the original question itself. Therefore, rather than just looking at final products that could possibly be made from short lengths of wood, the starting point for the project was to understand the project drivers and parameters. For this project, that meant looking at the supply chain for timber as a whole and trying to understand what had prompted the project in the first place and what have been the obstacles that meant that a solution had not naturally been developed by the stakeholders themselves - then framing an informed research question. A representative from The Arts Council for England\(^5\), Barry Hepton, described the difference between a scientist’s approach and a designer’s approach in a talk to design teachers in 1998 in UK, as part of the Supporting Innovation in Schools Project (SISP)\(^6\). Hepton said that scientists started with a very narrow research base and worked outwards, whilst designers started with as broad a research base as possible and consequently work in. For this project, the design based approach involved mapping out the supply chain, identifying stakeholders and production practices, then using an ethnographic research methodology to understand production and supply chain issues before identifying an intended outcome or outcomes in order to ensure that the brief was appropriate.

When the project was originally defined there were two main organisations involved. The first was the Queensland Forestry Research Institute
(renamed the Innovative Forest Products section of the Department of Primary Industries and Fisheries) and second was a flooring company that was one of the original industry stakeholders in the Co-operative Research Centre for Wood Innovations. The flooring company withdrew from the CRC before the project began, but their concerns were still included in the initial briefing. Another flooring company was chosen later on in the project as a case study to identify and address those concerns.

As part of the initial briefing, I was shown the batch of timber below. I was told that the marks and apparent damage to the timber were natural faults that would need to be cut out, or ‘docked’.

Timber samples at Salisbury facility (figure 3.1 /3.2 photos by Loy 2004)
The timber lengths were marked for docking (above), then the faults cut out and the pieces left were measured. Many were shorter than a metre. I was told that lengths of timber that were under 1 metre were generally not used in products for the construction industry. As a result there would be a great many short lengths of good quality hardwood left over that would not be used in production and wasted.

QFRI was a government testing laboratory, not a manufacturing business, so it was necessary to understand why this issue was important to the organization.
The answer was linked to changes in supply brought about by changes in government forestry policy. As discussed in earlier chapters, by 2024 the hardwood supply in South East Queensland is going to be different, and it is likely that those differences will result in more faults and more short lengths to the extent that it will significantly affect the supply to manufacturers, particularly with an expected overall reduction in supply. In addition, a use for very young trees that are thinned out whilst developing and maintaining a forest was identified as a need in order to supplement the income of private forest owners whilst waiting for their best trees to mature ready for harvesting. I was told that timber produced from these ‘thinnings’ would be predominantly in short lengths.

References and end notes:

2. ibid. p.59
4. [http://writing.colostate.edu/guides/research/observe/pop3b.cfm](http://writing.colostate.edu/guides/research/observe/pop3b.cfm). 15.07.07
6. Supporting Innovation in Schools Project, Liverpool John Moores University, Design and Technology Initial Teacher Education Department.
3.1 Initial research.

I began the project by researching background information on the development and general practices of the Australian hardwood industry in order to understand what the current paradigm was, and then went out to visit government and private plantations to gain a greater understanding of the naturally occurring faults in the wood, then to sawmills and manufacturers to learn about conversion (cutting up the original log) and production processes as well as the different production cultures in the supply chain. My initial observations were that it would seem that the Queensland timber industry has developed through an era of assumed abundance of natural resources, and practices have been based on that assumption. 34% of Australia’s natural forest is in Queensland, but Government plantations have now been developed in Queensland so that by 2004, the 216,500 hectares\(^1\) of pine plantation provided around 76% of the softwood log timber input for primary processing at sawmills. The hardwood plantation industry is still in its infancy in Queensland. Unlike other countries, such as America, private forests have rarely been fostered over generations to supplement farming\(^2\).

Land clearing for agriculture, a widespread practice which has caused problems with soil salinity, acidity and erosion, has also resulted in a lack of private forestry, which the government is trying to rectify with subsidies (until the 1980s state and federal governments linked Crown grants and leases to enforced land clearing, now grants are provided to plant trees on private land)\(^3\).

Through site visits to all sections of the supply chain, research including attendance of relevant conferences and workshops and background reading, I drew up a table illustrating the old paradigm and a suggested new paradigm based on sustainable practice strategies. The method used for my initial research was to review each section of the supply chain within the new paradigm.
Examples of contact with representative stakeholders, with repeated site visits, include:

<table>
<thead>
<tr>
<th>Eco Hardwoods sawmill</th>
<th>Queensland Manufacturing Institute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyne Timber</td>
<td>IUFRO Congress</td>
</tr>
<tr>
<td>Ausgum Furniture</td>
<td>Design Ex/Form and Function</td>
</tr>
<tr>
<td>Owen Thompson (agro forester)</td>
<td>Future Furniture Forums, Cooroy</td>
</tr>
<tr>
<td>Gympie Timber Company</td>
<td>Design Build Exhibitions and seminars</td>
</tr>
<tr>
<td>Kennedy's Classic Aged Timbers</td>
<td>Sustainable Materials Conference</td>
</tr>
<tr>
<td>David Kirby sawmill</td>
<td>Australian Timber Design Workshops</td>
</tr>
<tr>
<td>Hurford Hardwoods</td>
<td>Timber Queensland technical update</td>
</tr>
<tr>
<td>Lend Lease Millennium Arts Project</td>
<td>seminars</td>
</tr>
<tr>
<td>Ashley Sewell (forestry consultant)</td>
<td>Pine Manufacturers conference</td>
</tr>
<tr>
<td>Yandina Forests</td>
<td>World Environment Day Eco projects</td>
</tr>
<tr>
<td>Rivergum Timbers</td>
<td>Stack laminating workshop (Scobie)</td>
</tr>
<tr>
<td>David Linton sawmill / manufacturing</td>
<td>Laminating and veneering (Coles)</td>
</tr>
<tr>
<td>Ross Annels (steam bending)</td>
<td>Dr Patrick Moore seminar</td>
</tr>
<tr>
<td>Rix Turning (segmented work)</td>
<td>Construction and Demolition Waste</td>
</tr>
<tr>
<td>Bucca Workshops</td>
<td>Resource Recovery group</td>
</tr>
<tr>
<td>Sustainable Practice Workshops, run by Dr W. Schmidt, Ford Europe</td>
<td>Certificate in Global Sustainability RMIT</td>
</tr>
<tr>
<td>Northern Lifestyle Flooring</td>
<td>Designer Saturday, Brisbane</td>
</tr>
<tr>
<td>Outdoor Structures Australia</td>
<td>Devine Homes Clean Site demo.</td>
</tr>
<tr>
<td>Street and Garden Furniture Co</td>
<td>Concentric / Envizage</td>
</tr>
<tr>
<td>Maroochydore recycling centre</td>
<td>Advanced High Speed Machinery</td>
</tr>
<tr>
<td>Tone Wheeler (architect)</td>
<td>Caloundra Community Climate Change response group seminars (including Caroline Pidcock and Dr David Baggs)</td>
</tr>
<tr>
<td>Design Centre, Launceston</td>
<td></td>
</tr>
<tr>
<td>Ecohouse by Philip Boorman</td>
<td></td>
</tr>
<tr>
<td>Old paradigm</td>
<td>New paradigm</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>based on abundant, relatively cheap supply</td>
<td>based on limited supply, valuing raw material.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Forestry</th>
<th>Key tree felling, plantation sources (preferably agro forestry). Trees strength tested in the ground and after logged to maximise potential of each tree. Thinnings utilised</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crown owned and private hardwood resources, subsidised softwood plantation timber, thinnings not utilised</td>
<td>Small diameter log processing Scanners to maximise recovery Multiple, small baled cutters to maximise recovery</td>
</tr>
<tr>
<td>Conversion</td>
<td>Conversion of large, straight logs only.</td>
</tr>
<tr>
<td>Large cutters, conversion of large, straight logs only.</td>
<td>Value added products Value adding processes Niche products (CNC) Off cuts re-use as pre-consumer waste</td>
</tr>
<tr>
<td>Processing</td>
<td>Value added products</td>
</tr>
<tr>
<td>Cut lengths Docked defects Off cuts burnt</td>
<td>Value added products Value adding processes Niche products (CNC) Off cuts re-use as pre-consumer waste</td>
</tr>
<tr>
<td>Specification and installation</td>
<td>Feature grade (plus new, lower grades such as reject) Pre-prepared product to length to reduce waste during installation</td>
</tr>
<tr>
<td>Select grade Over engineered On site installation</td>
<td>Feature grade (plus new, lower grades such as reject) Pre-prepared product to length to reduce waste during installation</td>
</tr>
<tr>
<td>End of life</td>
<td>Resource recovery</td>
</tr>
<tr>
<td>Landfill Burning</td>
<td>Resource recovery</td>
</tr>
<tr>
<td>Operations</td>
<td>Value chain based operations. Communication between stakeholders Co-operation and clustering for the use of investment technology</td>
</tr>
<tr>
<td>Supply chain, over the wall manufacturing system, little communication</td>
<td>Value chain based operations. Communication between stakeholders Co-operation and clustering for the use of investment technology</td>
</tr>
</tbody>
</table>
Based on this initial information gathering and consideration of the drivers and parameters involved, I suggested the title for the project should change from ‘value added products from small and or narrow pieces of timber’ to:

‘To increase the proportion of wood used for value added applications by addressing the issue of using small and or narrow pieces of timber.’

I found this to be the basis for the project, and the main concern of the stakeholder. It would be of much greater economic value to everyone concerned if more of the wood could be used in the applications they already had rather than trying to use the left over pieces once they were cut, although for where off cuts are unavoidable, it is still part of the project.

References and end notes:

1. Department of Primary Industries and Fisheries 2004 *The Queensland forest industry* DPI&F Publications.
2. There are exceptions in small private forests, for example Owen Thompson’s cattle and timber agro forest property west of Gympie.
3.2: Applying sustainable design practice methodology.

The starting title for this project which was set by the client was titled ‘Value added product from small and or narrow pieces of timber’. A value added product, as defined for this project, is a constructed product rather than a plain cut length of timber. Selling timber as a constructed product is intended to improve margins for the producer. As a proximate designer, a basic starting approach would be to consider all products constructed of small pieces of material. In fact, finding mass produced products made from short lengths of timber is very easy - Joinery and furniture finished product are predominately made up of short lengths and narrow pieces and kitchen cupboards, wall cladding, door jambs are logical examples. Fencing, landscape edging and lattices are lower value products, but produced in quantity. Why would this need to be set as a project? What is missing from the brief? And if it is important to apply an eco-pluralistic approach to the work, what does that mean in practical terms?

3.2.1 Directed Research: Workshop practice

In order to understand more fully the project set from a designer’s perspective, the issues were explored through workshop practice.

_Demonstrating the issues when designing with, and then using in construction, small pieces of timber, by designing and constructing an exhibition piece using off cuts recovered from a production situation._

What defines a short length? For this project, it was specified as a length of timber that currently is not long enough to fit into the current product range in a standard manufacturing facility in Australia. This would not be in terms of the final product but in relation to the production capabilities of the company. There is a myriad of current products in construction, furniture and crafts that have short pieces included in their final design. Linings, claddings, joinery, framing, the majority of furniture designs and many craft products such as turnings and sculpture include short lengths of less than 1m (see project book one for examples of current products that include lengths of less than 1 metre). So why are the off cuts produced by docking, even those as long as 0.9m, not currently being utilised in production?

After discussing the issue with those on the production floor and studying production flow and machinery commonly used (see later chapter on supporting technology), I designed a demonstration piece of furniture to make in order to experience the reality of using short lengths myself.

I chose docked offcuts of spotted gum flooring that were around the smallest normally produced in significant quantities during construction product manufacturing. Spotted gum is a dense, strong timber that has not been traditionally used for fine furniture design, partly because the extractives, such as resin, in the timber have resisted adhesives in the past, a fact exacerbated
by relatively high shrinkage rates of 0.32% radial, and 0.38% tangential\textsuperscript{1} compared to other timbers.

![Example of docked spotted gum (figure 3.7 photo by Loy 2005)](image)

Although new adhesives are more effective, it was decided to use mechanical fixings for this project. The pieces measured approximately 120mm x 100mm x 20mm. The pieces had been docked for a variety of reasons: end splits, severe checks, splits, loose knots, gum pockets and loose gum veins.

Author’s self defined brief to experience the reality of the practicalities of using the offcuts in a demonstration piece:

- Use as much of each of the off cut pieces as possible.
- Design to exploit the size of the pieces used.

In order to fit in with the philosophy of maximising the resource, a demonstration piece was designed that used as much of each of the off cut pieces as possible. For this study, the design used pieces that had a finished measurement of 120mm x 110mm x 17mm.
Cleaned up spotted gum off cut, squared off, routered, sanded and drilled (figure 3.8 photo by Loy 2005)

To best exploit the size of the pieces used, I decided to design a piece with complex curves, since then, even if the piece were made from long lengths, the timber would still have to be cut into small blocks. Also, I wanted to demonstrate the idea that, unlike when working with long lengths, the size of the finished piece was not limited by the fixed size of the available lengths, but could be made taller or shorter (or even fatter or thinner) as required because it was built from a theoretically infinite number of small pieces. For this reason, and in order to fit in with sustainable design concept of creating flexible, interactive products (see section on improving sustainable practice) that can be changed as the consumers requirements change, the dowels were not glued, so that the finished product could be theoretically taken apart and reformed. The design could also be re-constructed as an infinitely curving screen for use in an interior architectural application.

The timber to be used was rescued from the rubbish bins behind a flooring manufacturer, and was destined for landfill (see later, Hurford Hardwoods, case study on design). It was first sorted into usable timber and timber that would need to be used in an application where the pieces were even smaller as there were significant faults in the timber. The design developed spread the stress on the individual pieces of timber in order to be able to utilise as much as possible, even if there was a degree of damage or natural imperfection in the piece. Out of the sample collected from the bins, approximately 50% was found to be suitable for the project.
The design was based on a double spiral with spaces between the pieces to emphasise the curved sections. The pieces were be doweled together to allow the curves to be formed.
The first task was to square off the pieces and cut them to a uniform size as they were not necessarily square and the sizes varied. Using a constructed jig, four drill holes were made in each of the hundred pieces of timber.

Two of the sides were then routered to a strong curved shape, and the other sides were chamfered.

The finished pieces were individually sanded as they had to be sanded on all sides including the curved edges. These tasks were very labour intensive and
took four days to complete. The pieces were dowelled together and, for this particular application of the design idea, shelving was made from narrow off cuts glued together.

Constructing the spiral (figure 3.14 photo by Loy 2005)

Small finishing knobs were turned for the open drill holes on the ends of each line of three pieces rather than the holes simply not being drilled so that the pieces all remained interchangeable.

Turned stops for spiral display unit (figure 3.15 photo by Loy 2005)
The finished demonstration piece was exhibited at the International Union of Forestry Research Congress in the Brisbane exhibition centre in 2005 for feedback from the timber industry research community.
Spiral display unit at IUFRO (figure 3.17 photo by Loy 2005)
From first hand experience of using off cuts for this work, the reasons for not using those off cuts in a production situation were very clear. The reprocessing costs due to the intensive labour involved in the work would be seriously prohibitive compared to the current costs of using long lengths to begin with. Long lengths could be edge jointed, dressed (thinned), squared, drilled, routered and given an initial sanding before being cut at all. This is not only far easier for an individual to do in a workshop situation, but currently essential in a mechanised manufacturing environment where machinery such as thicknessers, edge jointers, routers and drum sanders are built to take long pieces, and are generally unsafe to feed with short lengths.

Drum sander at Bucca workshops (figure 3.18 photo by Loy 2005)

For some machines, such as a cross cut saw, cutting from a long length is much safer than trying to effectively clamp and cut small lengths. From a cost point of view, I would estimate that I could build the same piece in two and a half days as opposed to five days if using long lengths to begin with. It would also reduce the skills and safety requirements necessary for very small pieces. If the piece was being made for batch production, costs could be partially reduced by the construction of jigs for some of the operations. This point is picked up in a later chapter on the design of production related products.
As a design, the spiral unit demonstrates that the wood itself is perfectly
viable to use. However, the exercise demonstrated very clearly the difficulties
associated with using short lengths that were not highlighted by the client in
the original brief. Whilst the wood itself is certainly usable, lengths of shorter
than a metre have two main disadvantages. The first is that many machines
for operations, such as tongue and groove, are set up for long lengths with
short lengths often not able to be held in place properly in traditional set ups,
the second is that using short lengths increases the labour costs, and based
on the current relative costs of material versus labour, it is more cost effective
to reduce labour wherever possible.

In order for the project to succeed, there have to be effective enough drivers
to overcome the problems illustrated by the spiral unit example. Based on the
arguments put forward at the beginning of this thesis, for a designer in 2008 it
is essential that the design outcomes are built on an ethnographic
understanding of the set brief and, as an example of sustainable design
practice, may result in changing practice as much as designed products.
These products, too, may not be limited to the original set of the brief, but
rather develop out of a thorough understanding of the situation that initiated
the brief, and negotiated outcomes based on situational design. In essence,
the design of these products, whilst for the benefit of the clients, is regarded
as being not limited to the concern of the immediate clients (the QFRI and a
flooring manufacturer in this case) but rather considered within the context of
the overall supply chain, with consideration of what impact any decisions
involved with the production, use and disposal of that product would have on
the broader community.

The first step, therefore, for this project, had been to shift the emphasis to a
broader consideration of the circumstances that inspired the brief. What is it
the client is trying to achieve? What would be the benefit of this project to the
wider community? In the case of the flooring manufacturer, it is not
specifically to create designs from small pieces of timber, but to reduce the
amount of timber discarded as waste after value added products have been
manufactured. For the DPI & F it was driven by concern over the quantity of
small pieces that are likely to be produced by the changed wood resource. With different drivers for the project, it was important to gather as much information as was practical about each stage of the supply chain and their integration in order that it may be understood as a whole and inform the design process.

Reference:

1 Kingston, RST & Risdon, CJE 1961 *Shrinkage and density of Australian and other south-west Pacific woods* CSIRO Division of Forest Products, Technological paper no.13. Melbourne.
Chapter 4: Growing wood - what a designer needs to know in order to specify timber within the new paradigm.

When I worked as a furniture designer for large manufacturers in the UK, I had never seen a plantation. I specified wood as if it were a board product. It was never suggested to me that the width of a table top or cupboard should relate in any way to the widths boards were supplied in. If I wanted a wide top, then the boards would be joined together to create it. Wasted timber was apparently not an issue during the eighties and nineties. Applying a sustainable practice rationale to the specification of timber, it is necessary to understand what creates the sizes of timber available, and what particular characteristics in the wood mean. But even more than that, the technical information supplied about a particular timber – density, strength, colour, grain, durability, shrinkage – suggests that each wood is a uniform material, rather than a natural material with endless variations depending on where the tree was grown, what the weather was like, what the soil is like, what other plants are nearby and what happens to it during its lifetime. From the way that timber products such as flooring are advertised for sale, and the approach to specification apparent in architectural projects, such as the Millennium Project discussed later, it is that assumption of uniformity and the efforts of producers to satisfy that customer expectation that cause much of the waste. The cloning of the fast growing softwood Radiata Pine contributes to that perception.

Spotted gum private forest, Gympie (figure 4.1 photo by Loy 2005)
Corymbia citriodora, Corymbia maculata and Corymbia henryi are botanical names for variations of the tree commonly known as spotted gum\textsuperscript{1} that the QFRI has a particular interest in. It is the highest volume hardwood harvested in Queensland, growing naturally in South East Queensland, even on difficult terrain. In addition to the vast reserves of natural stands, now subject to logging restrictions, plantations have been established and it is among the principal species for farm forestry, or small private forests, in south-east Queensland. The trees grow to around 30 metres tall and have a distinctive smooth bark that can be white or greyish-pink depending on the time of year.

Tree stems grow from the activity of a single layer of cells, called the cambium, just under the surface of the bark. When conditions are good, the cells in the layer divide, producing new bark cells (phloem) for the outside or new sapwood cells (xylem), on the inside. Sapwood conducts fluid throughout the living components of the tree, through pipe like cells, called vessels. As the tree grows, the inner cells become physiologically inert forming heartwood, providing strength for the tree to grow taller, but releasing minerals for the living sapwood. In spotted gum there is a more gradual transition zone between sapwood and heartwood than in most species\textsuperscript{2}. 

Stacked logs at a sawmill in Obi Obi (figure 4.2 photo by Loy 2005)
Usually there is a stronger contrast between the pale yellow of the sapwood, and the darker heartwood, or truewood. The inner core may suffer from high levels of compression stress, particularly when the tree is in its initial stages of growth. This can create a brittle inner core. It is liable to shatter on impact and fracture cleanly, rather than splintering\(^3\). This inner core needs to be either cut out during conversion at the sawmill, or it can be specified if it is fully enclosed inside a large section (called boxed heart). This way, large sized beams can be specified. The sapwood is susceptible to outside attack more than the dense, inner wood so the more sapwood; the more vulnerable a tree will be likely to be. In spotted gum the sapwood is susceptible to the lyctid borer and it is illegal for sapwood of the timber to be sold untreated in Queensland.

As trees are living things, so they can adjust their growth pattern according to need. When a forest grows naturally, there will usually be a mix of different species. Each plant competes for light and will grow towards it; however twisted its trunk may have to become to do so. If there is little competition, a tree will tend not to grow as tall, as well as not straight, spreading out with bigger branches instead. One of the problems with logging old growth forests, and why they are favoured for wood chip or pulp despite the quality of the wood, is that the trunks can be difficult shapes to cut, with the wood showing evidence of events during the trees life, such as lightning damage. Until recently, only the biggest, straightest trees were economic to convert into timber, and sawmills were built to convert the large diameter trunks. This is now changing as investment, such as that made by the government in the Tasmanian timber industry, allows for retooling for small diameter logs.

If the conditions for a tree vary dramatically from year to year, that will affect the growth of the tree. In temperate species, those conditions can be read from the resultant growth rings of the tree which show how much the tree has grown. If the conditions for that year were good, the growth rings will be further apart, if something affects the quality of the soil, the rings will be closer together. Also the tree reacts to the conditions it finds itself in, and that affects the width and shape of growth rings and the constitution of the wood.
For example, if the tree grew on a slope the trunk might be oval with distorted growth rings. The tree basically tries to compensate for the conditions by growing more vigorously on one side. The wood produced at this time is called ‘reaction’ wood. In hardwoods, on the side of the tree where there has been extra growth the resulting wood is under tension, and has a high longitudinal shrinkage which makes it vulnerable to splitting and distorting. In softwoods, compression wood is produced which is very dense and has a high lignin content, but is not strong.

Variations in seasonal conditions and external events can also affect the growth patterns of the wood. Drought will result in not much growth and so very narrow rings, fire damage will gradually be grown over by the tree, but the damaged wood will still be there, just encased, insect or fungal attack on roots and leaves will also slow down the tree’s ability to grow.
Basically, a tree that has even, roughly circular, growth rings of moderate width has suffered less stress than one with uneven, distorted rings. Currently those trees are both graded the same.

If the tree grows straight, the cones of cell growth will run up through the trunk in straight lines. The grain of the tree is then also going to be straight, as it is determined by the positioning of the cells as they grow. If, however, the tree spirals or is distorted in some way, then the growth of the rings will be affected, and so the grain direction is no longer straight, but follows the line of the cell growth cones. Grain spiralling about the vertical axis can cause the timber to split post harvest (after felling).

Trees have an astonishing ability to grow over any damage, such as fire, but also will grow over objects, for example nails, embedded in the trunk. Most of the ‘faults’ in that first rack of timber I was shown at the QFRI were caused by the trees growing over the scars where their branches have been pruned away as they have grown, in order to produce clear wood. If there is still tissue connectivity between the trimmed branch and the main stem, then as the joint between the branch and stem is grown over, the inclusion in the main stem will be in the form of a ‘live’ knot. That is, the branch stump will still be connected to the main stem on a cellular level. This knot will stay in place when the tree is cut and will not greatly affect the strength of the timber. However, if the branch has died, then there will be no tissue connectivity and the resultant inclusion will produce a dead knot. This is not connected to the stem at a cellular level and will fall out when cut. Healthy pruning cuts branches very close to the base so that a minimum of disruption to the line of the growth rings occurs, and there is less mass in the knot.

With spotted gum, splits or cavities (caused by insect attack, mechanical damage or fire) in the wood will fill with gum, or Kino, as a protective response, which gives it a distinctive look when cut. Sometimes cavities fill with mineral accumulations that are much harder than the wood and which can damage saw blades. Gum veins are much thinner lines of gum that thread through the wood. Gum veins that are interrupted by woody tissue do
not affect the final mechanical properties of the timber, but some gum veins that are uninterrupted by woody tissue can open during the seasoning, or drying process, and are called loose, rather than tight veins.

In plantations, such as the government managed hoop pine plantation near Gympie pictured below, seedlings can be uniformly planted in order to try and control their growth pattern and facilitate management and harvesting logistics. Timber that has had a medium growth rate, rather than particularly fast or slow, is likely to have better qualities⁴.

Government Hoop Pine Plantation, Imbil (figure 4.4 photo by Loy 2006)

Even in farm forestry, the farmer tries to control the growth of the tree to maximise its potential on harvesting. For example, pioneer species may be planted, such as happened on the farm forest land shown below, that shoot up fast to about 8 metres, forcing the seedlings to grow as quickly as they can in order to get more light, and therefore as straight as they can. When the plantation trees are established, the pioneer species are cleared away, and
any lower branches on the tree removed to keep the tree focussed on growing up rather than out.
A fully mature spotted gum tree would be at least forty years old. When the plantation is around eight years old, the straightest, healthiest trees are selected and the others are taken out. This process is called ‘thinning’. The thinnings removed are currently not harvested. The process is repeated at around twelve years to ensure that the best crop for the producer is fostered.

The thinnings have a predominance of sapwood, that make them difficult to use, and their small diameter means that conventional sawing produces very small boards. However, there are alternative options to do with small log processing that are discussed later.

On large, hoop pine plantations the select trees are clear felled at the end of the sixty year crop rotation, that is an entire area is harvested at the same time. In hardwood plantations and private farm forestry the trees are cut down selectively according to their best use.

Trees are measured by their diameter at chest height (figure 4.8 photo by Loy 2005)
All species in Australia are graded according to their expected strength and response to stress.

For spotted gum the grading is:

<table>
<thead>
<tr>
<th>Strength groups:  S2 unseasoned, SD2 seasoned.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stress grades</td>
</tr>
<tr>
<td>F11, F14, F17, F22 (unseasoned), F17, F22, F27, F34 (seasoned), when graded in accordance with AS2082 Visually stress-graded hardwood for structural purposes.</td>
</tr>
</tbody>
</table>

### 4.1 Reducing the material intensity of goods and services

In reducing the amount of timber used in timber products, it is important to look at the characteristics of the wood itself and how it is specified. The same species of tree will grow differently in different situations. Even in the same forest, trees on stony soil will grow differently to those in poorly drained valleys. Specification based on species must assume the weakest tree possible, grown in the worst conditions. Current grading necessarily generalises about the possible uses for each species in order to give safe standards to work to. This can result in over engineered product because the individual log actually used is not the weakest. If a standing tree could be assessed by non-destructive evaluation technologies, for example using an acoustic stress wave for stiffness the forester could base a decision on appropriate harvesting time on the best potential application for the stem, allowing trees to continue growing until they achieve their maximum value. Once then cut, strength testing of the individual log would provide valuable data to enable that log to be used to its full potential. In practical terms, this means that, as an example, the thickness of timber specified for a public
bench could be reduced because the strength of that actual piece of timber would be known.

Although in plantations the conditions in which neighbouring trees are grown are fairly consistent, there are still going to be differences in strength and characteristics of trees from one plantation to another as the growth of the trees is affected by their environment. For farm foresters there can be significant differences between the strength of different trees. Grading is done on a ‘worse case scenario’, so that the weakest tree grown in the worst area for forestry will meet the strength group the species has been given. However, applying the new paradigm, valuing the raw material and with the benefit of new technology, it should be possible to strength test the trees whilst they are still standing in order to maximise the resource and grow them to the perfect size for a specific task. Whether intended for power poles or furniture, depending on the specific characteristics of the tree, it could be harvested at the perfect time and graded individually. Ryan\textsuperscript{5} lists reducing material as one of the strategies for sustainable practice and individual testing of the trees whilst in the stands would reduce the need for over engineering.

References and end notes:

3. ibid p.27.
4.2: Tracking the stages of processing and production in which short and/or narrow lengths occur.

Waste wood includes bark and the slices cut off the log that will not produce pieces that are of the uniform, required shape for further processing. This green waste material may be used in landscaping applications. Off cuts produced during processing may be sold to be used as fuel, but due to often high transport costs to appropriate facilities and lack of current demand, is generally considered waste for landfill. Site visits were arranged to every stage of the supply chain, from plantations and farm forestry, through small sawmills, large scale production sawmills, manufacturers, on site installation, landfill and resource recovery. Material currently normally considered waste wood was identified as being potentially produced at the following stages:

4.2.1 Wood waste point 1: Growing

At this stage raw material is wasted because of trees being thinned out at eight and twelve years to improve the quality of those left standing, and the small diameter logs not being harvested or used. Currently in South east Queensland, only large diameter, straight trunk trees can be easily converted into timber. There is also technically waste attributed to this stage in that wood is not necessarily grown to its potential as it is not strength tested whilst in the ground.

4.2.2 Wood waste point 2: Harvesting

End splits on harvested log, Obi Obi (figure 4.9 photo by Loy 2005)
When the trees are cut, the release of tension in the trunk can cause end splits that can make the log vulnerable to external attack, such as by insects or fungi. Also, if the tree falls heavily the wood can fracture with ‘shakes’, reducing the amount of recoverable wood in the log.

The damaged ends have to be cut off and discarded as waste or used for low grade applications such as wood chips for landscaping or pulp for paper and cardboard. Currently there is no facility for creating pulp product in Queensland. The tops of the trees are docked at the point at which it becomes impractical to convert them because they are of too small a diameter. By leaving the crowns to break down into the soil, regeneration is encouraged.

4.2.3 Wood waste point 3: Initial conversion.

The idea of converting wood into timber is to take the large round log and cut it into more usable square and rectangular sections. Single blade and twin large circular saw blades that cut both outside edges of the log at the same time have been traditionally used on large diameter logs in South East Queensland, whilst smaller blades, including multiple blades and band saws can be used for more complex cuts.

The basic method is to cut a slice off the log, roll the log and use the flat edge and holding blades to stabilise it, then run it through the cutting blade, or
blades, to make a series of parallel cuts, simply slicing the log. This is called ‘through and through’ sawing or ‘live’ sawing. It creates boards that are partly ‘back sawn’, and partly ‘quarter sawn’. Although this has the advantage of simplicity and speed for large scale production, it does not take into account grain direction or any other variations, such as knotty areas, in the log. It is particularly unsuitable for hardwoods as they tend to vary more in log diameter than, for example, cloned plantation radiata pine and may have a large central pipe that needs to be cut around.

Back sawing (also called back or tangential cutting) is where the log is turned four times whilst it is being cut to create boards that are tangential to the growth rings. This is the most common method used in the sawmills in South East Queensland as it is still fairly fast and simple to do, and results in a higher recovery rate of wood than quarter sawn timber and generally wider boards. A back sawn board can be identified by the pattern of growth rings which curve away from its face. A back sawn board shows growth rings that meet the face of the board at an angle of less than 45 degrees. Knots on a
back sawn board will be round, and other faults, such as gum pockets, particularly an issue for spotted gum, will often only affect one board.

Quarter sawing (also called quarter or radial cutting – different to using a radial saw): in quarter sawn timber the log is cut in a simplified radial pattern, with the growth rings cut across so that they show at an angle of not less than 80 degrees to the face. The intention is to provide as many boards as possible cut in a radial pattern into the log, so that the growth rings are in line with each board.

The main advantage with quarter sawn boards is that there is that movement in service is minimised (shrinkage and swelling). Wood is hygroscopic, and even after being laid as flooring, for example, will still swell and shrink according to the humidity in the room. Cutting the timber quarter sawn means that direction of expansion is on the edge rather than the face, so is less of an issue. Equally, quarter sawn boards, having that grain pattern, are less prone to warping, checking or cupping. This is also the case during seasoning (drying).

Even with straight logs, the recovery rate for sawn timber in South East Queensland by these methods is currently around 30 – 50%\(^2\), depending on the quality of the log and which milling technique is used; dependent on what product is required from the wood (see later for improvements on recovery rates). There is also a method of sawing called radial sawing, where the log is held in a jig and turned so that the log is sliced up like an orange. Theoretically there is very little waste in this operation, with the inventor claiming up to 70% recovery rates\(^3\). However, the resultant timber is wedge shaped and tapered, which has limited applications and needs to be resawn into planks to produce traditional boards, thus reducing actual recovery.
If the log being processed is distorted, or not fed into the blades straight, or is significantly tapered, the boards can be cut with a diagonal grain which can adversely affect the mechanical and visual properties of the boards. Growth stresses, released when the log is cut can also cause problems that reduce the recovery rate for the wood.

Smaller sawmills, such as portable mills that are moved from site to site, rather than fixed at a particular mill, are becoming more frequent as the demand for a diminishing resource of high quality hardwood rises. These small mills have more flexibility in their operation to deal with smaller diameter timber.
4.2.4 Wood waste point 4: Drying, or seasoning the timber.

One area that the industry would greatly benefit from would be improvements in drying processes that are currently used to reduce the moisture content of the wood to pre-shrink it before putting the timber into service. To speed up the drying time and control the behaviour of the timber would make the process far more efficient – probably benefiting life cycle inventory in terms of the embodied energy necessary for the process – and reduce costs. Radio frequency, microwave and vacuum drying technologies have been the focus of recent seasoning research and development activities in Australia and overseas.

When trees are cut down, the moisture content in the wood varies from 30% to 200% depending on species. There are some applications where green wood is used, such as for some wood turning techniques that rely on the wood drying slowly after being turned to create unusual distortions in the design. Steam bending is also a technique that requires ‘wet’ or ‘green’
timber as its starting material. However, for most applications, it is necessary to dry out the water in the wood's cell cavities, and some of the water in the cell walls to produce a stable board. The final moisture content in dried wood is between 7% and 15%, depending on location around Australia, because of the different humidity levels in different places. In Queensland the acceptable levels are between 10% and 15%, as legislated by the Timber Utilisation and Marketing Act 1987, however, if the final piece is to be used in an air conditioned environment, it may need to be as low as 8% when it is installed or it will shrink after time in use. Wood waste occurs at this stage if the timber is dried too quickly or unevenly. Drying degrade is seen in a range of forms, such as distortion, surface checking, end splits and cupping.

There are two ways to dry timber. The first is to leave it stacked in the open air. The boards are separated by spacers or fillets to allow air to circulate around the wood and temperature and humidity will affect the rate of drying and the occurrence of related defects. One of the main causes of problems during drying is uneven stacking of the timber slats and spacers. It takes between six and twenty four months to air dry sawn timber. The thicker the boards, the slower the rate of drying will be. It is roughly a year to every 25mm of board, depending on the species (Sewell p.179). Kiln drying is much faster but also more expensive as energy is required to heat kilns. The boards are stacked with spacers as before, but inside a kiln for a few days or a few weeks, depending on the thickness of the wood and the density and initial moisture content of the species. The kiln shown below is a small scale solar kiln, typical of a remote, small scale operation. Some production kilns are the size of hangers. These are more commonly gas powered, or powered by sawdust from the processing operation.

Solar kiln, Mooloolah (figure 4.15 photo by Loy 2006)
The storage of timber affects the quality once it is then processed. If there is no alternative market for wood that is not required for a particular application, it can then become waste. The timber featured below was waste produced by a niche sawmill supplying musical instrument makers with very specific characteristics in the wood that make it suitable for the purpose. The wood is cut into blocks known as ‘flitches’ that can then be sliced into veneers. Much of the log is unsuitable and becomes waste.

Waste timber, Mooloolah (figure 4.16 photo by Loy 2006)

4.2.5 Wood waste point 5: Docking

Australian standards for timber grade the wood according to its ability to perform to structural requirements as well as by its visual features, depending on the end use. Timber is the term used to refer to the wood once it has been processed into a commercial product.

Commercial timber must achieve the appropriate levels of strength, stiffness, straightness, stability and appearance for its grade. Generally, the denser the species, the more likely it is that it will be stronger. Spotted gum has a ‘green’
density (before it has been dried) of 1150 kg/m$^3$, and a dried density of 1010 kg/m$^3$.

Within the tree itself the density may vary, with wood from the base, or butt, of the tree being denser and stronger. Wood from nearer the living outer edge of the tree will also tend to be stronger than from nearer the inner, more brittle, heart.

Changes in grain direction, as discussed in earlier chapters, can cause weaknesses in the timber. One of the challenges with grading is that if the wood is judged on the mechanical properties exhibited during tests on clear (defect free, straight grain) samples, but which does not cover its behaviour if there is distorted grain, or faults such as knots present. Knots are the main problem with regards to the strength of the timber, and so samples have to be tested that include knots. ‘Dead’ knots may fall out altogether, reducing the strength of the sample and even ‘live’ knots will cause changes in grain direction that could weaken the wood. Because of this, clusters of knots affecting grain direction can cause considerable problems. Interlocked, wavy and curly grain has very small changes in grain direction and does not affect the overall mechanical properties of the timber in large boards$^5$.

Other common defects are checks, splits and shakes. A check is a split in the wood fibres in the direction of the grain that is only on one surface of the cut section. It is called a split if it extends through the board. Splits are most common at the end of boards. Shakes are fibre separation caused by stress on the original tree. Stress can be caused by strong winds putting pressure on the trunk, or by growth stresses, some shakes can also be caused by the actual felling of the tree, as it hits the ground with force. Decay severely affects the strength, and particularly the impact resistance of wood.

Different species are given a strength group rating determined by the properties of that species, such as density. For seasoned spotted gum that rating is SD2, which is high. Within the species, individual pieces of timber are then visually graded to determine the expectations the consumer can
have of the properties of that piece in terms of its stress grade or F rating. For timber that is to be used as a structural product, there are three methods of sorting the timber from a particular species into groups with similar properties. These are:

- **Visual stress grading (AS 2082 2007: Timber – hardwood – visually stress graded for structural purposes).** This is done by eye by trained graders.

- **Machine stress grading (AS/NZS 1748: 2005 Timber – stress graded-product requirements for mechanically stress graded timber).** This is where a machine is used to measure the stiffness of the material by bending each piece about its minor axis to test its ‘modulus of elasticity’, (MoE) (see photograph below DPI & F, Salisbury (figure 4.17 photo by Loy 2005).

- **As the timber passes through the machine, it is loaded and the amount it deflects is measured in relation to the load. The timber is not damaged during this test, but although it measures stiffness and there is a correlation between stiffness and strength, it does not actually measure strength.**

- **Proof grading (AS 3519: 2005 Timber – machine proof grading).** This machine is used to prove that a particular piece of timber is suitable for the load required of it. The timber is visually graded first, and then
placed under the same load it will be subject to once in use. The advantage of this is that it provides the engineer with confidence in the beam or board. The disadvantage is that if the timber is not strong enough, it will break and be wasted.

Since it is not practical to test each piece of timber mechanically in the same way that samples have been tested to determine the original grades (as that would require putting each piece through destructive tests, such as under force, until it breaks), these forms of grading are infrequently used, visual grading is the most common form of grading practiced in hardwood sawmills in Australia. The graders look for features on each piece that might affect its strength and stiffness. For each grade, there are limitations on the size and frequency of different characteristics. There are four basic structural grades, 1 – 4. These four are determined by an allowance on the quantity of characteristics and their effect on the strength and stiffness of a piece of timber of a particular species compared to that same timber if it was a clear sample of the same species, that is with no visual inconsistencies at all. The allowance for the highest grade (grade 1) is intended to correspond to the piece being judged 75% as strong as a clear sample. Grade 2 is then determined as 60%, grade 3 is 47.5% and grade 4 is 38%.

The final rating for a piece is then defined by the initial strength group of the species, in conjunction with the structural grade determined by that piece’s individual characteristics. For seasoned spotted gum, this would result in a rating called F34 for the highest quality, F27 for grade 2, F22 for grade 3 and F17 for the lowest grade normally used. Timber that is used for appearance products, such as fine furniture, flooring and joinery can then also be visually graded for the presence of particular characteristics or features such as figure, a particular grain pattern that might be considered visually attractive, that might affect the value of the timber. Visual grading is done very fast to keep up with production, and the timber is traditionally hand marked by eye for docking allowing a generous space on either side of the defect to ensure it is cut out properly.
In addition to strength and stiffness, any distortion on the piece caused by warping is taken into account in the grading, and may result in the timber being rejected. Warping does not reduce the strength or stiffness of the piece, but it does reduce its commercial usefulness. Warping is where the cut length of wood is distorted in some way. This is caused by growth stresses whilst the tree is growing, or as a reaction to the seasoning (drying) process, usually caused by uneven stacking. There are four distinct types of warping:

- Bowing, where the timber curves lengthways.
- Spring, where the timber curves sideways.
- Cupping, where the timber curves upwards at the edges.
- Twisting, where the board twists along its length.

This stage is a major source of wood waste and the production of short or narrow pieces that are rejected in current production methods, and a focus for the project. Reject timber at the docking stage is usually discarded (see later for initiatives), either burnt or sent to landfill. From site visits, this was found to be as much as 10% of the timber that had already been profiled (this is discussed further in the case study on design, featuring Hurford Hardwoods). This is a significant issue as the waste material has all the inherent cost of getting it to that stage attached to it for the manufacturer.

4.2.6 Wood waste point 6: Cut to size for product and packaging.
For reasons of commercial standardisation different products are supplied in specific sizes. For example, unseasoned sawn hardwood to be used for boards is usually cut to thicknesses of 16, 25, 38, 50, and 75mm. It will be cut to widths of 38, 50, 75, 100, 125, 150, 175, 200, 225, and 250mm. Seasoned framing, cut to its final sizes, is usually a thickness of 35 and 45mm with widths of 70, 90, 120, 140, 170, 190 and 240mm.

Once the timber is dressed (cut to finished size and given any profile that may be needed, such as tongue and groove for flooring), it is then sorted into racks on spacers for packaging and transportation. Additional docking of good quality, defect free timber may occur at this stage in order to fit the timber lengths into the packing sizes required (often defined by transportation arrangements). It was found that in some cases, the available length of plastic wrapping provided the criteria for the cut lengths.

4.2.7 Wood waste point 7: Specification and installation

Bootle recommends that in order to choose the most appropriate timber for a project, specification must involve:
• Species or durability information.
• Width (depth) \times \text{thickness (breadth).}
• Stress grade.
• Moisture content specified as a percentage range.
• Preservation treatment.

4.2.7.1 Waste association with poor specification of species.
There is a potential for wood to be wasted because of the inappropriate specification of species for a particular project. A thorough knowledge of tree species that includes information on its durability, its availability, its visual characteristics, its shrinkage rates, what defects it might be prone to and so on, is the basis for life long study and is a specialised skill. Timber Queensland and the Department of Primary Industries and Fisheries (DPI & F) provide information on the specification of timber through publications, such as 'Construction Timbers in Queensland'. If an architect, for example, who deals with a myriad of materials and responsibilities for each project, specifies the actual species they require without sufficient consultation with appropriate experts from within the supply chain and from organisations such as Timber Queensland and the DPI & F, there can be wasted wood if the information they are working from is not absolutely up to date and complete, resulting in the timber being inappropriate in some way (this is discussed in the case study on specifying timber). From a sustainability point of view, specifying timber that needs to be transported from some distance to the project is also inappropriate, making the specification of local timbers important.

4.2.7.2 Waste association with poor specification timber sizes.
If timber is specified at sizes that are different to the standard sizes, unless the order goes directly to a sawmill rather than a manufacturer (as occasionally happens if a single company owns and runs both), then the previously cut widths and lengths of timber will be cut again. During installation waste can occur if timber has been supplied in standard lengths and needs to be cut to fit, particularly with flooring. Skill, and the need for speed are the two main factors in the amount of waste created at this stage.
as the longer lengths are quicker to fit with the cost of timber versus the cost of labour being a factor again.

If the timber is supplied in standard lengths, rather than cut to fit at the sawmill, large amounts of waste can occur. For example, the photographs below are of a public space decking project in Canberra where the spotted gum timber was supplied in standard lengths. In cutting the timber to shape, to fit the design of the layout, approximately a third of the quality spotted gum timber was wasted, with lengths of over a metre as off cuts. In addition to the waste of material, there was an additional cost for the removal and disposal of the off cuts.

Spotted gum decking project, Canberra, timber cut to size on site
(figure 4.20 photo by Hopewell, 2006)

Off cuts from Canberra decking project below (figure 4.21 photos by Hopewell 2006)

4.2.7.3 Waste through grading choice.
When a species is initially strength graded, each example of that timber must meet the grading specified for safety reasons. For this reason, the grading is biased towards ensuring that even the poorest example of that wood will function under whatever stresses it is intended for. This results in over engineered product as the timber supplied is almost always going to surpass the grading it has been given. Therefore the additional timber used is technically wasted.

Another way of creating more short lengths and severely wasting timber – as much as fifty percent of the timber can be wasted this way (see later example) – is by specifying that the timber supplied must be as clear from defects as possible, even though its application does not require a high strength grading. This is typically done for aesthetic reasons. For example, if a featured timber is specified so as to have no features showing (select grade) for overlay flooring (thin flooring laid on plywood rather than over joists so not requiring the same strength or stiffness), then surface marks are docked out unnecessarily and the timber, along with its embodied energy in harvesting and processing it, is wasted.

The list below is an example of an industry timber grading system where the value decreases as the imperfections increase:

Select grade: 95% of the timber must be clear, with only 5% gum feature.
Standard grade: 80 – 85% of the timber must be clear, with 15 – 20% gum feature.
Feature grade: 70% of the timber must be clear, with 30% gum feature.
High feature: 50% of the timber must be clear, 50% gum feature.
Fall down (this is defined by the fact that is the trunk was recovered after the tree had fallen over, rather than was felled).
High gum (this is where the timber has excessive amounts of gum, making it too difficult to process).
Reject grade (this is timber that does not pass any of the other grades, but may still be sold to hobbyists).

4.2.8 Waste point 9: Disposal of timber.
As the Canberra decking example above illustrates, short off cuts of wood that are considered waste are not always that short. Off cuts vary in size and as they are produced as a one off for a particular project, there is rarely anyone interested in using them. The timber then has to be removed and disposed of, generating transport and labour costs. In this kind of case, the likely destination is landfill, which incurs another cost and is a waste of the resource. Equally, factory off cuts that are burnt (particularly those not used for bio energy but burnt simply to be disposed of) or sent to landfill are not only a waste of the raw material, but a waste of the embodied energy and costs involved in getting them to that stage of the production supply chain.

As well as pre consumer waste, such as in these examples, there is post consumer waste where at the end of its useful life, a timber product is sent to landfill or burnt. As part of this project, I contributed to the Howard government review on waste, attended meetings on the recovery of resources from waste, and visited landfill and resource recovery centres. Although not the focus of this project, the recommendations on changing practice in the supply chain are relevant to resource recovery.

In resource recovery centres, such as this one associated with Kennedy’s Aged Timbers in south east Queensland, recovered wood can consist of solid
wood, wood based panels and wood composites. It may be contaminated with other materials, such as metal (particularly nails) and plastic, but more frequently with substances such as glue, varnish and wood preservative.

In Europe there are four grades of recovered wood:

A1: Solid, uncontaminated waste wood.
A2: Wood contaminated with glue, plastic or varnish, but not PVC.
A3: Wood contaminated with glue, plastic, varnish, PVC and preservatives.
A4: Wood contaminated with glue, plastic, varnish, PVC, preservatives and PCB.

A1 and A2 recovered wood can be used as the raw material for particle board and medium density fibre board (MDF).

The main challenge of using recovered wood is in preparing it for re-use. To prepare recovered wood for particle board production, the material must first be chipped, and then screened for metal using a metal detector, washed, flaked and rechecked for contaminants. The recovery rate from this process is approximately 75 – 90 %.

The quality of the finished particle board is moderate, compared to using pre-consumer timber as the raw material, because recovered wood is dryer and so tends to crumble during flaking and chipping.

Currently most recovered wood comes from buildings, with furniture and packaging providing the next most significant sources. In Europe, 3.5 million tonnes per year\textsuperscript{11} are used for energy production, whilst 2.0 million tonnes per year are used for wood based panels. This compares favourably with the 1 million tonnes going to landfill, and 1 million tonnes being burned to dispose of it. Both natural decomposition and burning are a problem if the wood is heavily contaminated.

In 1999, Dunedin City Council in New Zealand committed to the ‘National Zero Waste Pilot Project’, organised by the Zero Waste NZ trust\textsuperscript{12}. The
objective was to achieve zero waste to landfill by 2015. However, after six years it was found to be too difficult. With regards the timber component, there were two main reasons. The first was that it was too difficult to tell if the timber had been treated, so a cautious approach was taken, meaning more than necessary went to landfill. Secondly, the problem was finding a use for recovered wood. Timber pallets and shredding for landscaping were the main uses and supply outstripped demand.

‘Builders routinely find there is a 10% waste factor of materials in every house built’ Jo Knight, Chief Executive of Zero Waste NZ Trust.

In Australia the research group Ensis, working for the Forest and Wood Products Research and Development Corporation, reported that most secondary wood waste (that is post-manufacture) comes from construction and demolition waste. The amount of wood waste generated in Australia annually is approximately 1.8 million tonnes. New South Wales currently recycles approximately 30%, and Victoria only 25%. This suggests around 435,000 tonnes is recycled, and 1.3 million tonnes is disposed of in landfill annually, which compared to the European figures are poor.

One of the authors of the Ensis report, Dr Joely Taylor, states that the major challenges in establishing commercial markets for recovered wood products are developing a feasible quick scan method for treated wood, the cost of transport, and the variability in supply.

“The steel industry looks at the whole recycling issue as a positive. For them it is easier to separate and process and make recovery an economic part of what they do. The timber industry needs to be doing something similar.”

“This whole issue (waste minimisation) is on the agenda of state regulators and I think the timber industry has to work hard now to produce positive solutions before they are forced into it.”
In Europe, regulations compel manufacturers to establish acceptable end of life solutions for their building material products. In the UK, a 'carbon budget' is calculated on new buildings and architects have to provide information on the disposal of all the materials they plan on using. Because of this legislation, the UK is developing advanced recycling networks and organisations, such as the Waste and Resources Action Programme (WRAP), promoting resource efficiency. This must be applied to influence the thinking of Australia. The focus of WRAP is to create viable markets for products made from recovered materials. It has set up RecycleWood, which is a web based service linking waste wood producers with customers.

In the Netherlands and Denmark there are strict zero waste policies in place for the demolition of buildings. Currently about 95% of demolition waste is recovered in these countries, with the final 5% attracting large penalties for disposal. Nikau Contractors in Auckland salvages 80 – 95% of materials if it is brought in before demolition begins, but says it is a slower process than normal demolition.

References and end notes:

3. ibid p.176.
4. ibid p.49.
6. ibid p.43.


11. Hopewell, G (Ed) 2006 Construction timbers in Queensland: properties and specifications for satisfactory performance of construction timbers in Queensland, class 1 and class 10 buildings (books 1 & 2). Department of Primary Industries and Fisheries, Queensland.


16. Taylor, J 2006 ‘What a waste’ in INWOOD issue 64, p 6

17. Ibid p.6.

Chapter 5: Directed research.

Why use small pieces of timber at all? With only a few exceptions, the majority of the sawmillers and manufacturers I met in 2005/2006\(^1\) were initially disinterested in addressing the issue because of the problems and costs associated with reprocessing. Since many of the companies in business were established while old growth timber was readily available and with access to subsidised softwood plantation timber grown by the government\(^2\), for these companies waste during processing was not considered important, with the exception being with regards the cost of disposal of off cuts for those who did not run wood fired kilns on site. However, with the access to and nature of the resource changing in 2024, plus the need to promote private forests by offsetting the cost of thinning and providing short term income whilst the trees fully mature, added to a growing concern over the environmental impact of resource use, there are four compelling reasons that this project is important to the timber industry:

- the future resource will include a higher proportion of small pieces of timber and small diameter logs.
- there will be a financial loss from under-utilising the whole timber resource as timber supplies become more restricted.
- there is a cost in the removal and disposal of off cuts and thinnings.
- there will be an impact in the future on the timber industry from legislation demanding increased accountability for product lifecycle.

Of these four reasons, the final one is the one which I consider to be the most compelling and the one most likely to provide an economic driver for the implementation of the outcomes for this work. In the last half of 2006 and since 2007 in particular, there has been a dramatic increase in interest in establishing systems ensuring accountability for product lifecycle\(^3\). There have also been changes in legislation in Europe that make manufacturers responsible for their product once it has reached the end of its useful life\(^4\) which could become global and would have an impact not only on the end of
life issues for the timber industry, but the disposal of off cuts during processing. Meanwhile life cycle assessment (LCA)\(^5\) is a method of accounting for responsibilities such as material and energy usage and subsequent environmental impacts that result during a product’s life cycle (cradle to grave) that is becoming significant in the construction industry worldwide\(^6\).

According to Hendrickson, Lave and Matthews, life cycle assessment is a process that “studies the environmental aspects and potential impacts throughout a product’s life (i.e. cradle-to-grave) from raw material acquisition through production, use and disposal”\(^7\). There are three stages to it: inventory, impact and improvement\(^8\). It is a complex task as it takes into account everything up and down stream of the product, so it encompasses suppliers and consumer behaviour, and includes components such as transportation, the embodied energy involved in building the factory and even the social impact on those who might be affected when the raw materials are mined or harvested\(^9\). To make informed decisions and improvements it is necessary to know the implications of choices at each stage of the supply chain and life cycle assessment software has been developed – and is still being refined and tested – to aid in the decision making process for all stakeholders. In particular, there are software tools for LCA that are gaining significance in Australia. Different tools are designed for different projects. For example, the National Australian Built Environment Rating System NABERS\(^10\), is aimed specifically at rating existing buildings. Green Star\(^11\), Building Research Establishment Environmental Assessment Method BREEAM\(^12\), Sustainable Building Tool SBTool\(^13\) and the Danish Building Research Institute’s LCADesign\(^14\), are developing, but, as observed on the Australian Government’s website\(^15\) advising on the tools, there is still a lack of widely accepted methodology for conducting LCA and collating information to inform it. Even without this, it is necessary for the timber industry to invest in LCA research because it is assuming an importance to specifiers who are increasingly taking LCA into account\(^16\). For this reason it could act as a driver for the application of ideas from this project as part of the response of the
timber industry in providing information on aspects of life cycle with regards to best use of resources and the reduction of waste at each stage of production:

“As procurement policies focus increasingly on environmental impact, industry needs to ensure they are based on the best information available.” 17 Maureen Puettman, Life Cycle Assessment of Wood Seminar, Nov 2005.

Part of preparation for an LCA is the production of a life cycle inventory which provides the information to be fed into the LCA software. This is a controversial area because of the confidentiality issues implicit in supplying information and the objectivity of the sources. The final assessments are often controversial too as there is an inherent subjectivity in the process because the LCA tools include determination of relative weightings for significantly different things – for example, the importance of the impact of a particular process on water quality versus its impact on air quality. Although theoretically a carbon neutral renewable material such as timber should therefore score well in an LCA, the current level of waste in the production of timber products will disadvantage the timber industry in comparison to other materials, such as steel and aluminium. The outcomes of this project will be aimed at contributing to a positive approach to product lifecycle for the industry.

5.1 Methods for directed research.

- An understanding of the resource from the growing and harvesting (forest) stage, through the conversion and production of solid wood and engineered product, including end of life.
- Research for product design directions (see project books).
- Contact with stakeholders from each stage of the timber supply chain through visits and attending conferences and seminars relevant to the issue (see DPI &F industry contact reports), building of an overview, as well as finding out individual concerns from representative industry stakeholders.
• Workshop practice: working with small and narrow pieces of spotted gum off cuts to understand the difficulties of working with the material and of reprocessing.
• Maintaining a watching brief on global responses to the issue.
• The start of research into recent technological advances in Australia that could be utilised for this issue, and relevant technology abroad that could be imported.
• The beginnings of a direction for an Australian hardwood industry response to accountability with regards to off cuts.

References and end notes;

1. Exceptions are companies that have demonstrated initiative in this area, including Ausgum Kennedy’s Aged Timber and Eco Hardwood.
2. The cost of forestry has traditionally been subsidised to enable the Queensland timber industry to be competitive with imports.
4. Schmidt, W is the Sustainability Manager of Ford Automobiles in Europe.
9. 10 week on-line course in Global Sustainable Practice RMIT.
11. Green Building Council of Australia www.gbcaus.org 04.01.08 for a study of the different rating systems by the GBC
www.construction-innovation.info/images/pdfs/Aitken_and_Beck_Presentation.pdf
12. Building Research Establishment Environmental Assessment Method was developed by the Building Research Establishment based in the UK University, Herriot-Watt.
13. SB Tool is a Canadian tool developed in 1996. It was previously known as the GBTool. It was developed by the International Initiative for Sustainable Built Environment (IISBE).
14. LCA Design tool was developed by the Danish Building research Institute (SBI).
5.2: Adding value.

For large timber producers, such as the softwood company, Hyne Timber\(^1\), competing with low price imports for the cut length market means that competing effectively for exports is difficult. There is also a growing threat from value added product from the Baltic States\(^2\).

Stacked softwood cut to length, Hyne Timber Imbil (figure 5.1 photo by Loy 2006)

The issue of creating new value added products, therefore, is not restricted to using short lengths. However if short lengths are to be used for some processing techniques, the initial costs involved in cutting the pieces to length individually, rather than starting with long pieces that can be cut more efficiently, becomes proportionately lower in the overall cost of the piece, as the additional, value adding process itself is labour intensive or expensive to do, such as with laser cutting\(^3\). This is especially true if the final margins can be increased sufficiently because of the added value inherent in the product
Steam bending⁴ and laminating⁵ are two techniques that add value to timber. The same considerations apply as discussed earlier about reprocessing off cuts ready for use, but as there is much more handwork and skill involved, those considerations assume less importance. Steam bending in particular is of interest and was considered to be worth exploring for this project as the raw material has to have a high moisture content, around 30%, which makes it a good process for using thinnings as these younger trees naturally have a high moisture content.
5.2.1 Bending wood.

There are relatively few good books on steam bending, and I look forward with anticipation to the work being produced by Ross Annels⁶ as part of his PhD with the CRC for Wood Innovation in Melbourne, on designing for steam bending. Ross was taught steam bending by a leading furniture maker from the UK who specializes in steam bent work, David Colwell. Colwell’s work demonstrates the potential of steam bending for creating value added product. Originally part of the Hooke Park project in the UK, that used forest thinnings to build shelters⁷, Colwell started Trannon Furniture⁸, making batch produced steam bent timber designs for the commercial market.

Annels is a practising furniture designer who produces laminated and steam bent high end furniture. Studying Annels’ process reinforced the importance of hands-on skills in this work.

In order to understand the process more thoroughly, I worked with Annels at his workshop on the Sunshine Coast in Queensland to make a series of test pieces. The timbers I chose to use in the study were silver quandong⁹ (*Elaeocarpus grandis*), as it has a reputation of bending well, and is another favoured plantation species for the sub tropics and for comparison, spotted gum. I bought the quandong as thinnings from a local sawmiller, David Linton¹⁰, who is based in the hinterland of the Sunshine Coast in Queensland. I also visited the site where the thinnings were harvested by local forestry expert, Ashley Sewell (author of Australian Timbers Volume One, *Timber Species of Subtropical Australia¹¹*) and discussed with Ashley the thinnings
issue. He felt this was a very valuable area of research for both design and forestry practice, since in order to encourage more private plantations (like the various ones he took me to see) there needs to be a way of offsetting the cost of thinning the stands of trees.

For my test pieces I was interested in seeing how far I could bend the timber, and also how complex I could make the bends. My first task was to build jigs for each bend I was interested in. For steam bending, as in laminating, the majority of labour costs involved are in building jigs to accommodate the bends required for the design, and also building drying jigs in which the bent wood must be stored whilst it dries out, often over a few weeks.

Building a 360° bending jig, Cooroy (figure 5.5 photo by Loy 2005)

The most extreme jig we built for the study was circular and approximately 1 metre in diameter. The jig has to be built strongly as the pressure from the wood would otherwise break it.
I built a series of other jigs of different radii, to see how far the wood would bend, and also a series of jigs with double and triple bends in them to see what would happen.

I thinned and trimmed the wood to size. Then I bought lengths of steel which are needed to wrap around the outside bend of the timber where the wood is in tension, to help prevent splitting. Wooden blocks are attached to the ends of the steel that the wood slots into, to keep the wood in compression.
The wood is heated in a steam box. The steam circulates around the wood, permeating the fibres and softening the lignin so that the cells can move in relation to each other.

When the wood is removed from the steam box it is very hot and insulating gloves must be worn (figure 5.10 photo by Loy 2005).
When the wood is pulled out of the steam box it is very hot. It is then quickly fitted into its steel strap and pulled around the shape of the jig. Clamps then fix it into shape. The time to do this is very short, only a matter of a minute or so before the timber cools too much to bend. After clamping, the wood is left to cool down, and then transferred into a drying jig to keep the shape whilst the timber is seasoned.

Although, as illustrated here by the twisted wood, the wood is remarkably flexible, the process is hard work and requires physical strength to achieve.
The jigs that I built with double and triple bends in them could not accommodate a steel strap, so the pieces were more likely to break - and often did. However, it was found to be possible to create interesting shapes, if not consistently.

Annels had not worked with spotted gum before, and although it is a local timber as it has not traditionally been used in fine furniture, partly because its density made it attractive as a construction timber (although it can be so dense it blunts workshop blades) and partly because of other characteristics, such as its waxy surface and colour.
Spotted gum does not have a particularly distinct figure, and Annels was concerned that the gum veins and pockets would affect its bending capabilities. In practice, whilst Annels and I were readily able to bend the Quandong into complete 360 degree circles, the spotted gum broke or simply would not bend, or if it did, it would break with both compression and tension failures on the wood.

![Example of attempt at 360° bend, tension failure on outside of bend](figure 5.17 / 5.18 photo by Loy 2005)

However, to test whether leaving the spotted gum in the steamer for longer would have any effect, I decided to leave the timber in the steamer for far longer than recommended in the literature, which was approximately one hour per 2.5 cm thickness. Once the timber was left in for four hours, it became pliable, and bent well. The gum pockets did prove to be a problem, causing twists, but gum veins were not an issue.

One of the issues raised with furniture makers during discussions with makers on the use of spotted gum was the widespread perception of it as unsuitable for quality products. John Chapman, Head of Horticulture and Forestry Science at the Department of Primary Industries and Fisheries in Queensland appealed to furniture makers and artists at the opening of the 2005 Cooroy Fine Furniture exhibition to consider using spotted gum in high end products in order to raise the profile of the timber as a designer material and thus maximise the resource in value added applications. The issues relating to spotted gum raised the point that, even if value added products were
designed, would there be a market for them? I decided to test this by making a high end, value added designer product from spotted gum as an exhibition piece to demonstrate its suitability for both steam bending and value added product.

I chose to use basic lengths of spotted gum decking to see how much value could be added just by process and design. The design outcome was to be an exhibition piece to be displayed by the Department of Primary Industries and Fisheries at the 2005 International Union of Forestry Research Organisations Congress in Brisbane. To make it a practical, commercial product, I decided to update the traditional curved display units common in hotels and company foyers (see example and project book 2).

The final design was kept as simple as possible to emphasise the curved decking timbers, with clear shelving and plain black aluminium supporting struts. Following the production of the design drawings and working sketches, I prepared the lengths by feeding them through the thicknesser and cutting the timbers to the same size so that the curve produced would be the same in each piece, and they would all fit the same steel strap. I built the jig to form the initial bend and then two drying jigs to support the timber whilst it was seasoned.

Steam box, Cooroy (figure 5.19 photo by Loy 2005)
The timber slats were stacked on their sides, to maximise the circulation of steam around them, and steamed for four hours. Then they were removed one at a time and bent around the jig, then clamped in place.

Author bending the spotted gum to the forming jig (figure 5.20 photo by Annels 2005)

(figure 5.21 photo by Loy 2005)
Detail showing the two blocks attached to the steel strap and the bent timber trapped in between them and the jig.
After around half an hour, the wood was sufficiently cooled to allow it to be transferred into the drying jig, where it was stored for approximately three weeks until the moisture in the timber had reduced sufficiently to meet Australian standards and retain its stability without the jig.

Testing wood with a moisture meter in the end of the board to avoid marking the surface. The board should preferably be tested in surface of timber (figure 5.23 photo by Loy 2005)
The curved uprights for the design were batch produced. That is, they were prepared and then bent in batches and placed in drying jigs. Where gum veins were present, the bend was slightly distorted, but the design took probability into account and had the uprights some distance apart so that small differences in the curves would not be noticeable.

Prototype drying jig (figure 5.24 photo by Loy 2005)
Curved, steam bent leaflet display stand © Loy 2005

(figure 5.25 photo by Waugh 2005)
It was exhibited at the International Union of Forestry Organisations Congress in Brisbane in 2005. It received positive feedback on the design, leading to a commission from the Department of Natural Resources and Water\textsuperscript{13} for three display units for their Brisbane Foyer, which demonstrated that the timber itself can be accepted by the market in high quality, value added products, and that the margins for the use of this timber can be substantially improved with value added processes, including design.
This workshop exercise was very valuable in providing possible direction for design work using short and or narrow lengths of wood, and in particular in suggesting at least one response to the need for the utilisation of thinnings. However, it highlights the problem with the initial starting title. Designing out of context does not address the realities of working within a supply chain. Bearing in mind the parameters laid down in the earlier chapters and the eco-pluralistic methodology relating to the importance of considering the context for a design, it is necessary therefore to consider the usefulness of a design project such as this when considered as part of the supply chain as a whole.

5.3 Different markets.

The One Tree project which was initiated in the UK and repeated in Tasmania set out to show that every piece of the tree could be used in a value added product. Artists and craftsmen produced high value products from every part, including bark and leaves. These were then auctioned. It illustrates the point that if valuing the raw material itself was to be the only consideration, then any process or product that could find a market would be worthwhile and individualised designs could be developed in isolation from any supply chain.

Neil Scobie’s pallet wood turning (figure 5.30 photo by Scobie 2004)
This wood turning was produced from a discarded pallet. Even the nails were from the pallet. It was made by prominent Australian craftsman, Neil Scobie\textsuperscript{14} and was auctioned for around $1200 as part of the ‘Create from a Crate’ initiative\textsuperscript{15}.

To explore the same principle, I used some of the experimental off cuts that I produced with double bends from silver quandong and spotted gum, such as those shown, to produce two sculptures about a metre high (see an example in picture below with laminated, turned base).

Example of double bends created in test bending pieces
(figure 5.31 photo by Loy 2005)

The sculptures won the Zonta Craft award, the Zonta Packers award and the Cooloola Shire Art Exhibition award for sculpture (acquisitive), judged by the curator of International Art at the Gallery of Modern Art in Brisbane\textsuperscript{16}. It was also selected for the curated art exhibition in Stanthorpe\textsuperscript{17}.

The exercise was good illustration for me not only of the value of raw material that has no commercial value (that is it cannot be used to create traditional market products in Australia), but also in the creative impetus of limitations in a design brief.
However successful these designs may be in the open market, their production is dependent on the company concerned having:

- Steam bending equipment.
- Materials available in consistent quality at a reasonable cost.
- Skills in the workforce.
- Storage for drying jigs.
- A suitable market.
This final one is the most influential with regards to considering the success of a product through a supply chain. Whilst equipment and manpower can be bought in, establishing contacts and outlets in a new market for a manufacturer in which they have no reputation is a problem.

References and end notes:

8. Trannon Furniture [www.davidcolwell.com](http://www.davidcolwell.com)
13. Natural Resources and Water, Forest Products, Department of Natural Resources and Water, 160 Mary Street, Brisbane.
14. Bucca Workshops [www.neilandlizscobie.com](http://www.neilandlizscobie.com) 24.05.06.
15. Create from a Crate
   4.2.06.
Chapter 6: Case studies on specification and production

In this chapter two case studies have been selected in order to describe real world practice. The first follows an example of specification practice for a large, commercial project. The second tracks timber processing and manufacturing practices.

6.1 Case study on specifying timber.

Study of the effects of specification and installation practice on the use of timber.

The millennium arts project (2006) on the banks of the river in Brisbane involved the upgrade of the current Queensland State Library\(^1\), and the building of a large, new art gallery, the Gallery of Modern Art\(^2\). Together the projects cost approximately $291 million\(^3\). One of the reasons for choosing this project as a case study was that it was being managed by Lend Lease, who have a reputation for best practice in applying sustainable principles, as demonstrated by their flag ship eco-building headquarters in Sydney (30 Bond Street). I decided that it would be more useful to track a well managed project to see where opportunities for improvement lay to promote the clarification of timber specification, rather than choosing a project managed by an organisation that had not already introduced best working practice. Lend Lease promote their policies on social, economic and environmental sustainability, stating "Sustainability is how we do business, now and into the future".
Lend Lease were co-operative and supportive of the study, and were keen to be kept informed as the study progressed. For the case study I was allowed access visits to the site during construction once I had gained a construction site health and safety accreditation (blue card).
One half of the project was the refurbishment of the State Library. This was undertaken by two Brisbane architectural firms working in association; Donovan Hill\(^5\) and Peddle Thorp\(^6\). The refurbished building won ‘Building of the Year’ in 2007 at the Royal Australian Institute of Architects awards ceremony. Donovan Hill in particular has a reputation for using timber imaginatively, as demonstrated during their presentation\(^7\) at the Australian Timber Design Workshops in 2007, and Tasmanian oak (\textit{Eucalyptus delegatensis} / \textit{Eucalyptus regnans} / \textit{Eucalyptus oblique} spp.) was the dominant material used in this refurbishment.

The international architectural firm, Architectus\(^8\) (offices in Auckland, Dubai, Shanghai, Sydney, Melbourne and Brisbane) was appointed in 2002 to create the new Gallery of Modern Art building, which is the main centre piece of the overall project. This is a quote from their artist’s statement, illustrating their design intent:

“The Gallery building, through its transparency, a long, linear, connective spine, and a series of expansive, open verandas, becomes one with the public space in which it is situated. It is a gallery building
utilising walls for the presentation and protection of art (black box) without losing its transparency, readability, and openness to the city and the surrounding landscape (light box). The duality of the design approach is that the architecture is impressive and monumental without losing its openness and freshness, and without being intimidating; international yet responsive to local conditions and the south-east Queensland context.”9

The Gallery of Modern Art has five levels, with an overall floor area of 25,600m² of which 14,200m² are public space, with 5,825m² dedicated to galleries. The largest gallery is 1,100m². The overall design features very high ceilings, with the foyer being 18 metres high.

Architectus promote their work as sustainable design:

“A sustainable design integrates consideration of resource and energy efficiency, healthy buildings and materials, ecologically and socially sensitive land use, and aesthetic sensitivity that inspires, affirms and ennobles humanity.”10

Materials for the project included timber of different species for different applications, but predominantly tallowwood (eucalyptus microcorys) and spotted gum.

*Internal cladding being fitted (figure 6.4 photo by Loy 2006)*
The main uses for timber in the project were:

- Exterior shading battens.
- Flooring (over joists and over plywood).
- Lining.
- Joinery.
- Built in furniture.

I was particularly interested in the installation of flooring for this project. Timber specifications had to be approved by the project manager on site before materials were ordered or installed.

Diagram of Supply chain:

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architect  project manager  supplier  installer
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The timber was stored on site in preparation to being fitted in order to equalise the moisture content. It was stacked with spacers to allow the air to circulate around it.
Tallowwood flooring acclimatising in the gallery where it will then be fitted (figure 6.6 photo by Loy 2006)

Tallowwood\textsuperscript{11} was chosen as the main timber for flooring in the galleries. Tallowwood is a medium to large tree that grows up to 60m in height and has a stem diameter of between 1 and 2 metres. It has a dried density of 1010 kg/m\textsuperscript{3}, and a good general hardness rating.

6.1.1 Issues raised by tracking timber specification and installation.

6.1.1.1 Appearance grading:
Timber to be used in feature applications, such as flooring, is specified by an appearance grade. These are basically ‘select’ grade – meaning timber that displays few visibly discernable growth characteristics, and ‘feature’ grade – which has more growth characteristics. Feature grade is often chosen because those characteristics make the timber more attractive for particular applications, especially in fine furniture and wood turning. However, there can be a perception that select grade is a better quality timber, even though it can be argued that feature grade actually shows the more interesting and attractive qualities of the timber.

For this project, 18,000 linear metres of tallowwood timber was specified for the flooring in the main galleries. It was specified as select grade, and therefore had to be docked to remove features. Although it is not a timber that has a high feature level, in order to obtain 18,000 linear metres after
docking for select grade, 40,000 linear metres were initially required. That means 55% of the timber had to be docked and then discarded as short lengths.

**Recommendation: abolish select grade timber.**

6.1.1.2 Specification of species:
Applying in depth knowledge of the different characteristics of different species of wood is a highly specialised skill. Although some architects, such as Donovan Hill in Brisbane, demonstrate a good working knowledge of timber as a construction material, for most architects, timber is only one of the many materials they choose and they are unlikely to have a specialist knowledge in the area. Common practice is to use the construction timbers’ tables published, such as the Department of Primary Industries and Fisheries publication ‘Construction Timbers in Queensland’\textsuperscript{12} to determine from a list of characteristics that they need their timber to have and therefore which timbers would be suitable. This publication forms an appendix to the building code of Australia.

However, for sustainable practice, the timber species specification needs to go further. In his talk on sustainable material choice at the Sustainable Materials Conference, Niclas Svenningsen from the United Nations Environment Program, listed the following practices as contributory to sustainable practice decision making:

- Use materials that support low energy solutions.
- Use materials with lower embodied energy.
- Use materials that are, and can be, recycled.
- Use materials with a long lifetime to reduce the need for replacement.
- Use materials that are sustainably sourced.
- Use materials that are sourced within the vicinity of the building site.
- Use materials that can be integrated into smart designs.
Hardwood timber fares well with regards to this list, however, buying the timber from a certified sustainable source can be an issue, especially in terms of being sure that the certification stamped on the product is genuine and, in Australia with the distances involved, sourcing the timber from local supplies to reduce the impact of transportation on the environment can also reduce the choice for specifiers for architectural firms and builders. Another issue for timber as a material is the availability of certain species, with availability changes depending on seasonal changes.

6.1.1. 3 Certified timber:
The Forest Stewardship Council\(^\text{13}\) certifies timber that has come from sustainably managed forests. In 2006 fifty seven countries have forests that are certified by independent certification that meet the criteria and principles of the FSC. Products that are certified are marked with the FSC logo:

![FSC logo](figure 6.7 FSC web site).

Although forestry certification has been in practice in the northern hemisphere for around ten years, it is only within the last four years that forest certification has been introduced into Australia. In 2006 over 5.7 million hectares of Australian forest was certified as sustainably managed\(^\text{14}\). Whilst this has been a positive development, it has not been without controversy and that has contributed to the inconsistencies in marketing that have undermined the efforts to ensure that architects and other buyers can specify timber with confidence.

At the time of writing there are two certification schemes available to forest managers in Australia. The first is the globally operating Forest Stewardship Council (FSC), founded in 1994 by a group of traders, consumers, environmentalists and human rights activists to ‘promote environmentally appropriate, socially beneficial and economically viable management of the world’s forests\(^\text{15}\) and which gives accreditation for the Woodmark and
SmartWood standards. The second is the Australian Forestry Standard (AFS). The Australian scheme that has gained international recognition from an organisation called the Programme for the Endorsement of Forest Certification Schemes\textsuperscript{16} (PEFC), which is an independent, not-for-profit, non-governmental global organisation that covers 190.8 million hectares of forest worldwide. This scheme, however, has taken some time to develop and in the meantime, the established Forest Stewardship Council schemes have been used to provide interim standards. FSC is recognised as a standard setting body in the area of forestry by the International Standards Organisation (ISO) (ISO 14000 is a general environmental standard, rather than specifically for forestry, that ensures the particular industry complies with laws and regulations, demonstrates continuous improvement and prevents pollution) and so already has a brand acceptance in Australia, which the AFS will need to develop. FSC covers approximately 76.5 million hectares of forest worldwide, over 72 countries\textsuperscript{17}. The AFCS uses the Australian Forestry Standard developed by Australian Forestry Standard Limited, an accredited Standards development organisation. Native hardwood forests managed by the Queensland government have achieved certification under the AFS.

Both the FSC and AFS use a similar, three level approach to assessing if a forest can be certified as sustainably managed, but there are significant differences. In particular, the AFS scheme takes into account the role of forests in carbon cycles and greenhouse gas emissions, which the FSC does not and the FSC is definitively against genetically modified products, whereas the AFS is not. The problem with the differences in the schemes is that the many similarities are overshadowed by confusion over these differences. Any confusion can be capitalised by negative campaigns from competing materials, and it was evident at the Sustainable Building Materials Conference in Melbourne in 2006 that some specifiers are afraid of specifying timber at all for fear of it not being genuinely sustainably sourced, whatever the scheme it has been assessed by.

However, if a more consistent image of certification can be promoted, the AFS in particular provides the tools for the hardwood timber industry to
demonstrate its ability to respond to the sustainability imperative with in particular, in addition to the forestry certification itself, the chain of custody certification providing ‘a significant market competitive position in a future marketplace which favour materials and products that are sustainable – in their production, application and wider life cycle impacts’\(^\text{18}\). In his report on Australian forest certification, Crawford (2006) stated that ‘certification for forest confers significant leadership over other competing industry sectors that impact heavily on our natural environment’\(^\text{19}\).

For the Gallery of Modern Art project, the exterior batons were initially specified as turpentine. Turpentine (botanical name \textit{Syncarpia glomulifera}) is very resistant to decay, termites, marine borers and fire\(^\text{20}\). It is recommended to use it in the round when possible, with the bark still on for longevity in marine applications. It has straight, sometimes interlocked grain, is not susceptible to lyctid borer and has a dry density of 945 kg/m\(^3\). It has a strength rating of SD3 seasoned and is recommended for use as marine pilings, scantling, flooring, furniture and paneling.

External battens being fitted to State Library (figure 6.8 photo by Loy 2006)
Whilst it is an appropriate choice on paper for this application, on this project, and it does grow in the vicinity which reduces transport costs, it is not currently readily available in the quantities needed. Therefore the specification was changed from turpentine to spotted gum as it is still a local timber but is more abundant in Queensland and can be sourced from AFS certified forests.

**Recommendation:** Improved communication within the supply chain. Rather than specifying species, architects, unless they are specialists in design using timber, should discuss their choice of timber with not only project managers, but timber suppliers and installers.

In the State library the flooring installed in the side galleries was Tasmanian oak\(^2\). The built in furniture in the foyer and open spaces is also made from Tasmanian oak. Tasmanian oak is the trade name for mixed mountain ash (*Eucalyptus regnans*), alpine ash (*Eucalyptus delegatensis*) and messmate (*Eucalyptus obliqua*). Although the timber choice works well aesthetically, it does not fit in with sustainable practice as these timbers are sourced from south eastern Australia, a long way from Brisbane. It is also disappointing in terms of promoting local timbers in Queensland in such a high profile project that is funded by public money.

**Recommendation:** Specify local timbers, particularly for public projects.

In addition to the new tallowwood flooring specified, recycled tallowwood was specified for as much of the project as there was recycled material available. This fits in with the sustainability principle of using recycled product whenever possible. However, there are currently no recognised standards in place for grading recycled timber. As a result, disputes can arise over the quality of the product supplied. Tallowwood flooring pictured below supplied for GOMA indicates a typical supply problem – mixed species supplied instead of single species as specified.
This is under review in 2008 and new standards are being developed that establish parameters for different grades of recycled timber. Until these have been finalised, recycled timber will be difficult to specify with confidence if the timber is specified using the same standard as for new timber, rather than valuing the characteristics and variety of recycled timber that may have to be used together for a quantity of supply. However, this requires a change in attitude by the consumer. In this project, the recycled wood specified was tallowwood, which magnified the problems that can occur in re-utilising timbers, as the original timber is prone to faults even when new, even though it has a seasoned strength rating of SD2, a density of 1010 kg/m³, and is recommended for use as flooring, as well as scantling, cladding, poles and furniture²².

The scarcity of quality recycled tallowwood suitable for reprocessing as flooring resulted in the timber shown above being supplied for this project and a dispute followed. When dealing with recycled timber, the specifier needs to be aware of the challenges of building a consistent product and must work with the resource recovery specialist in a flexible manner to utilise what material is available at that time. The variety and characteristics of a recycled wood supply need to be celebrated rather than the product being specified as
if it were new wood. Expecting select grade, quantities of single species timber product from a recycled supply is unrealistic and misses the aesthetic, heritage and social values that it has attached to it.

**Recommendation:** Introduction of recycled timber grading

**Recommendation:** Changes in attitude towards the use of recycled timber to exploit the characteristics and variety in supply, rather than as a straight substitute for new timber.

![Gallery flooring being sanded after fitting (figure 6.10 photo by Loy 2006)](image)

6.1.1. 4 Specifying lengths.

For this project, set lengths for some of the timber in some of the galleries for was specified for aesthetic reasons. The length of timber specified was 3.6 metres. The timber was supplied to the installer in mixed lengths, caused by docking which was determined by the original characteristics of the wood.
The lengths measured from 1 metre to approximately 5.2 metres. In order to meet the specified lengths the installer had to reject shorter lengths and cut down longer lengths. As 5.2 metres was the predominant length supplied, cutting 3.6 lengths left 1.6 metre length off cuts. Being longer than a metre, these could in theory be used elsewhere in the project where the same timber is specified.

Photos of gallery spaces (figure 6.11 / 6.12 photos by Loy 2006)

This gallery was to be used to exhibit large artworks and there was a concern over loading. The joists were specified at 300mm spacings, closer together than normal. With good communication back up the supply chain, any waste created by re-cutting end matched standard length boards could be avoided. This would also avoid the loss of the cost of an additional process because the timber had already been end match profiled.

Recommendation: Increase communication to ensure that the specification of lengths not only achieves the desired effect, but is also understood early enough in the supply chain for waste of materials and processes is minimised.

As part of the overall aesthetic for the State Library refurbishment, the architects chose to use a repeating pattern on the walls that was then carried on into the specification of the detailing and flooring.
The idea was that the flooring would echo the walls with the same irregular pattern. In this gallery, for example, the Tasmanian oak flooring was specified in widths of 40mm and 60mm. The timber was supplied from the sawmill at 80mm and then cut down (cutting in half would lose the width of the saw blade (kerf) so an 80mm piece would only provide one 40mm piece, not two). Taking into account the widths the timber would be supplied in when deciding on the pattern widths would have reduced off cuts.
In addition, the overall effect was diminished because of the lack of sufficient contrast in the timber.

**Recommendation:** Improved communication within the supply chain at the design stage to provide the designers with the optimum effect with the least amount of waste produced.

Wiring and air-conditioning access in the flooring created off cuts as the boards were laid over the gaps so that the whole floor could be sanded more easily, and then the gaps were cut.

**Recommendation:** If possible, wiring and air conditioning units should not be placed in the flooring.

Where off cuts are created on site, Lend Lease has a policy in place that the timber is collected, then transported to a bioenergy site and burnt rather than being sent to landfill. However, if the bin was not locked then general
construction waste was inevitably placed in the wood bin, making the load unsuitable for burning whilst the fire department was concerned over a closed bin of timber being left on site. In addition, the cost of transporting the off cuts to the bioenergy site was over a $1000 a load, which made it expensive, certainly outweighing the economic benefits of selling the off cuts as fuel. To address some of these issues Lend Lease supplied an open trailer for off cuts that could be taken to specific installation points on the site and then supervised, which was a more successful option.

Recycling trailer in gallery (figure 6.19 / 6.20 photos by Loy 2006)
Recommendation: Ensure that a clean bin policy is practical.
Component of outcomes of the PhD: Education within the supply chain to promote a value chain approach.

References and end notes:

3. Estimated costs during site visit.
11. For details on Tallowood characteristics see:
15. ibid p.7.
16. ibid p.6.
17. ibid p.7.
18. ibid p.5.
19. ibid p.5.
6.2 Case study on design.

Study of current production. Subject of case study Hurford Hardwoods’ flooring\textsuperscript{1}

As with the Lend Lease project, a company that already displays a positive philosophy to sustainable practice was chosen in order that any new ideas gained from studying their working practice would be additional to what is already good practice, providing new direction in the area of sustainable practices for the industry. Hurford Hardwoods is a timber processing company that has been established for over seventy years. It has been family-owned and operated for three generations. There is a drymill (manufacturing) operation and two sawmills, one in Casino and the other is located just outside of Lismore in Northern New South Wales. Combined log throughput from the two sawmills totals approximately 40,000 m\textsuperscript{3} per annum.
Hurford Hardwoods demonstrate good practices in maximizing their raw material area and showed interest and support for the project. The company’s dry mill produces around 3 cubic metres of seasoned short length off cuts of mixed hardwood per day. The off cuts used to be sold as firewood, but there was insufficient demand for the firewood to keep up with production, so the company now has to pay for the off cuts to be sent to landfill. Hurford Hardwoods produce:

- Tongue and groove edged strip flooring (wide and narrow board).
- Thin, overlay flooring.
- Framing and trusses.
- Joinery.
- Green residues (directed to a hardboard manufacturing plant in Queensland).

The timbers they use are:

- Spotted gum (*Corymbia* spp.).
- Blackbutt (*Eucalyptus pilularis*).
- Grey gum (*Eucalyptus* spp.).
- Grey box (*Eucalyptus moluccana*).
- Brush box (*Lophostemon confertus*).
- Forest red gum (*Eucalyptus tereticornis*).
- Northern beech – trade name for mixed tableland hardwood species such as *Eucalyptus andrewsii*, *Eucalyptus acmenoides*, *Eucalyptus laevopinea*, *Eucalyptus eugenioides*, *Eucalyptus cameronii*, *Eucalyptus obliqua* that have similar characteristics and a range of colour from a pinkish-brown to light brown.
Timber stacks, Lismore, stripped with spacers to allow air to circulate

(figure 6.22 / 6.23 photos by Loy 2006)
I visited both of Hurford Hardwoods’ Lismore facilities, the sawmill and manufacturing plant, and revisited the manufacturing facility after directed research. At the time of the visits (2006/2007) the major concern identified by the company was increased competition from value added product imported from China and the Baltic States. Hurford Hardwoods produce cut length, unfinished flooring with tongue and groove profiling. Chinese imports include pre-sanded and sealed flooring, already glued into sections in the same way that laminate flooring is supplied, to ease installation. Unfortunately pre-gluing does not allow for the expansion and contraction that occurs in the changing seasonal humidities of Australia and thus it has a tendency to eventually fail. However, because of the competitive price and because any cupping in the flooring occurs after time, the product is affecting Hurford Hardwoods’ market share.

Flooring manufacturers in Queensland and New South Wales are voluntarily audited and accredited by an independent governing body to ensure product quality is consistent with its given grading under a certification scheme. Timber Queensland, which was formed out of the merger of the Queensland Timber Board, and the Timber Research and Development Advisory Council (TRADAC) in July 2003, undertakes this quality audit for Queensland manufacturers and those based in northern New South Wales. Timber Queensland is funded by, and represents, stakeholders of the forest and timber industries including sawmills, loggers, timber treatment suppliers, fabricators and wholesalers. The aim of Timber Queensland is to support and encourage the development and expansion of the forest industry as a means of securing the long-term business viability of its members by increasing the per-capita consumption of timber in Queensland and to create business opportunities throughout the supply chain, from growing trees to using timber products in end-use applications.

Timber Queensland audits each participating company up to three times per year to ensure the product quality is consistent with its given grading. The factory manager at Hurford Hardwoods estimated that 10% of their flooring was docked because of defects. Defects included knots, surface checks, gum
veins and gum pockets, machining imperfections and insect damaged wood. End splits also required docking, however, in an example of good practice, these are minimized because the manufacturing plant works in conjunction with the sawmilling plant and end splits were left on the boards from the sawmill, in order that the ends were cut only once during overall processing. This also reduced the amount of timber docked for length to fit with standard packaging and marketing sizes.

Packaged and reject grade timber, Lismore (figure 6.24 / 6.25 photos by Loy 2006)

In terms of sustainable practice, one example of best practice by the company was to have a policy that rather than docking high feature grade timber, they relegated the lengths, before profiling, to a new grade, which they called reject grade. This was then sold to hobbyists for projects that had no structural requirements. In the high feature, cover and reject grades, unavoidable off cuts were kept long enough to be used as spacers for airing out the timber during drying.
6.2.1 Applying an eco-pluralistic design methodology to the case study of Hurford Hardwoods flooring off cuts.

Although Hurford Hardwoods management expressed concern over the quantity of flooring off cuts produced, their concern was primarily for the cost of removal. They had tried to encourage small businesses to set up to use these off cuts, but this had failed for the reasons demonstrated earlier in the author’s workshop practice. Basically, the labour required in reprocessing the small, different sized off cuts into new product cost too much in comparison to using new, long lengths of timber - therefore this remanufacturing process is not viable using current technologies.

Approaching this problem using the new paradigm of increasing the amount of timber used in value added products, therefore reducing the waste produced, meant looking at the company as a whole, reviewing its products, market, practices and potential.

6.2.1.1 Designing for Hurford Hardwoods:
The drivers identified for the Hurford Hardwoods design project were increased competition and the growing influence of life cycle assessment on specification practice, particularly for high profile projects.

Task:
- Apply the sustainable design paradigm to designing for Hurford’s Hardwood.

Method:
- Review of practice in line with the new paradigm outlined in earlier chapters leading to recommendations on changes in practice
- Review of design for Hurford Hardwoods: threats and potential, product range, market, manufacturing capabilities

Wood profiling and LCA as drivers:
- Importance of utilising as much of our hardwood resource as possible for value added product to contribute to reassuring specifiers that it is an environmentally friendly material.

One of the problems facing Hurford Hardwoods as an Australian hardwood flooring company is the growing imperative to demonstrate sustainable practices in order that architects and interior designers are able to specify their product with confidence. At the Design Build Exhibition in Sydney in 2005, all the seminars delivered by architects and interior designers mentioned sustainability as an increasingly important issue for them and their clients, and the design competitions featured there all had eco-design as their focus. By 2007, the Design Build Exhibition was all about sustainable practice.
Influential companies, such as Lend Lease, advertise their sustainable practice policies on their web site, and will only specify products that they can promote as eco-design.

Interior designers not only specify eco-design products because of their sustainability credentials, but, in my opinion, also because the mainly engineered product they can choose from provides a fresh aesthetic that can be readily identified.
6.2.1.2 Changing practice:

Applying the recommendations made earlier on manufacturing to this case study; Hurford Hardwoods has the potential to improve their utilisation of the raw material by:

- Investment in log scanning software to produce cutting patterns that maximise the log.
- Retooling for small dimension logs.
- Investment in board scanning software to maximise the potential of the board.
- Laser marking for docking for increased accuracy in marking and cutting defects.

Docking and scanning in use at Hurfords Hardwood in Lismore (figure 6.29 – 6.32 photos by Loy 2006)
There is currently good two-way communication and co-ordination between the sawmill and manufacturing site in Lismore, resulting in the reverse engineering of products to determine the best cutting lists to maximise the wood as early in the process as possible.

6.2.1.3 Method: Formulate a design brief based on a review of Hurford Hardwoods’ Flooring product.

From a review of Hurford Hardwoods’ current product and market position, I defined four areas that were relevant for consideration in the design brief:

- China producing competitive finished product that reduce installation costs.
- LCA imperative.
- Alternative flooring competition.
- Limitations of product for commercial interiors.

Hurford Hardwoods provides a good example of how new challenges are affecting Australian manufacturers. At the start of 2008, the French president told his country that in order to maintain its place in the world order, everyone would have to think differently about work, about what they did, the way they did it and what markets they were aiming at in the face of the changing global market, and changing nature of competitors. Australian’s need to review their situation in the same way, particularly with their proximity to China. China currently has a population of approximately 1 billion and with 50 million people estimated to be moving from rural China to the city each year looking for industrial based work; Australian manufacturing will be under increasing pressure when trying to compete in the production of low value (low cost) products. Australians will have to invest in technology and education in order to maintain their life style, and manufacturing will need to produce more sophisticated, high end product to survive.

For Hurford Hardwoods, as for most of the flooring producers in this country, this means a shift of focus to value added product. In order to compete, they
need to look at what the market is buying and how they can capitalise on that. In my opinion, this means making their product more interesting and sophisticated to allow architects and interior designers to add value themselves to the designs they are presenting to their clients. Straight timber flooring may have a reputation for representing quality, but it lacks any opportunity for designer interaction in order to create interest, variety and unique design features. New types of engineered product, and alternative flooring products, such as vinyl, do provide that opportunity.

The millennium arts project described in the case study of specification provides a good example for Hurford Hardwoods. The architects refurbishing the State Library were keen to introduce a design feature that could be echoed throughout the building, providing a recognisable look to the project. The architects tried to repeat the pattern that was on the walls in the timber flooring. Because flooring is generally specified by species rather than colour – as colours within a single species can vary a great deal and are therefore currently an unreliable method of specifying – and there are variations within the timber, but not a way of specifying contrast, the repeating pattern was lost, even though the strips were cut to varying widths in an attempt to create it.

For commercial interiors in particular, but increasingly with the domestic market too, designers and architects look for ways to introduce design features and differentiation within an area. In the Millennium project, architects were forced to have the timber especially stained for the project as this option was not part of the normal product range. Decorative paint and stains on timber work very well, and can create dramatic contemporary looks, particularly for features. With the help of good advertising and effective marketing, trends can be easily created. In addition, the use of stains reduces the need for select grade to be specified (although in my opinion, standard grade is the highest appearance grade that should exist because with no features showing, timber might as well be plastic).
Architecture is constantly changing, and the Australian timber flooring industry needs to catch up in terms of design and attitude in order to improve its market share.
Examples of use of colour as demarcation in commercial carpet applications.
Left – (figure 6.35 www.thomasinterior.com.)

Example of timber look, vinyl flooring used in commercial interior design (figure 6.36 photo Loy 2007)

Alternative floorings are constantly re-inventing themselves in terms of design and material. The timber flooring industry’s present marketing initiatives are reminiscent of the numerous shoe manufacturers in the midlands in the UK who made good quality, long lasting shoes but went out of business in the face of ever changing, cheaper fashions from abroad. Only firms that identified a top end niche market survived there, and, in my opinion, flooring manufacturers need to rethink their product to aim at their own designer, top end, high price, high quality sophisticated, value added product. The brief for this project is aimed at satisfying the designer market within the Australian context.
Because the calls for the use of short lengths (assuming a specification advantage from promoting products that value the raw material by utilising off cuts through pre-consumer recycling that outweighs the costs of reprocessing over using new wood), the raw material chosen in this case is to be wide board, spotted gum and blackbutt flooring off cuts, pre-tongue and grooved.

Manufacturing off cuts, Lismore (figure 6.37 photo by Loy 2006)

6.2.1.4 Working brief: Create designer detailing from short lengths for flooring for commercial interiors (see project books for sketches).

Method: Workshop practice to explore the potential of wood for detailing.

- Texturing.
- Finishes.
- Pattern.
- Combining with other materials.
During workshop practice for this section of the project, the aim was to explore the creation of very sophisticated, high end material from the off cuts. This piece pictured, shows the off cuts laminated together into a strip then carved into. The resultant material was of sufficient quality that I was able to enter a short strip into an exhibition, the 2007 Cooloola Shire Art Exhibition as a sculpture.
I then looked at simple carved detailing and shaping applied to strips of short lengths joined so that the installation costs could be reduced to off-set the cost of production, and make installation much easier. Demarcation by texturing would provide an opportunity to give an additional dimension to the product.

Strip floor detailing testing by Loy (figure 6.40 / 6.41 photos by Loy 2006)

I then researched finishes. Stains from the timber slats used to space the timber whilst it is being dried can be a cause of reject grade timber. Industrial grade decorative paint finishes would enable this timber to be used for value added product. The Australian manufacturer, Porter’s Paints produce an Industrial Lustre, which is water based acrylic designed for commercial interiors and exteriors. In addition to decorative paint, liming and staining, there are recent advances in finishes that create sophisticated new looks that could be exploited for design detailing for timber floors. In particular, the use of a fine layer of metal to create a new finish has great potential.

Metal finishes, a liquid metal formula by Metafinish (figure 6.42 www.metafinish.com)
Pattern is the other feature that alternative flooring can easily offer the designer. Carpet, for example, can be designed to include logos or other features in any position on the carpet as required. The potential to repeat pattern features on the walls is also of interest. Timber is frequently used in lining, and therefore could easily incorporate designer features that extend from the flooring and up the walls as required by the designer if pattern could be effectively worked into new value added products. Laser engraving tools are available for use on timber products, but their use at present appears to be limited to small items such as trophies, signs and plaques.

Use of colour in carpet (figure 6.43 / 6.44 www.ontera.com)
The large features that are created in alternative flooring materials, for instance this vinyl feature in newly fitted out Brisbane bookshop, have been produced in parquetry form since timber was first used as a flooring material. In parquetry, small pieces of timber are precisely cut and then adhered to a concrete slab. It is very labour intensive, with approximately 25 to 35 pieces of individually laid tiles per square metre traditionally used, compared to strip flooring where only around five pieces are required to be installed.

Hardwood flooring is usually supplied at 19mm in thickness. Overlay timber flooring needs to be over 12mm thick to reduce the likelihood of cupping in the flooring after it has been in place for some time. Any thinner than that and it is recommended that a ‘plank-on-ply’ system is used. Overlay flooring is where a base of 12mm plywood is securely laid over a concrete base using adhesive and nails and thin layers of timber, preferably approximately 12/13mm, but can be as thin as 10mm, are fixed to the plywood using parquetry adhesive
that remains flexible when cured to allow for expansion, and is fixed with fine pins.

However, parquetry is a labour intensive, skill intensive product to install which reduces its commercial viability as a mass produced product. Even so, new parquetry designs are emerging onto the market with contemporary designs being introduced. I decided to research new ways of creating pattern and parquetry that were practical to process and simple to install.

In creating patterns from short lengths for this project, the two issues of reprocessing and installation were the main concerns again. Therefore, ways to reprocess the timber that were less labour intensive were needed, but also that added enough additional value to compensate for the time and skill required.

I initially tried to create complex shapes with a CNC router, but found that for the depth of the pieces I had (re-feeding them through the thicknesser as short lengths was too dangerous, and feeding them through a drum sander slow as I could only remove a quarter of a millimetre at a time), the diameter of the cutter had to be such that only simple shapes were possible.
Laser cutting and water jet cutting provide the opportunity to create complex shapes that allow for sufficient added value and the potential of offering individualised designs for niche markets to be worth the investment in the cost of the equipment. Waterjet cutting uses a combination of high pressure water and an abrasive feed directed at the material surface as the cutting medium. It has an advantage over laser cutting for low melting point materials, such as aluminium, and is used on composite materials as the erosion process is less damaging to the material than other processes. It tends to be mostly used for inlays in materials such as tile and stone, and for delicate cutting work. Laser cutting is usually used on steel, but can be used on wood. However, the biggest challenge for reprocessing using either a CNC router or laser cutting, or even a water jet, is holding the pieces in place for them to be cut. Usually these processes are undertaken on sheets of board material, such as ply wood. The solution that I found would require an additional investment in technology, but would allow for interesting shapes to be created, and that is using vacuum clamp machinery.

Mini vacuum clamp Vac-Clamp [www.vac-clamp.com](http://www.vac-clamp.com) Commercial scale vacuum clamp (figure 6.47 / 6.48)

The Carter Flip-Pod Vacuum Holding System (above right) is made of a vacuum panel into which cavities are routed that can hold a series of pods. In the ‘down’ position, the pods are flush with the surface of the panel, but when flipped over into the ‘up’ position, they are raised about a centimetre from the surface. When in the ‘up’ position the pods allow the vacuum to work
through them, holding the material at that point. This allows for free routering around complex shapes, making complex parquetry possible.

If there were sufficient economic or sustainability drivers for this to be a viable possibility, the design of contemporary parquetry would open up a strong new market for timber. With computer controlled machinery, complex cutting patterns could be designed (for example tessellations, such as that in the picture below), that, used in conjunction with finishes and texturing, could compete with alternative flooring materials for the designer market.

Example of Tessellation (figure 6.49)

To address the issue of the additional costs associated with the installation of such parquetry because of the increased labour skill needed for each project on site, the laser cut tessellations could be supplied pre-glued on to backing sheets (traditional parquetry is glued down as the pieces are so small that the expansion spacers can be built into the finished product). Alternatively they could be mechanically fixed to a backing, such as plastic grids, like those used in the modular decking tile systems shown below.

Ezy Deck (figure 6.50 [www.ezydeck.net](http://www.ezydeck.net))

If the tessellations were designed using small pieces laid linearly, the backing could be a flexible material and supplied in a roll to be cut to size. This style of application would also work as an internal and external feature wall covering and for complementary detailing in furniture. The construction timber products industry does produce complex, sophisticated products from timber for ceilings and walls. The flooring industry can do the same. As an alternative to providing tessellated parquetry systems on a backing, combining wood with other eco materials provides further opportunities for new design directions. Flexible materials, such as the recycled product ‘Cobblepavers’, produced by Flexitec Rubber Surfaces in Victoria, made from moulded, recycled tyre rubber suggest that it would be possible to create contemporary eco parquetry with a moulded, rubber inlay that would allow for expansion with distinctive, textured surfaces.

The following section describes a flooring product design directions proposal suitable for Hurford Hardwood flooring. The brief would enable the company to:

- To expand the product range to include options for design detailing for commercial interior design.
- To demonstrate the company’s commitment to sustainable practice through its utilisation of off cuts.

The commercial interior design market relies on differentiation to create value. With increased competition in the lower end of the market, new product that enables Hurford Hardwoods to compete in the high end of the commercial design market would benefit the company. Detailing strips that utilise value added processes, such as carving and complex shaping (by CNC router, laser or water jet depending on complexity required, and technology available to the company), complemented by sophisticated finishes, such as wiring (an industrial process for scraping out soft grain with metal brushes) and tinted liming, or a fine coating of metal, are recommended to be developed for this company.
Hurford Hardwoods are a company committed to sustainable practices, with an integrated value chain in operation through the communication they have within their different divisions, from initial conversion to customer sales. The timber they use is sourced from certified, sustainably managed supplies, and their grading practice ensures that the value of the raw material is maximised. Designing new product that can be marketed as eco-friendly complements Hurford Hardwoods projected image, and enables it to be sold at a premium to compensate for any increased costs in production or capital investment.

References and end notes:

2. Through discussion and observation and consideration of the product range and market.
5. Channel Seven news item, Jan. 2008.
9. Vac-Clamp illustrated, sold to individuals for small projects.
10. Ezy Deck Austimber Supplies, Box Hill NSW.

   Flexitec Rubber Surfaces, 10 Kimberly Road, Dandenong,
   Victoria 3175  tel: (03) 9706 6606.
Chapter 7: Improving sustainability practices.

As an industrial designer, experiencing much of the Australian hardwood timber industry culture and practice for the first time, my overwhelming impression, with a few exceptions, has been of individual companies struggling to operate effectively within a disparate supply chain, often hampered by outdated technology and outmoded working practice and out of touch with research and current thinking. Considering the relatively short time in which the industry has developed, and the distances involved not only nationally but internationally, this is understandable. Small, isolated sawmills established to service old growth forests with ready access to large diameter trees, and with little need for investment in technology and design, have been ill equipped to adapt to the changing resources and changing needs of an international market. Many have closed down in the last three years since the project started, but there are others springing up and which are responding to the sustainability imperative, part of which is targeting niche markets, these have the potential to survive if nurtured as part of an industry that is in a position to exploit the opportunities that the sustainability imperative is offering, such as carbon credits.

In terms of this project, in order to increase the percentage of timber used for value added products by addressing the issue of short and or narrow lengths, the basis for the proposed solutions is an integrated value chain. Value, in that the expertise and opportunities of each stage are maximised throughout the chain, and integrated because the starting point is to regard the relatively small industry sector as a whole, rather than a collection of disparate suppliers. Working from this standpoint, four stages of solutions are proposed as outcomes of this project to contribute to increasing the percentage of timber used for value added products in the hardwood industry in South East Queensland.

From my research for this study there are four areas I have identified that could be addressed that would contribute to improving sustainability practices,
contributing to the ‘whole material’ lifecycle response to this increasingly high profile issue to assist the timber industry in competing with other building material industries in the future.

7.1 Communication initiative

1. Communication initiative
2. Education within the current supply chain
3. Supporting technology
4. Design and design education

The largest dimensions of solid wood used, other than in engineered products, are for applications such as power poles and bridge girders. In these cases the heartwood centre is enclosed by the stronger wood and, as far as possible, the whole log is used. If, however, the application requires the wood to be cut to size, then there are going to be off cuts. The problem in utilising this wood is not in finding applications, but addressing the costs and challenges of reprocessing small pieces, designing for the skills and equipment of the particular company and then having access to appropriate markets. Assuming the value of the raw material outweighed the additional reprocessing costs, or the LCA driver forces the industry to account for off cuts at each stage of production to demonstrate how the raw material being valued, then pieces too small for construction applications could theoretically be used for joinery by other companies, and pieces too small for joinery could be used for furniture, for example. Pieces too small for furniture could be used for wood turning, and those which are too small for traditional wood turning could even then be used for segmented wood turning projects.

For an integrated value chain to work effectively there would need to be many lines of communication established. For a starting point, as a demonstration of the industry’s willingness to address the issue of maximising the raw material as part of the industry’s response to the growing sustainability imperative from developers and consumers, I propose a centralised distribution point, such as a web site, be set up to initiate the transfer of good
quality off cuts from one discipline to another. On the site, companies could advertise their off cuts, either for sale if the market proves this is possible, or for free as this not only would eliminate removal costs but, again, demonstrate a commitment to maximising the resource.

The web site mock up shown (© Loy 2006) illustrates the idea. It is the intention of the site to:

- Provide an on-line market place for anyone involved in the timber industry, wood craft or even unrelated disciplines that occasionally need cut wood.
- Provide a format that is accessible and easy to use.
- Contribute to the use of short and or narrow pieces of wood in value added products.
- Contribute to the efforts of the timber industry to ensure their operations support life cycle analysis.

![Wood To Go](figure 7.1 Loy)
There are currently sites set up in other countries that allow the exchange of different waste products, and these have been successful enterprises. The Waste Matchers\(^1\), for example, is a waste exchange operating in Staffordshire and the West Midlands in the UK. It is a free service, open to any organisation with the aim of reducing waste disposal costs for companies, whilst overall reducing the quantity of possibly useful material that is disposed of in landfills. According to statistics on the site, after its launch in September 2005 and within the first five months, 608 registered members of the site had contacted other members to request material exchanges, and 412,170.32 tonnes of material had been advertised on the site.

There are many other similar sites in the UK, many with funding from organisations such as:

Logos downloaded from web sites of each organisation 2005 (figure 7.2)

This has been in line with the European Commission’s Integrated Product Policy (IPP)\(^2\) which has shifted focus from prosecuting companies who damage the air and water supply through emissions and waste, to a policy of working with companies to ‘reduce the environmental impacts of products along the life cycle’. It bases this on following five principles:
• Product life cycle thinking.
• Working with markets.
• Continuous improvement.
• Stakeholder involvement.
• Development of policy instruments.

Recognising that all products cause environmental degradation to some extent during production, use or disposal, Integrated Product Policy seeks to minimise the impact of all phases\(^3\). This is part of the global shift in thinking towards sustainable practices and results in IPP initiatives such as the 2007 EC initiative to help companies to identify target products that have the biggest potential for environmental improvement and then develop appropriate improvement strategies. IPP tools, some voluntary, some mandatory, used to achieve improvements are economic instruments, substance bans, voluntary agreements, environmental labelling and product design guidelines\(^4\). The European Commission also began a program in 2005, due for completion 2008, called ‘The European Platform of Life Cycle Assessment\(^5\)’ to promote life cycle thinking in business and policy making in the European Union by focusing on providing comprehensive reliable data for LCA.

There are existing web sites in Australia and New Zealand that could, or to an extent, do include limited opportunities for a wood exchange, but do not yet on a manufacturing, organised level. The Woodwork forums\(^6\) for example, run by Woodworking Australia, have a timber swap forum but it is predominantly craft based, small pieces of specialised timber. The industry based Friday Off cuts Newsletter\(^7\) could also be a vehicle to be used in this, and in Queensland, the Timber Queensland\(^8\) site, as the base for industry representation, would seem to be the ideal forum to establish the site as part of the industry response to the sustainability imperative. Related advertising on the site could be sold to offset any costs. It could even be possible to charge for membership. ‘Ecospecifier\(^9\)’ has exchanged its printed format for a web based solution. The site charges members (monthly or yearly membership) to access information
on how eco friendly products are rated and currently receives up to 95,000 hits per month\textsuperscript{10}.

Such sites site could also be used to offer for sale production time on under utilised technology. Because of the cost of investment in technology, and the relatively small sizes of Australian manufacturers (in addition to the need to adapt to a market dominated by niche markets and create value by added processes), pooling technology in the proposed clustered development of the industry could be promoted on this site too.

References and end notes

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2. \url{http://ec.europa.eu/environment/ipp/} 11.09.06.
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4. \url{http://ec.europa.eu/environment/ipp/} 18.03.07.
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6. \url{www.woodworkforums.ubeaut.com.au/} 29.05.07.
7. The Friday Off cuts newsletter is produced by Brent Apthorp of Innovatek, Dunedin, New Zealand. \url{www.innovatek.co.nz}. The newsletters can be viewed on \url{www.fridayoffcuts.com} 14.01.08.
8. \url{www.timberqueensland.com.au} 14.01.08.
9. \url{www.ecospecifier.org} 20.11.07.
7.2: Education within the current supply chain

1. Communication initiative
2. Education within the current supply chain
3. Supporting technology
4. Design and design education

From my research, this section of study is the most interesting, and in my opinion, the most important in terms of forming part of an industry response to the sustainability imperative (both environmental and, because of future specification policy, economic) with regards to the prevention of waste production in the form of off cuts through improved specification and use of timber.

Why, when the 2007 Sustainable Building Materials Conference, held in Melbourne, was organised since timber is a renewable source, were no representatives of the timber industry invited to present? Brick, concrete and steel were well represented, with booths and presenters promoting their materials to the influential developers, builders, project managers and architects attending\(^1\). During two opening presentations, made by Rick Fadrizzi of the United States Green Building Council\(^2\), and Niclas Svenningsen\(^3\) from the United Nations Environment Programme (UNEP), timber was highlighted as the only carbon neutral, truly renewable building material (a fact that was confirmed by the work of the CRC for Greenhouse Gas\(^4\) accounting in a presentation to the Australian Timber Design Workshops\(^5\) in July 2007) and its importance reinforced throughout both Fadrizzi’s and Svenningsen’s presentations. However, no Australian presenters promoted timber, even when discussing relative embodied energy in different building materials. Greg Nolan\(^6\), from the University of Tasmania, who presented the Australian Timber Design Workshops in 2007, stated that he would like to have been invited to speak on behalf of timber, but was not invited to attend\(^7\). Comments from the floor at the conference from the attending architects, researchers and developers were overwhelmingly negative about timber. They included ‘trees should be left in the ground’,
‘aluminium is a better choice than timber for window framing because it can be recycled’, and ‘Bamboo is the only timber that is environmentally friendly’. Bamboo\(^8\) is not actually a tree; it is a large grass so the felled material is not defined as timber. It is rarely grown in Australia, with most of it imported from south-east Asia and China which raises questions about whether sustainable practices used for its production. As surprising to the author as the negative comments made about timber as building material were, they are reinforced by the warning on the Eco-specifier web site about the unreliability of timber sourcing for use in Australia\(^9\).

I attended an architectural tour in Sydney to visit sites that had received accolades for their approach to sustainability through design, energy creation (solar power being fed back into the grid) and water management (collection, storage, aeration). These included the Victoria Park development pictured above\(^10\) and the Kogarah main street project\(^11\). The tour was led by a leading Sydney environmental architect, Tone Wheeler\(^12\), during which his concerns over using timber from an environmental point of view were raised, although he does specify timber in his project work, for example in his house for Edward De Bono in Queensland\(^13\).
Lend Lease\textsuperscript{14} have gained a reputation for sustainable practice through their research into creating non-toxic environments, water/air cooling systems, solar passive designs and the use of eco-design furnishings. The project manager on the ground-breaking 30 Bond Street\textsuperscript{15} project by Lend Lease (that was set up to demonstrate how sustainable practices could be included in commercial building design and construction) also said he deliberately avoided specifying natural timber as much as possible. He did specify Bamboo as a sustainable choice because of its short growing cycle, about eight years. Svenningsen also mentioned bamboo as a sustainable material choice\textsuperscript{18}. 
Clearly there are promotional and perceptual issues at work here, with the Australian timber industry’s perceived profile being out of step with current thinking on sustainable practice. With the forecast introduction of carbon credits in Australia\textsuperscript{16}, if the hardwood timber industry must change public perception, by demonstrating a new, sustainable paradigm in action for an effective, cohesive value chain, it should come to be seen as the number one – arguably the only – truly sustainable building material. According to an article in InWood magazine:

“The Australian manufactured wood industry has become complacent and is pretty lousy at promoting its products. That was the overwhelming impression to emerge from the first joint conference of the Australian Timber Importers Federation (ATIF) and the New Zealand Pine Manufacturers (PMA) at Twin Waters in late July…. Confused messages, under-selling of timber attributes, lack of contact with customers (builders, specifiers, etc) and inconsistent product performance were cited frequently.”\textsuperscript{17}
Education within the current supply chain is an essential first step to creating a value chain mentality and thus altering the perception of the industry by the buying public. In Australia’s history, the logging of timber, its processing and use, has been cavalier. With an abundant supply of natural, old growth forests available to the industry, low recovery rates have not been a concern. This attitude, plus the use of quality wood for low value products, such as wood chip and pulp (particularly the controversial exporting of woodchips to Japan from the Tasmanian based Gunns\textsuperscript{18}) and a casual attitude towards valuing the resource in terms of specification need to be seen to be changing for the material to be effectively promoted by the industry as a sustainable choice.

However, even with the best of intentions, a lack of communication, trust and co-operation within the supply chain can result in specification practices that continue to create unnecessary off cuts. According to the timber supplier, the off cuts pictured could have been reduced if the supplier had been allowed to cut the timber to lengths specific for that site rather than supplying standard cut lengths which had to then be recut to size with additional waste produced. The reason this did not happen was because there is an extra costs involved for cutting to a plan rather than provided straight forward cut lengths.

Spotted gum off cuts from Canberra decking project (figure 7.9 photo by Hopewell 2006)
However, it is very likely that the consumer would have saved money by the end of the project because of the reduction in the cost of on-site labour, and the elimination of the cost of removal of the waste. It is a good example of how changes in practice and co-operation between stakeholders in the supply chain can affect the environmental outcomes.

Since prevention is better than cure, if off cuts can be reduced or eliminated, through changing practice, this would result in a greater proportion of timber being used for value added applications. In order to illustrate the potential for making improvements through education, a case study was initiated to track the decisions made on timber specification and the actual practices involved in major project, including installation, specification, disposal and resource recovery.

References and end notes:

6. Nolan, G Director of the Centre for Sustainable Architecture with Wood (CSAW) in the School of Architecture and Design, University of Tasmania.


9. [www.ecospecifier.org](http://www.ecospecifier.org) 2.2.08.


15. Head Office Bovis Lend Lease, 30 The Bond, Miller’s Point, Sydney.


17. InWood issue 64 p.56. 2.2.08.

7.3 Supporting technology.

1. Communication initiative
2. Education within the current supply chain
3. Supporting technology
4. Design and design education

Aim: Flexibility in conversion and production, and improving information gathering on the resource.

Our ageing population reinforces the need for a design methodology based on inclusive, appropriate design\(^1\) by emphasising that previously marginal markets are now part of mainstream design and this is a challenge for our industries. From a mass production mentality to a batch production way of working, our industries need to change their thinking about the way in which they design, manufacture and promote themselves and their products if they are to compete with overseas manufacturers by producing more desirable, individualised products. The Australian hardwood industry as a whole needs to be prepared to invest in the technologies that allow them to create for the pattern of multiple ‘niche’ markets that is emerging as opposed to the mainstream ‘one size fits all’ it was built on.

At the same time, the global environmental crisis demands that we apply a correspondingly inclusive attitude to maximising our resources. This is particularly true for the Australian hardwood industry. Changing existing practice to respond to the changing wood resource needs a mind shift that challenges a currently wasteful, segregated timber supply chain that under utilises its resource. In particular, technology must be used to give a full and accurate assessment of the changed resource in order to maximise utilisation at each stage of processing, production, specification and installation. Fostering an integrated value chain that can provide more flexible, value added solutions for the changing demographic, whilst responding to the lower grade material available, is part of the role of the designer, a role that is becoming increasingly complex.
There has been a positive change in the industry with regards to government investment in sawmills that have the capability of converting small diameter logs. The industry as a whole needs to rethink its strategies to match this development.

7.3.1 Changing practice in manufacturing.

At the Pine Manufacturers Association Conference in 2005, ‘Australian markets, threats and opportunities’, co-hosted by the Australian Timber Importers Federation², the economic imperative of shifting from producing cut lengths of timber, to producing value added product was the main point made by the speakers. Competition, identified as coming from the Baltic States, and China was the biggest concern. During the conference, the outmoded idea of China being a labour intensive, low technology competitor was disabused, with reports by delegates, who had visited China on fact-finding missions, of low tax, high investment in technology and education.

Stacked softwood timber in large producer's yard (figure 7.10 photo by Loy 2006)

For the Australian hardwood industry, already with a market share of only 1% of all the building materials used in construction in Victoria³, this is even more important as the industry is already under public criticism for under-valuing its
raw material. Market share is being lost to engineered substitutes for timber, partly, according to Ian Unwin, the CEO of CHH Wood Products, in his presentation at the 2005 Pine Manufacturers’ Association Conference, because of ‘bad news stories based on emotion, not fact’. Based on fact or not, clearly the public perception of the Australian Timber Industry needs to be addressed, and a change in attitude is needed to encourage an integrated value chain that maximises, and is seen to be maximising, the use of all its timber resource.

Ausgum⁴, an outdoor furniture manufacturer, based in Gympie, Queensland, who use spotted gum (Corymbia spp.) for their products, provided an example of how this could be achieved. They have invested in new technology⁵ and demonstrate an integrated value chain approach to production.

Ausgum was initially set up by the owner of a sawmill in Emerald, who was keen to utilise short and narrow lengths of timber that were the by-product of the cut-length timber market he traditionally supplied. The outdoor furniture products were designed to specifically fit the off cuts he commonly produced,
rather than the designs being made from cut lengths. The advantage of this was that when docking, the company could deliberately dock to set lengths he knew could then be used, rather than being left with a variety of lengths that would need reprocessing.

The Emerald sawmill has now been closed because the Queensland Government’s policy of locking up Crown land from logging has removed the raw material source. However, the furniture manufacturing business is currently still operating, and local growers in the Gympie area are supplying the material.

One key to reducing off cuts and therefore using as much of the resource for value added applications as possible, is for the manufacturer and sawmill to work in conjunction, so that short lengths are docked to uniform sizes, (perhaps longer than they otherwise would be in some cases) that fit the
supply needed for the final designs - negating the need for reprocessing. Products could also be reverse engineered to identify where off cuts are produced and where common components could be developed across ranges, so that the product range of a company is considered as a whole in terms of maximising the resource. This creates a batch production approach, essentially pattern cutting from the supply to fit the products required rather than simply cutting straight lengths and the manufacturer then having to recut to size. This is much like a textile nested pattern cutting approach to the use of material. If the final product is known, it can be reverse engineered to provide a cutting list for the sawmill, eliminating the in between stage of cut lengths.

Short lengths used in production, Gympie (figure 7.16 photo by Loy 2005) www.procutconverting.com (figure 7.17)

The other advantage with a batch production, flexible supply approach is that with an increase in niche products required as part of a changing market, manufacturers are in a better position to individualise their products as needed.

CNC router, Gympie (figure 7.18 photo by Loy 2005)
The increasing use of CNC routers - both flat bed and up to 5 axis - make this a very realistic possibility for the hardwood industry, but requires considerable investment in technology and a changed marketing approach.

**Recommendation:** Review of product design for manufacturers in relation to the overall integration of the way the supply is cut and used to maximise the resource.

**Recommendation:** Encourage an integrated value chain that maximises the use of all its timber resource by reverse engineering products as the basis for the design of new product

**Recommendation:** Clustered manufacturing to provide, and effectively market, a more integrated, flexible service.

References and end notes:

2. Level 7, 28 Foveaux Street Surry Hills NSW 2010.
7.3.2 Improving production practice.

Improving practice in the Australian hardwood timber industry requires investment in new technologies and the use of those technologies in such a way as to maximise equipment availability around as many stakeholders as possible. In order for the Australian hardwood industry (in particular those in the South Eastern Queensland corner), to work sustainably, a planned approach throughout the supply chain needs to be imposed across the industry as part of an overall commitment - as determined by the eco-efficient strategies discussed in Ryan (2004)\(^1\), in particular reducing the material intensity in a product and maximising the resource in terms of value added applications.

Committing to the use of technology at each stage of a value chain would present many possibilities for maximising the use of the timber in value added products, especially in terms of maximising its application, to the best of its actual strength and stiffness or appearance capability. Theoretically, if a hardwood plantation tree that is still growing could be assessed by non-destructive evaluation technologies, the forester could then base the decision for the most appropriate harvesting time on the best potential application for that particular stem, assuming a selective harvesting program rather than clear felling. In this way trees could be allowed to continue growing until they achieve their maximum value. Equally, once cut, if the logs could be subject to non-destructive individual testing, their potential return could be maximised.

A 2004 New South Wales study\(^2\) exploring the potential of acoustic stress wave testing (using a stress wave timer) in predicting the stiffness of boards that would be taken from still standing trees and cut logs argued that the ‘improvements in the value recovered from logs and the performance of sawn timber in service were critical for the commercial viability of growing trees on farms’. As intrinsic wood properties vary so much between trees and even within a single log, being able to accurately, rather than just visually (which only indicates the likely quality of boards from a particular tree, rather than the actual quality achieved) sort logs would result in the private forester being
able to achieve a premium for timber. Stand and Log allocation would be determined far more accurately on ‘fitness for use’. In practical terms, this means that the thickness of timber specified for a particular application (i.e for a girder or beam, even furniture applications) could be reduced to exactly what is required, rather than having to leave a large margin for error, a system that often generates an over engineered product that essentially wastes timber.

The research by Joe, Dickson et al (2004) concluded that a correlation could be made between cut logs using acoustic stress wave testing and the final quality of boards made from those logs. A weaker, but still significant, correlation could be made between the results from tests made on standing trees and the quality of the final logs produced. The study also confirmed that density was a less accurate parameter for predicting stiffness than acoustic stress wave testing. The hardwood tested in this study was Dunn’s white gum (*Eucalyptus dunnii*). The widespread use of acoustic stress wave testing, particularly for private forests, would assist in the value adding of forestry and support agro foresters, thereby also helping reduce erosion.

The next stage, where the log is initially converted, is the one where the greatest commitment to technology is currently being made (and could be very much expanded) in order to make the most use of the raw material. The upgrading of sawmills to include the capability of processing small diameter
logs been happening in America. Over the last ten years\textsuperscript{4} and over the past five years in Australia, as can be seen by the number of grants issued to sawmills in Queensland and the recent investment in small diameter log processing equipment in Tasmania.

If a log is simply cut without taking into account either the internal growth characteristics of the log, or of the final product it is intended for, it can result in much of the log being rejected because of defects - or requiring further processing. By scanning the log first, a cutting pattern can be designed to cut the material more efficiently, taking into account the final product (assuming an integrated value chain practice). An example of this is the processes used by Vaughn Brothers Lumber in America (working with Douglas fir: \textit{Pseudotsuga menziesii}). This company uses a specialist software program that was originally developed in Finland to optimise recovery for an estimated increase of 5\% on percentage of the whole log usually recovered. This is considerable when compared to the normal recovery rate for timber of approximately 30\%. Complete systems for scanning, optimisation and information management are now available worldwide\textsuperscript{5}.

With a primary breakdown optimiser, the computer program first scans the log for volume and density, then checks for defects and analyses each log to give an individual cutting list for that log to provide the highest possible return from each log. Vaughn Brothers Lumber process between 500 and 800 trees per day through the mill. The logging manager of Vaughn brothers stated “Volume wise, we could be a lot quicker in getting through a stand, but there is more value this way….It fits us, and gets most dollars out of each tree. Recovery is one of the key things for our outfit, and it’s a different game now”\textsuperscript{6}. Whilst this attitude is not yet dominant in the hardwood sector in Australia, the technology to respond to it is becoming available with Autolog\textsuperscript{7} products, for example, now being imported into Australia by SAATECH\textsuperscript{8} Systems - offering true-shape laser-scanning systems for log sorting, revenue scanning, optimisation and sawline control.
The production process of the south east Queensland timber processing company, Hyne, is now predominantly mechanised, although visual grading is still the role of individuals, rather than software (such as the Linear Planer Optimiser, Visual Defect Detector\(^9\)). There are examples of smaller concerns making substantial investments in technology at this stage of conversion, such as Gympie Timbers\(^{10}\), who use a secondary processing scanning, optimisation software system.

![Log scanning and recording equipment at Gympie Timbers (figure 7.20 / 7.21 photo by Loy 2005)](image)

7.3.3 Advances in sawmill cutting technology.

![Sawmill, Mooloolah (figure 7.22 photo by Loy 2006)](image)

In October 2000, the Forest Industry Development Assistance Program for South East Queensland (FIDAQ) was set up under the auspices of the Federal Minister for Forestry and Conservation, Senator Ian Macdonald. $5 million dollars was allocated to the region to support local sawmills and
production. This was a direct response to the changes in supply in south east Queensland with the move from native forest supplies to plantation sources and was intended to help businesses in the region adapt those changes, particularly with regards to log quality, diameter and species type.

“This funding will help the native forest timber industry, which is committed to becoming more cost efficient, more competitive and willing to add more value to its products, while at the same time maximising regional job opportunities,”

Many small sawmills were given grants - for example the forty year old Caboolture based saw mill, Schiffke, received a $146,487 grant for investment in new plant and equipment to produce value-added products such as flooring and decking, rather than simple cut lengths of hardwood. Twelve grants issued through the Forest Industry Development Assistance Program for south east Queensland, five were for increasing the production of value added products over cut lengths, and three were for enabling the mills to process smaller dimension logs.

However, although individual grants to small operations have been a positive step, the cost of the latest equipment is still beyond the reach of individual sawmills. For example, state of the art sawmills have single pass machines that cut the log to square or rectangular product at 200 metres per minute. Multiple bladed machines with narrow blades (and so a thin saw kerf) are combined with scanning, optimised pattern selection and active sweep sawing to maximise the log recovery. Off-set and profiled solutions are also possible with live skewing for asymmetrical logs, significantly improving recovery rates.

There are several examples of manufacturers who have been able to make the kind of investment necessary to keep up with technology. Australian Solar Timbers has made a capital investment of $10 million in new equipment and innovative technology in order to transform from a small pallet and paling mill to a state-of-the-art processing facility dedicated to the production of solid hardwood flooring products.
7.3.4 Docking technology.

Marking out timber for docking has traditionally been a hand process, with dockers marking the wood with fluorescent lines where the cuts are to be made. Although some small sawmills still use a manual cross cut blade to dock the timber, larger facilities now use scanner cutters that cut the boards accurately to the marked line. Investment in technology in this phase of production would see the widespread introduction of electronic eye scanning that speeds up the process and cuts more closely to the defect, saving quality timber. One example of the type of scanning equipment for docking in use is shown here in the Gympie Timber Co, in South East Queensland.

Laser docking system, Gympie (figure 7.23 photo by Loy 2005)

7.3.5 Manufacturing technologies.

In terms of both adding value to product by enabling the designer to design more complex products and reprocessing short lengths, investing in technology at this stage has the greatest potential for returns.

In a fragmented industry (such as the hardwood timber industry in South East Queensland) the development of technology and subsequent investment in machinery developed overseas is a challenge because of the enormous relative costs involved to the size of the market. However, there are examples of relevant innovative technology being used in the area, such as
the Bacci double router\textsuperscript{15} used by Ausgum in Gympie, and a variety of finger jointing systems for construction and moulding applications in use across various locations.

The Bacci double headed router has a machine gun feed that allows it to use smaller lengths than are usual in conventional manufacturing, and swivel headed five axis routers that are controlled by the computer software program Solidworks\textsuperscript{16} to produce complex, 3D configurations in the wood.

Bacci double headed router in operation, Gympie (figure 7.24 / 7.25 photo by Loy 2005)
This allows for the production of complex joints and eliminates the skill required from the machinist, other than in using the program itself. Ausgum furniture’s investment in the Bacci Double cost $700,000. Their main use for the machine being to produce chair and table mortise and tenons.

Example of joint produced on Bacci Double (figure 7.26 photo by Loy 2005)

The case of Ausgum’s investment in high cost technology highlights the need to cluster production cells, as the Bacci Double is under utilised and could run for twice as long per day as it currently does. Perhaps, as part of the web site suggested in the communication initiative outlined earlier, manufacturers could offer time on their specialist machines to reduce overheads and increase productivity.  Web site mock up (figure 7.27 by Loy 2006)
Even this advanced technology is out-dated compared to the growth in development tools such as 3D printers and rapid prototyping in resin\textsuperscript{7}. These new generation devices allow for greater experimentation in design to explore new components, such as connectors, that could contribute to improved efficiencies in the construction of complex products. This technology is available to the south east corner through Concentric in Brisbane and provides an opportunity for the design of value added product utilising complex fixings. Although currently expensive in relation to the cost of the types of products usually produced in wood, it is possible that in the future this will have potential for allowing the timber industry to create higher value products.

**Recommendation:** Increased investment in technology through the clustering of investing companies thereby increasing access for smaller manufacturers.

There are also excellent local initiatives introduced by individual entrepreneurs, such as Perry and Wesley Corbett of Gympie Timber Co. Although a relatively small sawmill, Gympie Timber has made considerable investments in technology, including their own design of machinery to address the issue of using small lengths of timber in value added products. In order to minimize waste, the Corbetts were interested in the engineering of finger joints that would create a length of board (including pieces as small as 150mm) that still passed the testing requirements for flooring over joists. Their machine cost over a million dollars to build in Germany, and they have recently been successful (on recommendation from this study) in gaining a Queensland Industry Development Scheme grant of $98,000\textsuperscript{17}. The product is now being sold under the name Eco Board. There is an additional cost to the builder for the extra processing for this product, however, the installation costs for the builder are lower as the lengths are engineered to the exact size for the particular project with total width or length boards are supplied as ordered requiring less skill and time on site.
Recommendation: Leadership by industry bodies, such as Timber Queensland, to promote improved co-operation as part of a value chain approach moving the industry away from supplying lengths towards value added product.

A good example of an individual's initiative that demonstrates that it is possible to add value to timber to produce high value product that can compete on a world scale can be seen in the work of David Trubridge.

David Trubridge, [www.davidtrubridge.com](http://www.davidtrubridge.com) is a New Zealand furniture maker who batch produces fine furniture using steam bending, boat building techniques and design to create pieces that are sold across Europe, through both the Milan Furniture Fair, and via an Italian manufacturer. His work demonstrates that design and innovative processes can add value. It also underlines the potential of targeting niche markets.

References and end note:

4. e.g. Collins Pine Company www.collinswood.com
5. Example:  http://www.usnr.com/prod/line.asp?line_id=409  2.2.08
7.4 Design and design education

1. Communication initiative
2. Education within the current supply chain
3. Supporting technology
4. Design and design education

In 2004 Good Environmental Choice Australia (the Australian Environmental Labelling Association) in association with Clean Up Australia has launched ‘2004 – the state of green procurement in Australia’. The first of its kind in Australia, this report provided a comprehensive picture of green consumer spending in Australia’s institutions and consumer environmental preferences. According to Peter Johnson, the President of the American Environmental Labelling Association:

“Australians and their institutions are realising that environmentally preferable products are now widely available in the market, and that these products benefit the environment, they facilitate business innovation for sustainability and often they deliver good results to the bottom line.”

“The report highlights the presence of significantly greener markets in Australia, and shows evidence of the demand for environmental products and services. Business and Industry are being forced to re-design and supply products in response to changes in consumer environmental preference.”

7.4.1 Strategies for teaching sustainable design to product design students.*

Teaching students how to tackle the issue of producing practical, commercial product designs that respond to the sustainability imperative is an important challenge for design educators at this time. This chapter provides clear strategies for this essential aspect of product design teaching, breaking down
sustainable design practice into six approaches that allow the educator to introduce a spectrum of sustainable design strategies to future students, whilst providing them with the opportunity to explore the work of practitioners in each area, as well as the tools to differentiate their sustainable design basis.

For example, designing within an eco-pluralistic philosophy such as suggested by Fuad-Luke in ‘Eco Design’ (2004)\(^2\), still provides the opportunity for the inclusion of several different strategies that would be considered contradictory if attempts were made to contain them within one designed object. Clarifying sustainable design strategies enables designers to then clarify their intentions for different ideas. Understanding the design intent provides a basis for value judgments defining the success of a product within a sustainable design portfolio. This chapter outlines the suggested definitions for six approaches which can be used by product design educators as starting points for students in their quest for a sophisticated understanding of designing for sustainable practice.

A rough sawn chair, such as that designed by Natanel Gluska\(^3\) (and presented as an example of successful sustainable design in Fuad-Luke’s Eco Design sourcebook), is in such contrast to the sophisticated work of practitioners such as Ross Lovegrove\(^4\) - with his advanced use of materials, production and elegant design - is apparent that students and consumers alike will need to be provided with increasingly clear guidelines on which to base their acceptance of these very different products. With their new design
imperative to reassess products on a product service system and life cycle assessment basis there will be a growing need for a clarification of what constitutes sustainable design practice. Differentiation of sustainable design strategies and discussion of these different approaches with clients needs to be complex enough for sustainable design practice to develop an integrity that can be challenged and defended both academically and commercially. The following section provides starting points for design educators to advance this development, and then shows examples of how the ideas can be applied through the design of product for this project.

7.4.1.1 Invested objects – emotional, financial.

This describes an approach to design in which the aim is to ensure that the object is highly valued by the consumer and therefore has a long user life. It is an approach described as sustainable by designers and design educators, such as Dr Simon Jackson (co-author of a book on sustainable design, The New Design Nexus⁵). During an ABC radio interview on sustainable design in 2006⁶ when Jackson spoke of the importance of producing quality products that could last a long time. Similarly, Stuart Walker describes the idea of creating enduring artefacts in his book Sustainable by Design⁷, where objects have an inspirational/spiritual or social/positional dimension attached to them that adds value. The term artefact suggests the object is an expression of a culture, and Walker discusses these objects within the context of museum collections. However, an invested object may be a uniquely personalized object, such as that made by a child, or with a link to an experience such as with a holiday souvenir, and the opportunity to personalize objects would increase the likelihood that they are kept in use longer. One question currently being debated amongst designers is how can consumers be encouraged to keep an object that cannot be personalised to them, and yet still have an emotional – or financial - attachment, therefore making its useful life longer, and spreading out over a longer period the effect of the embodied energy required to make it?
One example would be that of attaching a designer name to the object. By raising the profile of the designer or maker, or both, additional value is projected onto the piece ensuring that it will be kept in circulation longer. The London based furniture designer Tom Dixon\(^8\) discussed this in his talk at the Gallery of Modern Art in Brisbane\(^9\) in 2007, when he described two different uses. The first was where he created individual pieces of furniture that could probably more properly be described as investment art. The example he gave was of his ‘Fresh Fat’ chairs\(^10\), each of which uses 30 kg of extruded Polyethylene Terephthalate Glycol (PETG) co-polyester meaning the chair in question was not on the face of it environmentally sound, however, his argument was that it was only produced if it was definitely wanted (rather than as a mass produced object that might not be wanted by the time it was produced in quantity then built and distributed), ensuring it is valued, kept and in fact becomes more valuable over time so - will therefore be used indefinitely. A second approach was illustrated by his discussion of Artek\(^11\). After buying the company, Dixon advertised for old Artek chairs that were being used in government buildings (such as schools), then resold them without revamping them but with a badge describing their use since production. By adding a story to each individual chair, he added value and created a relationship between the chair and its new owner in order to ensure it was kept.

7.4.1.2. Current production Life Cycle Assessment (LCA).

At its most simple level, this strategy accepts the need for ‘temporary products’. This strategy embraces the human desire for change and focuses
on creating objects that have a limited life span but are designed to take this into account. Chairs made from cardboard, drinking cups made from biodegradable or even edible materials are the most straightforward examples of how this philosophy might be utilized. However, the use in production of full life cycle inventory and environmental impact assessment (including recycling and reuse but still within a current production philosophy, such as is used by car manufacturers), could also still be labelled as applying to ‘temporary products’, as they have a limited lifespan - albeit it as much as forty years or more in the case of a house. The impact of production, use and disposal/resource recovery necessitates a thorough lifecycle approach that has become highly complex, with the introduction of software and legislation now affecting the markets. One interesting aspect of life cycle assessment is that manufacturers such as Ford\textsuperscript{12} have identified the use phase of their product as one that they can affect to improve its LCA rating. They now offer eco driving school lessons which they claim reduces the environmental impact of their products dramatically. This example in particular illustrates that a life cycle inventory approach needs to be thorough and include upstream and downstream suppliers if it is to be effective. It is a complex and still much debated area that in itself creates seemingly contradictory outcomes. For example, is it a good idea to transport timber off cuts, thereby burning oil, to a biomass facility to be burnt, releasing CO\textsubscript{2} in order to offset the use of oil to create energy? Life cycle inventory and assessment ideally form the basis for all sustainable design approaches, but the results currently obtained from a straightforward assessment may exclude designs that are still arguably eco design under a different strategy.

\subsection*{7.4.1.3. Value adding: smart materials and technology.}

Technological innovation was identified as a means to achieve sustainable design practice by Dr C. Ryan in his book ‘Digital Eco-Sense: Sustainability and ICT – A New Terrain for Innovation\textsuperscript{13}. This strategy works to improve the value gained from raw materials, predominantly through the use of technology, to ensure that materials are fully valued. Smart materials, techno textiles and manufacturing examples such as metal injection moulding, gas-
assisted injection moulding and ultimately 3D home printing based on the developing rapid prototyping technology, all add value and enable more complex, niche market designs to be produced as increasingly bespoke product. All of these strategies are a technological response to the need for a craftsperson based approach to utilizing materials. In the same way as demonstrations such as the Australian ‘Create from a Crate’14, or the UK’s ‘One tree project’15 (repeated in Tasmania) show that materials normally discarded by traditional mass production, when used by craftspersons and artists, can result in even small, or poor quality materials being fully utilized, high-end technologies such as microwave bending16 and laser cutting can be used to improve the value of the same raw materials, such as small and or narrow pieces of timber17

7.4.1. 4. Product service systems.

This is a sophisticated strategy that involves the re-evaluation of a product within a holistic thinking approach based on lifecycle assessment tools. The system works on the assumption that the originating company will be ultimately responsible for the lifecycle of that product (as is becoming more legislated e.g. with plastic bags) and therefore must rethink how it could provide that product as a service on a cradle to cradle rather than cradle to grave basis. Cradle to cradle thinking was detailed by McDonough and Braungart18 (2002), and built on the business approach in Natural Capitalism by Lovins19 (1999) A major carpet manufacturer, Interface20 are probably the most well know of this new breed of manufacturer, publicly accepting corporate responsibility for their products. Through this re-evaluation, they have changed their business strategy towards providing a product system service for carpeting that has resulted in leasing rather than selling the product.

Flexible design is a key part of this design category. The basis of flexible design is to accept (as with temporary products) changing needs and desires, but rather than replacing a product, things are designed so that the product itself can be altered with changing circumstances. For example it can be
made larger, smaller, curvier or flatter, with different surfaces as required. This modular approach extends the life of the product to adapt to changing circumstances and therefore extends the life of the piece. This can be a dramatic rather than a small change, such as illustrated in the work of New Zealand designer David Trubridge\textsuperscript{21}, who creates a range of products from lights to 3D environments with the use of simple shapes joined together to create complex forms. He uses CADCAM plywood pieces fixed together with plastic fixings to build flexible curves that are easily transported flat and can be dismantled and rebuilt in a new form as required.

7.4.1.5. Biomimicry.

This strand of sustainable design has emerged most notably from the work of Janine Benyus\textsuperscript{22} and approaches design from the point of view of natural systems. Bayer offers workshops at the Biomimicry Institute to enable designers and biologists to work together to mimic natural systems in order to create design solutions that work with the environment rather than against it. Moving on from the mathematical inspiration of nature (e.g. golden ratio based on Phi, 1 to 1.618 and the Fibonacci series), this emerging discipline strives to create effective closed loop systems that are essentially environmentally neutral. An example of a designer successfully working in this area is Ross Lovegrove\textsuperscript{23}. Embracing technology in production and materials, Lovegrove, said by the Italian production designer Meda\textsuperscript{24} to have a ‘creative and conscious approach..(which)..reflects an awareness of environmental and sustainable issues\textsuperscript{25}, describes his approach as contemporary organic design, with nature as a ‘sensible and sustainable system that provides answers to several fundamental questions concerning industrial production\textsuperscript{26}.

7.4.1.6. Holistic thinking: stakeholders and design for humanity.

This design approach refers to socially responsible design strategies that are based on a holistic approach to production, use and resource recovery. It takes into account the effect of design decisions on stakeholders such as
landowners, workers’ quality of life, the effect on the lives of users themselves and also of the environment. Whilst it could be argued that an LCA approach should encompass this, different weightings in LCA tools mean that holistic thinking should be considered as an independent strategy. Back in 1918, a British economist, Arthur Pigou (1877 – 1959), suggested that a three part LCA should be used that included a social impact assessment, with the monetarisation of external costs such as welfare economics being applied to manufacturing. The British Institute of Applied Ecology (established 1985) echoed this thinking in their triple product line analysis of environment, society and economy, which was subsequently taken up John Elkington (1999) in his book, Cannibals with Forks and consolidated as triple bottom line thinking into the corporate arena. One of the difficulties in applying this thinking has been the qualitative nature of the input. It is therefore important to recognize this as a separate strategy so that its impact is not diminished as could happen if considered it as part of the same LCA strategy as current production ‘temporary products’.

Papenek (1999), suggested that the first world already had enough products and that designers should be designing for the third world. Humanitarian, holistic design is a sustainability strategy that considers global social and corporate responsibility. However, humanitarian design is not only for the third world, member of the organisation Architecture for Humanity would add to that design for the homeless, for example. For this area of design work, the use of appropriate technology would be a major consideration in whether or not the design was successful. Freecharge, from Freepay and Motorola, is an example of designing using appropriate technology, with a wind up phone charger that provides 6 minutes of speaking time for 45 seconds of winding. The disaster relief shelters described at the International Union of Forestry Research Organisations (IUFRO) congress in 2005 are another interesting example. These shelters are designed with no connectors for quick disassembly in the face of a hurricane warning, when they can be laid flat and buried. This design work has already attracted the attention of exhibition designers.
For this project, the application of the sustainability paradigm provides a basis for the design of appropriate product. Differentiation of the possible approaches within that paradigm enables the analysis of designs to ensure they are judged in their intended context.

References and end notes:

15. One Tree Project can be found on www.onetree.org.uk/home 08.05.06.
16. CRC Wood Innovations, Melbourne, Wood shapes project.


26. ibid p.9.

27. LCA tools such as Accurate, BERS Pro and First-Rate v5 www.architecture.com.au 05.02.08.

28. Pigou was Professor of Political Economy at Cambridge University from 1908 to 1943.


32. Architecture For Humanity, 2006 Design like you give a Damn Thames and Hudson, London.


34. IUFRO The International Forestry Review 2005 Commonwealth Forestry Association Shropshire, UK.

* Please note, this chapter has been published in:
7.4. 2 Design development for short lengths of timber.

a. Flooring: strips and parquetry
b. Fencing: acoustic and anti-graffiti and curved.
c. Window frames: laminated and steam bent.
d. Furniture: carved and turned.

Spotted gum docked off cuts (figure 7.32 photo by Loy 2005)

For this section of the project work, items b – d, the design intention is to exploit the nature of the off cuts in order to contribute to creating a value added product. A variety of different approaches have been used to produce different products (see sketch work in project books). If it is possible to produce products that do not involve the need to reprocess the timber off cuts, then that will reduce costs. If short lengths of timber are stacked, they will produce an uneven stack because they are all different sizes and are often cut at different angles. Although this finish to the edge of the stack is usually undesirable, I was interested in finding applications where it would be an advantage. In addition, by having a design where loose pieces are stacked together in layers, there are opportunities for acoustic applications to be developed.
Graffiti is painted on any flat surface that the paint will adhere to, such as concrete or timber. A flat surface shows the design in the paint work to its best advantage, allowing the graffiti to be read more easily and accurately, communicating to its target audience. A distorted or broken (with gaps) surface is therefore less likely to be defaced.

Stacked tongue and groove flooring off cuts, with no reprocessing, create uneven surfaces that could have uses in anti-graffiti applications.
Examples of road fencing where graffiti deterrent fencing could be appropriate (figure 7.37/7.38 internet images)

Fencing for public roads created from laminated, or mechanically fixed stacked off cuts could provide an uneven, and therefore graffiti safe surface. In addition, as discussed earlier in reference to the initiatives in America for the use of small diameter round logs in public space applications as a positive lead for society in maximising the uses of raw material currently considered waste, the Department of Main Roads in Australia would be demonstrating a commitment to leading the way in contributing to the sustainable use of timber in their various sites.

Examples of graffiti in public spaces (figure 7.39 internet images)
Uneven cladding for surface under threat would also be an interesting product, although some reprocessing would be necessary, perhaps even laser cut patterns. This idea, taken to the next step of refinement, would produce a product that could be used as cladding for furniture and interiors.
Uses of uneven surface, Brisbane (figure 7.40 photo by Loy 2006)

Because the off cuts are infinite when stacked, they could be stacked into endless different shapes, with corners and curves, as needed. These can then be carved to produce a smooth surface which could be used to produce very solid, uniquely, and individually shaped for the setting, public seating. Again, this would be a good project for the Department of Main Roads, in utilising off cuts in high value product for public spaces. It would be very resistant to the damage that can be caused by skateboards and BMX bikes.

Stacked, laminated for uneven surfaces
(figure 7.41 / 7.42)
Carved for smooth surface (figure 7.43 photos by Loy 2007)

Stack laminated off cuts also produce a material block that can be turned or carved to produce a quality product. It is a difficult material to turn, as the end grain on such a dense timber is very hard. However, with effort it can be turned or carved successfully, and the glue lines and grooved flooring detailing offer interesting opportunities for an unusual product that could be easily used for furniture or for detailing in commercial interiors.

Turning laminated off cuts (figure 7.44 photo by Loy 2007)
Craftsman docks timber for fine furniture (figure 7.45 / 7.46 photo by Loy 2007)
Where docked off cuts include longer off cuts, of up to a metre, maximising the wood involves designing to exploit the different lengths, rather than cutting them down again to an even size. This means designing a product that can vary in its dimensions, and in fact using that variation to give it its design features. This bench for example, is designed to follow the curve created by the size of docked off cuts available (figure 7.47 photo by Loy 2007).

Here the rails are steam bent spotted gum, but they could equally be metal. With metal or timber legs the seating area itself could also vary in height (see design project book). Either way the raw material is maximised.

An alternative to designing to exploit the uneven sizes of the off cuts to be used, which avoids the issues involved in reprocessing small pieces, is to design so that edges of the material are not seen in the final product. Using a mesh based, sandwich design; the uneven pieces can be stacked on their ends with only sections of good wood showing in any cut out centre detail. This would be an interesting product, made from, for example, CNC routered plywood skins which could be painted, with quality hardwood detailing.
The loose pieces could be stacked to allow for expansion and contraction, or built flat and mechanically fixed with an allowance for expansion around each piece.

Designing with small pieces, such as with the work of David Trubridge, allows for designs that can be altered for changing needs and which build up to create different sized items since they are not limited by board length. Trubridge uses a CNC router to cut the shapes from plywood, to create value added product from a low cost sheet material. Trubridge took the design shown below in small pieces packed in a suitcase with him to the Milan Furniture fair, where he built it using plastic clips that could be removed after the piece had been displayed.

Using the size of the small lengths to produce a curve, as in the exhibition piece ‘spiral’, allows for the design of unlimited length, s-shaped partitioning applications. This design requires the pieces to be reprocessed and would therefore have to be used in conjunction with the development of safe equipment to do so. However, the idea would have interesting commercial interior applications.
In addition to laminating the off cuts as stacks, they can also be laminated in layers to create a new board product that is dense enough to produce a high quality finish when carved. This design idea requires that the pieces be small enough that expansion will be as insignificant as possible in order not to stress the glue.

This has only been possible with the advances in glues that can cope with the extractives exuded by spotted gum timber after dressing. Bostik’s AV515 adhesive and a strong two part epoxy were both found to work well, both in work shop practice through trials, but also in production at companies like Ausgum in Queensland.
Flooring strips constructed from glued pieces could be made as detailing strips for companies such as Hurford Hardwoods flooring. Mixing colours and sizes allow for interesting patterns would add to the range of a flooring company.

7.4.2.1 Using short length off cuts for producing curved framing.

For this project, circular window frames were considered as they are currently made from multiple blocks of wood glued together to create a piece large enough for the frame to be cut from. Not only is this wasteful, but also the glue lines are horizontal or vertical rather than radial.

The off cuts were cut into wedges (it was less dangerous to cut more off than simply squaring the timber). These were glued into a two layer circular block with two-part epoxy.
An inner frame was made from steam bent spotted gum, and the surface of the wood was carved to explore the idea of a high value porthole window frame for fixed glass. The steam bent centre was slot routered to take the glass. Variations were explored using single layers and steam bent curves of narrow pieces of timber.
This workshop practice demonstrated the potential and challenges of using various lengths of offcuts from the furniture and flooring industries in alternative high value applications, both 3D and 2D.

Reference:

1. David Trubridge  www.davidtrubridge.com  09.08.07
7.4.3 Design development for narrow pieces of timber.

This chapter explores the creation of value added products from narrow pieces of timber using value adding processes such as steam bending and lamination – furniture, railings, shelters, partitioning, window frames.

Narrow lengths are created when boards are ripped lengthways to cut out sap, and when small diameter thinnings are harvested and sawn. Currently, neither of these occurs on a regular basis during hardwood production in south east Queensland.

Short and narrow lengths of timber present the same challenges in reprocessing as do short, wide lengths. If reprocessing was possible to undertake on a production scale, then one of the best prospects for use would be in the construction of laminated beams for use in building. There is currently a Chinese beam produced that is 140mm x 140mm made up of strips that are 45mm x 12mm finger jointed and glued together and composed of mixed hardwoods, that retails at approximately $60 per lineal metre\(^1\). This beam can be produced in any length, as it is made of small pieces and, according to the retailer, Ironbark Timbers in Queensland, displays good strength properties.

Because the most likely need for the industry with regards to the utilisation of narrow lengths of timber at this time is for a use for thinnings (to supplement the income of private forest owners until their main crop matures, and to off
set the cost involved in thinning), I have concentrated on this in identifying
design development opportunities.

Thinnings are well suited to the value added process of steam bending. High
value steam bent products using narrow pieces of timber are produced in
Australia by designers such as Matthew Harding (see ‘pelican’ chair design
below). In New Zealand, David Trubridge produces innovative commercial
designs using narrow pieces. The boat building technique he uses, where the
steamed lengths are attached directly onto the final frame rather than a drying
jig, provided the inspiration for the method behind the designs for public
seating suggested in this project.

**Pelican Chair by Matthew Harding (figure 7.58.ww.matthewharding.com.au)**

The steam bending workshop practice described earlier informed the design
work for this section (see sketches in project books). As demonstrated in this
study, narrow pieces are particularly pliable to use in steam bending or
laminating applications - suggesting that value added products based on
curved slats present a viable design direction.

Although narrow pieces of timber have long been used in the creation of
decorative window and door treatments, the process of steam bending offers
the potential of value added applications. The CRC for Wood Innovations in
Melbourne found through a survey of Australian manufacturers that there is a
market for bent components with current manufacturers and is currently
researching the possibility of producing these components using microwave
techniques, through the research production company, Wood Shapes². The
project has not yet been completed.
Laminating allows for narrow timbers to be shaped into value added products and so was a technique was explored as part of this project.

As well as steam bending, lamination allows for more complex curves to be created than steam bending, unless the technique of compressing the wood is used, as with the Danish firm Compwood\(^3\), which produces timber that can be twisted and knotted as well as bent. Their patented process was developed by the Danish Technological Institute in the mid nineties. Wood with a high moisture content, around 20-25\%, is first heated, and then compressed longitudinally using a hydraulic press that folds the cell walls. The change in cell structure means that the wood can be twisted or bent later, even when cold. It can be bent in more than one direction, and to very small radii. It becomes stable once it is dried in a kiln (the company does produce another product that stays permanently flexible). Investment in developing a similar
process would be of value to the Australian timber industry; however, this technology is currently not available in Australia.

There is certainly the potential to use timber, both laminated and steam bent, for value added architectural and commercial interior applications that are currently made from other materials, such as metal, as for decorative screening. Pathway railings and shelters offer a good market for value added product for manufacturers who would currently offer low value products, for example stakes, for their off cuts when producing outdoor products such as fencing as high value products.

References and end notes:

1. Ironbark Timbers, Kunda Park, Queensland.
2. www.crcwood.unimelb.edu.au
3. www.compwood.dk
7.4.4: Public procurement to promote the utilisation of short and / or narrow lengths of timber for value added products.

For any product idea for this project, the LCA driver is, in my opinion, the most powerful for their success as commercial products at the moment. In particular, any designs that could be used by government departments, such as by the Department of Main Roads in its upcoming $8 million bike paths scheme for Brisbane, would contribute to the positive response of the timber industry to the sustainability imperative and demonstrate the government’s commitment to a new sustainability paradigm in a high profile, easily publicised situation. Combine the product with explanatory boards and sculptures made from off cuts and the results would be very effective in educating the public and demonstrating good practice. Designs could include railings, signage, seating, shelters and sculptures.

Recommendation: Lobby public bodies for public site (e.g. seating, shelters and fencing on bike paths and pedestrian malls) and public art works (such as has been achieved in America where park buildings are built from small diameter logs as a matter of policy) to promote the use of off cuts and short length recycled timber in projects that communicate to the public the intention of the industry to value its raw material.

Suggested example: an approach could be made to the Department of Main Roads, Queensland with the following Bike Path Project proposal.

As part of the Metropolitan Transport Infrastructure Development Scheme\(^1\) (TIDS) planned for the next four years, the Department of Main Roads has allocated around 8 million dollars to bikeways in the city area. Products specified for these projects will provide facilities for cyclists, such as bike stands, signage, seating, shelters and rubbish bins. There will also be a need for fencing along some stretches of the bikeways. Artworks are also a possibility if relevant funding could be attracted.
With large concurrent bikeway developments in the city, there is an opportunity for the Department of Main Roads to integrate into their plans a design style that is not only interesting and aesthetically distinctive, but contributes to the reduction of wood waste going to landfill, which is an expressed concern of the Department through their involvement in the Construction and Demolition Waste Resource Recovery Group for south east Queensland.

The Department of Primary Industries and Fisheries, Innovative Forest Products section in Brisbane has a PhD student who has been working in conjunction with the Co-operative Research Centre for Wood Innovations, on a project utilising pre-consumer-use wood waste from local sawmills and manufacturers, and post-consumer-use wood from Resource Recovery Centres. The premise is to design value added products from the short and/or narrow lengths that are either the result of docking during production, or recovered from recycled timbers.

One of the conclusions of the study was that, although there is a growing sustainability imperative for manufacturing industries in Brisbane, it is still in the early stages. Leadership by government departments, such as the Department of Main Roads, will help to publicise the issues and promote solutions that will contribute to the attitude shift necessary for the general public as consumers, and the manufacturing sector, to move from a society based on obsolescence to one based on maximising resource use, resource recovery and reuse.

The basis for the design briefs for utilising short and/or narrow lengths of timber currently sent to landfill or burnt, are threefold:

- Design inspired and directed by the variety of short (up to one metre) and/or narrow lengths docked.
- Designs to utilise very short off cuts (less than 140mm long) with minimal reprocessing.
- Designs that utilise value adding processes.
The Brisbane River, the interlacing curves of the riverside expressway and the movement of the cyclists themselves inspired the overall design ideas. The complementary pieces are intended to work together to create a sinuous, flowing look to the bikeways, with points of interest marked by features that utilise curves and innovative design aesthetics. It would also be worthwhile to provide signage and artworks explaining the premise for the designs.

This project proposal is based on sketch development work in the project books, which suggests three possible directions for specific briefs. The first utilises short lengths as in the bench shown, where fencing, seating and screening is based on mixed lengths sorted into wave shapes, giving a flowing style of products.
The second is based on solid, laminated blocks of off cuts that are industrially carved to create amorphous pod shapes for central seating areas in particular, that would be resistant to graffiti because of the rougher texture of the exposed end grain. In places, the sides of these blocks could retain the uneven surface of stacked laminates to add visual and textural interest and discourage graffiti. These blocks would be solid enough to withstand skateboards and BMX. The third design direction would be to explore the use of steam bent timbers of different lengths to create railings, seating, signage, screens and artworks. Seating forms could be created using the boat building technique of initially producing a frame, then forming the softened timbers directly onto them. Mixing lengths of narrow timbers for this would give an unusual and interesting aesthetic. Railings with undulating curves top and bottom, with uprights that have been bent in a variety of formers, including double bend formers, could be used to provide a sense of direction and movement along the paths. Steam bent narrow lengths would provide a good material for artistic screening and signage.

Reference:
17.02.08
7.4.5: Equipment design directions.

As the research and workshop practice in this project has demonstrated, the main challenge in using pre-consumer off cuts of less than one metre in a manufacturing situation (batch or mass production), has been the difficulties associated with reprocessing. Conventional machinery is built to suit large pieces of timber and is generally dangerous to feed with small pieces. In order to utilise small pieces more often (particularly in a batch production situation) but equipment to help with reprocessing. In addition, for value added processes such as steam bending and laminating, there are no commercial jigs available in Australia to make the process easier and more flexible. Designs for equipment in these areas would significantly increase the amount of timber, including short and narrow lengths that could be used for value added product and this area should be given priority in future research.

7.4.5.1 Reprocessing jigs, directions for engineering design briefs.

The first jig needed is a docking jig. It needs to allow for short lengths to be slotted into it and held in place, and yet still allow the blade to move freely. A second jig would be suitable for both a drum sander and a thicknesser. The pieces would need to be held in their centres, so that the jig could be turned in order to be fed back into the machine.

A third, detailing jig, allowing for the use of routers and carving tools needs to hold the pieces in place without inhibiting the tools. Vacuum clamps would be suitable for this. There are small sized vacuum clamps that would be ideal for use in a batch production situation where detailing was to be used for value adding.

More extensive use of vacuum clamps would also make sanding easier, particularly when using small pieces to make intricate shapes, such as illustrated in the construction of triangles below. I found that in order to practically sand these pieces (part of a design for an exhibition piece of
sculptural furniture to illustrate the value of spotted gum in high spec. furniture design) I had to build the triangles first, then sand them collectively as the pieces were too small otherwise.

(figure 7.65 – 7.67 photos by Loy 2007)
7.4.5.2 Steam bending jigs, directions for engineering design briefs.

The majority of the labour involved in steam bending is in building a jig to the exact specification required for the project as well as making sure there are enough drying jigs for the quantity of product needed. These are traditionally made from a board product, such as medium density fibre board and built up in glued layers, or with blocks depending on the curve required. They have to be strong enough to resist the timber bending back to its original shape.

One approach to the design of equipment that could improve flexibility and speed when steam bending, would be the development of a frame that had the flexibility to be easily altered for different sizes of timber. An example could be a double, slotted steel frame that allowed for cross pieces to be placed at a variety of locations to alter the curve. This could be taken apart easily for storage and re-used when needed. This idea would need to be developed further and tested before discussed further in this text.

7.5.4.3 Laminating jigs, directions for engineering design briefs.

With lamination, as with steam bending, a shaping jig is necessary to create the desired curves, but any length, however small can be used if the timber is thin enough to contour around the jig. However, because laminating typically involves using thin strips of already seasoned (dried) timber, the glued stack of laminations can be vacuum pressed on the jig in less than twelve hours (depending on the size). Therefore, no drying jig is necessary. Innovations in jig design that result in easily formed jigs that give enough support for the stack to be vacuum pressed would reduce the labour costs for this process and therefore make it a more viable option for value adding to timber product.

Stack laminates are difficult to clamp into curves using traditional clamps. On the basis of findings outlined in this study, innovations in clamp design that assist in the stack laminating of short off cuts would be most beneficial.
Clamping stack laminates (figure 7.68 / 7.69 photos by Loy 2007)

Designs of equipment that would allow for more flexibility in the shapes and details thus created would enable more interesting designs to be more easily made, contributing to the ability of makers to target higher value markets - or reduce the labour cost of production thereby reaching a new audience.

Leaf shaped table, laminated edges and box triangles © Loy 2007

(figure 7.70 photo by Loy 2007)
Chapter 8: Summary and Conclusions.

Changing resources, changing attitudes, changing practice. *

Our ageing population reinforces the need for acceptance of a design methodology of inclusive, appropriate design\(^1\) by emphasising the fact that previously marginal markets are now part of mainstream design - and this is a challenge for all of our industries. From a mass production mentality to a batch production way of working, our industries need to invest in the technologies to allow them to create for the pattern of multiple ‘niche’ markets that is emerging - as opposed to the mainstream ‘one size fits all’ it was built on.

At the same time, the global environmental crisis demands that we apply a correspondingly inclusive attitude to maximising our resources. Because of the particular demands on it at this time, the timber industry provides an excellent example. Changing existing practice to respond to our changing wood resource needs a mind shift that challenges a currently wasteful, segregated timber supply chain that significantly under utilises its resources. In particular, technology could be used during the transition to give a full and accurate assessment of the changing resource, to maximise utilisation at each stage of processing, production, specification and installation. Fostering an integrated value chain that can provide more flexible, value added solutions for the changing demographic, whilst responding to the lower grade material available, is part of the role of the designer - a role that has become increasingly complex. There are, however, tools that designers can now use, and support in terms of methodology that can be effective as the basis for a new design strategy.

The emergence of design research as a discipline has seen a growing body of work regarding the role of the designer. Facilitating design decisions through the application of a design philosophy disengaged from traditional corporate culture when approaching the work has been the subject of much debate\(^2\).
deciding which projects to undertake, defining the limits of a demographic,
specifying materials and processes and balancing the relationship between
responsibility to the stakeholders and a wider responsibility to society, the
designer is now making decisions that affect ‘forms of life’\(^3\), alter the balance
of power between social groups and have long term impacts on world
resources.

Design research debate over the past five years has focused on defining the
responsibilities of designers. Design methodologies forcing proximate
designers\(^4\) to think more broadly, have been advocated to address the needs
and concerns of society from different standpoints. In his 2004 essay ‘The
Challenge of Responsible Design’, Jesse Tatum voices his opinion on the
necessity of a ‘vigorous grasp’ of consequentiality for individual designers. He
argues that even designers who feel they are designing ‘innocuous,
insignificant products’ must understand that their work can have far reaching
consequences.

“There is, perhaps, no more powerful mechanism in our grasp for
shaping the choice of a way of life than the accumulated increments of
design (technology) that progressively and selectively underwrite certain
patterns at the relative expense of others”\(^5\).

If this is the case, then it is essential to approach each and every design
project, however small or seemingly localised with a design philosophy and
methodology that stands up to scrutiny.

“The client-focused, one product-at-a-time marketed approach also
means that designers tend to assume that any given design has little
effect on other design, so negative synergisms can be ignored”\(^6\).

At the same time the issues of sustainability and the urgency of providing
practical responses – including design responses – have been developing.
By the time the World Summit on Sustainable Development took place in
Johannesburg in 2002 the issue of ‘sustainability’ had become fundamental to
political and industrial agendas throughout the world. It was recognised that an environmental crisis point had been reached that required ‘revolutionary’ thinking to respond to the time frame. Shapiro, the former CEO of a company that promotes itself as a biotech company, Monsanto, emphasised the urgency of the task:

“We don’t have 100 years to figure out how to avoid ecological catastrophe…at best we have decades”7.

Sustainable development was defined as intergenerational responsibility by the Bruntland Commission8, when it described it as the ability to meet the needs of the current generation without compromising the potential of future generations to meet their own needs. McKenzie (1997) in her book on green design, said that the implication was that in order for development to be truly sustainable, it must ‘take account not just of economic factors, but also environmental and social factors, and must assess long-term consequences of actions as well as short-term9’.

Design of all descriptions is now at the forefront of debate on what constitutes the new industrial revolution10. In 2002 environmentalists McDonough and Braungart reinforced the message of a partnership between environmentalism and business and took it further to completely reject the cradle to grave mantra of the late nineties in favour of only closed-loop industrial practice to reduce landfill and incineration. Their argument was that a broader, more realistic view of product lifecycles needed to be considered as products themselves contain on average only 5% of the raw materials involved in production and delivery11. Ryan suggests that ‘60 – 80% of the lifecycle impacts from products are determined at the design stage12 - which makes being an industrial designer now quite a daunting prospect. Far from designing products in isolation for a limited market, it is the responsible designer’s role to think broadly across processing and production as an eco-pluralist13 within the sustainability imperative.
So what tools do we have to rise to the challenge? The main tool that has emerged in the last few years has been a positive approach to technology. From initial calls to de-mechanise, industry and business can now promote technology as the way forward. One of the main reasons for this is that the changes needed to avoid ecological disaster are so radical that it is generally recognised that we need advanced technological solutions. In his book Chris Ryan (2004) describes the consolidation of ideas over the last three decades as coalescing into a new paradigm for sustainable development. He states that the economy can be uncoupled from environmental degradation only through industry and business working together with technology as a positive force for change\textsuperscript{14}. The necessity for ‘break through innovation\textsuperscript{15}, in order to provide any kind of meaningful response to the demands of creating sustainable practice within this paradigm require new ways of thinking, new ways of working and the support mechanism to make these ideas a reality.

**An example of theory into practice: applying the eco-innovation paradigm to the Australian timber industry.**

Ten years ago the focus for research and development in forestry\textsuperscript{16} was on scientific forestry management, genetics and certification, controlling die-back, air pollution and biodiversity. Today, research and development reflects the global concern over the environment - with research into the effects of climate change, carbon sequestration, plantations, the sustainable use of wood and non-wood forest products and international forest restoration. The idea of a cross-disciplinary paradigm ‘in order to transcend the limitation of traditional disciplinary thinking’ was raised by Hickey and Nitschke (2005) in their paper ‘Crossing disciplinary boundaries in forest research: an international challenge\textsuperscript{17}. This new, transdisciplinary approach surely is essential in the face of the need for ‘break through innovation’ as opposed to gradual change. And, whilst innovative technology can provide the tools, the designer must work with industry to step back from current practice to provide objective, holistic solutions. Ryan (2004) argues that ‘Fundamental to this new consensus is a belief in innovation: innovation in its widest sense – not only ‘technical innovation’, but also ‘innovation in economic, social and institutional
structures’. Only by providing an interdisciplinary, integrated plan for improvement can radical new thinking emerge that could succeed in meeting the demands made on the industry.

Unlike any other industry, the timber industry has a fundamental responsibility because of the ability of trees to support the atmosphere, and yet it also has a background of practice and processes that work against its valuing its own resource – which has to be challenged by the designer. The future of Forestry in Australia is a huge issue. Australia contains just 4% of the world’s forests at 154,539,000 hectares (including ‘non-productive’ types of forests) and, of the ten most forested countries in the world, has the highest forest area per capita with forest covering 21% of the continent. Total wood exports for 2003/2004 reached $2.06 billion and there is an estimated 10.5 million tonnes of carbon currently stored in the forests.

In the face of the need to maintain this natural capital, there could be the argument that trees should be left in the ground and that the construction industry and manufacturing should look to other materials. However, effectively managed plantations provide not only atmospheric benefits, but a truly renewable resource. Ryan (2004) lists six strategic principles for sustainable development:

- Valuing prevention (designing for effective systems rather than for correcting problems at a later date).
- Preserving and restoring ‘natural capital’.
- Life cycle thinking (closed system cycles).
- Increasing ‘eco-efficiency’ by ‘factor x’ (the level needed for sustainability).
- Decarbonising and dematerialising the economy.
- Focusing on design – of products and product service.

If decarbonising is a strategy, then the promotion of timber product is indeed a good idea. Lifecycle analysis, although still a developing and complex discipline indicates that the actual growth and conversion of timber competes favourably with steel and aluminium. Annually 7.5 billion tons of raw materials are extracted from the earth to make concrete, steel, sheetrock
and glass. The long term implications of those figures are staggering. As Talarico (2005) observes, ‘After 11,000 years of building to protect ourselves from the environment, the delicate environment must now be protected from us’.

Currently approximately a quarter of the global annual wood harvest is used in construction. The higher the proportion of timber used for value added products, such as construction products, rather than being chipped or pulped, the more the resource is being valued. However, current practice within the conversion and processing of that timber needs to convert to the first key principle of ‘valuing prevention’ as proposed on Ryan’s list for a sustainability paradigm, and that will require the biggest mind and practice shift of all. It is in this area that investment in technology, improved information gathering and communication flow could have the most benefit. Valuing prevention as a strategic approach requires that preventing the creation of waste is prioritised over the disposal or reuse of waste (including low value products such as pulp), thereby utilising as much of the resource as possible, irrespective of the economic cost.

In applying the strategy of ‘valuing prevention’ to the practices of the timber industry, it is necessary to suspend consideration of the current economic drivers and project into the future. As opposed to continuing with the legacy of the past, which Ryan (2004) describes as ‘a resistance to preventative thinking is often just the continuation of past habits and a tendency in business to focus on short-term goals’. With a hugely abundant resource and a relatively small population, the pioneering foundation for logging practice in Australia created a culture of excess. Over engineering occurs as products are designed for specification of the weakest timber that could possibly be supplied (just in case that happens) rather than the timber being selected specifically to maximise its potential. Sawmills were built to handle fully grown trees with wide girths as old growth forests were logged. Recovery rates were unimportant as the resource was cheap and plentiful, and as a result there was little incentive to invest in designing equipment to maximise the log. Visual as well as structural faults were routinely docked to
supply clearer grades for specifiers\textsuperscript{27} and, because long lengths fetched the highest return, smaller pieces were discarded. ‘Valuing prevention’ as a strategy requires a fundamental shift in thinking that such current practices will make difficult. During conversion, timber is currently rejected that would be utilised with a different mind set – or different economic drivers. As discussed in the book ‘Natural Capitalism’ (1999), the current economic value placed on natural resources, and in particular old growth forests, does not take replacement costs into account:

If there are doubts about how to value a seven hundred year old tree, ask how much it would cost to make a new one\textsuperscript{28}.

If wood had the value of gold, the cost of the resource would outweigh the cost of processing and every little piece would be valued. This approach was applied during a project originally conceived in 1998 in the National Trust Estate of Tatton Park in Cheshire, England. Known as the One Tree Project\textsuperscript{29}, the project was repeated in Tasmania with 50 artisans (the original involved 70 artists, designers and makers). An 86 year old, 44m high, messmate stringybark tree (\textit{Eucalyptus obliqua}) was heading for the chipper, having been considered not worth milling. The artisans produced many varied products from every part of the tree, including the roots. The goods were auctioned for $13,851.

Without expecting industry to go that far, changing the focus to maximising recovery through incentives or penalties would be a start. Financial support for the widespread use of available technology, or investing in the invention of new technologies to gather information to enable decisions to be made on maximising the resource, then investing in the best technology possible to convert and process the resource, would be even better. Providing a working framework, through a review of standards (particularly with regards to appearance grades), education on specification and the design of products and processes that support maximising the resource would be the ideal. Looking to the future – and perhaps only twenty years into the future - when the timber industry will be more dependent on plantation timbers (private
natural forests will still be available), the economic as well as the environmental drivers will force a shift in values that could create such change. The problem is we need the changes to be implemented now.

To protect native hardwood forest, a series of agreements were signed in 1999 that locked up native forests on Crown land from the hardwood processing segment of the timber industry in south east Queensland, and reduced access in other states across Australia by 2024. To compensate for the loss of supply, the creation of hardwood plantations was encouraged through incentives, although this was not as successful as anticipated and has led to a critical shortage of supply. In addition, many of the hardwood plantations established five years ago will have to be harvested in eighteen years time, even though the trees will not be fully mature. Their higher proportion of juvenile wood is expected to result in more defects, which with current practice means more docking and more waste at each stage of conversion and production. The Australian timber industry – and consumers – will need to change their expectations of the quality of the resource. With a growing population, a demand for more flexible products to supply an increasingly diverse and aging demographic, and a changed resource, designers will have to work with industry to develop new technology and working practices if positive benefits are to be achieved for growers, sawmillers, manufacturers, specifiers and architects. The new role of industrial designers in contributing to the reorganisation and regeneration of the supply chain as a whole is a challenge, but it is also an exciting opportunity to have the economic drivers to support radical change and serious investment in new technology.

8.1 Key areas for change.

Wines, in his essay on architecture and ecology, suggests sustainability also provides a positive stimulus for architects:

“This is potentially one of the most challenging periods of architectural innovation in history. While many of the established architects today will
seem intimidated by the accelerating momentum of change – fearing their stylistic commitments may be under attack – there is no reason why the environmental revolution cannot be welcomed as the threshold of a great creative era. Here is an opportunity to invent the future on terms that are sociologically and ecologically responsible.\(^{30}\)

In an attempt to invent the future of the timber industry ‘in terms that are sociologically and ecologically responsible’ following an overall design approach to improving production processes, practice and product within the Australian timber industry, four stages of solutions are proposed:

1. Information and communication flow through the supply chain in both directions.
2. Education within the current supply chain to improve specification practices.
3. Design to promote an integrated value chain.
4. Investment in innovative technology to support the shift to maximising resources.

If 60 – 80% of the lifecycle impacts from products are determined at the design stage then designing products within an eco-innovation paradigm for the timber industry must promote maximising the resource. The focus of design then should be on promoting an integrated value chain, maximising the resource, reducing off cuts and supporting disassembly. For example, poor specification practice often means that avoidable quantities of off cuts have to be removed at a cost from site during flooring and decking installations. This could be avoided by designing a product where the flooring is supplied in pre-joined lengths ready to fit. Increased processing costs would be off set by a reduction in installation costs – less skilled labour, less time and no waste. The added bonus of utilising small pieces would be included. To do this, designers need to be able to design the product, and then work on a brief to produce the technology to achieve it.\(^{31}\)

Taking this idea one step further, if other construction products could be designed as clusters and cutting patterns sent back to the sawmills as a group...
so that the design and processing were more integrated, the resource could be maximised, thus the design of products would alter practices towards sustainability. There are successful examples of this. For example, Ausgum Furniture an outdoor furniture specialist who use lemon scented gum (*Corymbia* spp.) for their product, was initially set up to utilise off cuts from a flooring sawmill. The designs were originally specified to utilise small pieces left over from the flooring operation, but gradually it was found that a better working practice was to design the pieces and then specify lengths back to the sawmill. Whilst they will still have some off cuts at the mill, they have no off cuts at the manufacturing point in the supply chain. This area has potential for the redesign of products in clusters, but also the design of equipment to assist in the processing of small pieces.

9.1.1 The potential of technology.

The key to improving practice in the timber industry is investment in technology and changed practice through the use of that technology. There are examples of relevant innovative technology being utilised to solve unique problems such as the Bacci double router and a variety of finger jointing systems used for construction and moulding applications, but in order to achieve the ‘factor x’ improvements needed to work sustainably, a planned approach throughout the supply chain needs to be imposed across the industry as part of an overall commitment to sustainability - as outlined by some of the eco-efficient strategies - developed since 1996:

9.1.2 Reducing the material intensity of goods and services.

In reducing the amount of timber used in timber products, it is important to look at the characteristics of the wood itself and how it is specified. The same species of tree will grow differently in different situations. Even in the same forest, trees on stony soil will grow differently to those in poorly drained valleys. Specification based on species must assume the weakest tree possible, grown in the worst conditions. Current grading necessarily generalises about the possible uses for each species in order to give safe
standards to work to. This can result in over engineered product because the individual log actually used is not the weakest. If a standing tree could be assessed by non-destructive evaluation technologies, for example using an acoustic stress wave for stiffness, the forester could base a decision on appropriate harvesting time on the best potential application for the stem, allowing trees to continue growing until they achieve their maximum value.

Once then cut, strength testing of the individual log would provide valuable data to enable that log to be used to its full potential. In practical terms, this means that, as an example, the thickness of timber specified for a public bench could be reduced because the strength of that actual piece of timber would be known.

9.1.3 Reducing the energy intensity of goods and services.

One area of research that the industry would greatly benefit from would be developing improvements in drying processes. To speed up the drying time and control the behaviour of the timber would make the process far more efficient – benefiting life cycle inventory – and reduce costs. The potential of microwave drying has begun to attract research funding.

Another area of conversion that could be made more efficient and thus reduce the energy intensity used (this would also eliminate waste by avoiding poor initial processing of timber that then requires reprocessing or rejection) is through scanning of logs to give a cutting pattern that maximises recovery. Before cutting, the computer scans the log for volume, checks for defects and analyses each log to give an individual cutting list that provides the highest value return for the log.

Although not a major focus for this study, advanced technology prototype development tools such as 3D printers and rapid prototyping in resin,\textsuperscript{34} allow for greater experimentation in design to explore new components, such as connectors, that could contribute to improved efficiencies in the construction of complex products.
9.1. 4 Enhancing material recyclability and component reuse.

This is a very interesting area as recycled timber has become increasingly sought after for architectural applications. Currently preparing the reclaimed timber for reuse is a labour intensive process. It is necessary to find and remove old nails by hand. Technology to scan for nails and assist in their retrieval would be the first step; however, ideally, all timber applications, including construction and manufacturing could be designed for disassembly. Joining systems could be based on mechanical fixings rather than adhesives that could be undone at the end of the product’s life, or in order to replace individual components.

The other significant area where there is potential to enhance material recyclability in the timber industry is pre, rather than post-consumer. Once the timber is processed and dressed for, for example, flooring, further docking occurs to fit the standard lengths traditionally supplied. At this stage the timber already has costs attached to it, and yet the waste is currently binned. As an example, a medium sized sawmill in northern New South Wales has 3 cubic metres of hardwood off cuts per day. Around half of these have been docked because of knots in the timber – which may mean they are not suitable for the grading the company wants them for and the other half is binned simply in order to fit lengths to the standard packaging sizes. Next, the timber goes to the manufacturer or on site. In either case, the timber must then be cut to size. Wastage of approximately 10- 15% is accepted at this stage, but can be higher.

As well as retooling for small logs, changes to the Australian grading system to encourage the use of lower, visually graded timber and education into specification practice would reduce the incidence of off cuts. In the meantime more machinery capable of reprocessing small pieces and assisting in the reprocessing of small pieces, such as machine-gun fed routers and equipment such as vacuum sanding jigs would benefit the industry.
substantially, making the design of product using small pieces more economically viable.

9.1.5 Maximising sustainable use of renewable resources.

Short of encouraging a ‘One Tree’ philosophy, the fundamental change that needs to occur is retooling (and a change of attitude in specification) to use more of the log. Currently only approximately 30% of the log is recovered (it is possible to use specialist cutters such as radial saws which the manufacturer claims can make a far higher recovery from the log). The economic incentive to use more of the wood is currently not there. Also, there needs to be universal retooling of sawmills for small diameter logs, including thinnings in order to utilise as much of the resource as possible. Government grants to retool for small diameter logs have been issued across Australia, e.g. the Tasmanian timber industry has recently received a $56 million grant. This problem is not unique to Australia. In America the timber industry has a similar heritage and was forced to face the issue of diminishing resources earlier than Australia with major investments in retooling.

Beyond retooling for small diameter trees, there is also a need for the ability to convert thinnings. Thinnings are less vigorous, damaged or suppressed stems in a plantation that are removed to allow the strongest trees to develop to their capacity. Hardwood thinnings are typically removed at about 8 years old, and again at 12 years, depending on the management system and target products. Currently there is little commercial use for thinnings in Australia, although they are ideal for steam bending. In addition, current research into the microwave bending of small components opens up the possibility of more commercial uses of bent timber which would be valuable as it could provide income for growers to offset costs until the main stands were mature enough to harvest.

Scanner-docker machines that generate a computerised image of the board can take a mix of plank sizes without any reconfiguring necessary. Each plank is scanned and a dimensioned plan of it recorded. Meanwhile, the
operator uses a laser to mark the plank for docking. It is fast and effective and provides valuable data on stock. Combined with a sophisticated planner that provides an integrated cutting pattern for product clusters, the equipment enables the resource to be used to its full potential.

Computerised routers that give flexible, complex cutting to improve product potential in adding value will contribute to maximising the use of the resource. In the past, the cost of new dies for cutting tools was so prohibitive that in mass production, all new products had to have long runs. Recent advances in computerised routers mean that batch production can be employed by mass production manufacturers, providing for an increased flexibility of product. Innovative, double headed computer controlled routers offer complex cuts that open up the potential for design.

9.1. 6 Extending product durability and increasing the service intensity of goods and services.

With a quarter of all timber used for housing construction, it is interesting to consider these two issues together. At a recent seminar on life-cycle analysis\(^\text{37}\), it was suggested that the average life of a timber house in Australia is forty years. Product durability was not the concern, but fashion. After forty years, the houses were removed and a new version put in its place. If the industry, like all other industries, needs to consider a radical shift towards service based goods, would it be beneficial to recognise that forty years is the likely life of the house, provide a contract that effectively rents the house to the owners for forty years after which time it is removed for disassembly and a new one provided? Instead of building it to last, build it to be changed every five years as fashions change and easily disassembled and reprocessed. As suggested in the chapter on design education, the same could be true of furniture.

* Please note, this chapter has been published in Anderson, L Jackson, S 2006 *The New Design Nexus: ICT, changing demographics and sustainability*, Lab 3000, Melbourne
9.1. 7 Designing futures.

We are at an environmental crisis point and revolutionary thinking is needed. As the timber industry example illustrates, radical changes in practice are possible using tools that new technologies provide us. Designers can initiate the development of innovative technology by thinking broadly in response to the sustainability imperative and then designing beyond the parameters set by their immediate clients. Fundamental to this, as discussed in the paper ‘Design education’ by Ramirez (2004), if we are to have a shift in the role and responsibilities of the designer towards a broader view of design to include leading changes in processes and practices for sustainability and demographic inclusion, then we will need to give our students the tools to meet that challenge. Lateral and holistic thinking are already part of the curriculum, but stepping back to understand the underlying issues of a brief and an understanding on writing briefs for supporting innovative technology will also need to be included. Courses in sustainability, such as that established at Swinburne in 2005 will need to become far more widespread and support for innovative ideas will be essential if we are to translate the outcomes of that education to Australian industry and business effectively.

For the sake of the economy and the environment, designers need to shift their thinking in line with the move to sustainable practice in order to ensure they have the clients to design for in the future and the sustainable practices and resources needed to maintain them.

Action points:

Recommendations for design education.

- To discuss and define more specific strategies for sustainable design practices and eco design.
- To broaden design teaching to ensure an eco-pluralistic approach, with consideration of the impact of design decisions on stakeholders, society and the environment.
To ensure the inclusion in design education of the redesign of current product from a sustainable design practice stand point.

Recommendations for the south east Queensland hardwood timber industry.

1. Communication.
   - Promote timber more actively as the only carbon neutral, truly sustainable building material through an increased presence at conferences attended by developers and architects, and through sponsored research by architects and designers.
   - Set up a web site dedicated to promoting timber as the only carbon neutral, truly sustainable building material and provide on that web site the opportunity for co-operation between stakeholders in the supply chain to be seen to be actively working towards sustainable strategies, such as the re-use of waste timber.
   - Approach public bodies for public site (e.g. seating, shelters and fencing on bike paths and pedestrian malls) and public art works to promote the use of off cuts and short length recycled timber in projects that communicate to the public the intention of the industry to value its raw material.

2. Education.
   - Implement strategies to improve sustainability practices in the industry, i.e. valuing wood through value chain over supply chain practices. An example would be to organise workshops on specification where architects, project managers, installation managers and manufacturers brain storm ‘best use’ for valuing raw material in sample projects to ensure all parties achieve their intended goals through co-operation and understanding of the impact of their decisions on the other operations in the supply chain.
3. Supporting technology.
   - Investing in valuing the raw material through encouraging companies to hold a review of the use of technology at each stage of production and consider the introduction of relevant machinery to improve recovery and reduce off cuts.
   - Exploring the idea of clustered manufacturing at local council level where in value adding processes could be used by groups of companies (not necessarily in the same product area) to ensure that the value of the raw material is maximised.

4. Design directions (product and equipment).
   - Support the employment of designers for short projects for targeted companies such as flooring manufacturers who are facing increased competition from imports in the lower end of the market, to help them move towards value added products, and away from wasteful (in LCA terms), low value, cut to length operations.
   - Support the employment of an engineer to work with designers to develop and prototype equipment that assists in utilising short lengths of timber in value added products.

Fundamentally, this project was set in response to the desire of stakeholders in the South East Queensland hardwood timber industry to use more of the available resource in value added products. This fits in with the sustainability ethos of valuing the resource, so maximising the value gained from each piece, eliminating waste and low value applications as far as possible. Ideally, rather than marginalising the added costs and challenges of reprocessing short lengths, the hardwood timber industry should work to not only address the fundamental needs of the stakeholders but also satisfy the sustainability imperative on the design industry and provide outcomes that, whether through the design of products or changing practice, increase the percentage of timber used in value added applications.
The hardwood timber industry in Australia needs to respond to the growing sustainability imperative and the issues relating to life cycle assessment, but it must do so convincingly. The industry, in my opinion, needs to reassess itself as, rather than a collection of related organisations in a supply chain, an integrated value chain that operates seamlessly for the benefit of all sections of the chain. I would recommend the idea of organising clusters that are then overseen by an industry body that ensures that information, technology and strategies are shared and a forward thinking, innovative, responsive united front is presented to the consumer. This may seem idealistic, but if the industry intends to compete with other construction materials such as steel and brick, who present a well organised industry front at a time when life cycle assessment is assuming growing importance, it needs to be seen to be valuing, and also to actually demonstrate, contemporary practices.

In terms of this project, in order to increase the percentage of timber used for value added products by addressing the issue of short and or narrow lengths, the basis for the proposed solutions is an integrated value chain. Value, in that the expertise and opportunities of each stage are maximised throughout the chain, and integrated because the starting point is to regard the relatively small industry sector as a whole, rather than a collection of disparate suppliers. Working from this standpoint, the four stages of solutions proposed as outcomes of this project are recommended by the author to contribute to increasing the percentage of timber used for value added products in the hardwood industry in South East Queensland.

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4. Woodhouse, E & Patton, J 2004 \textit{Design by society: science and technology studies and the social shaping of design} Design Issues, Volume 20, Number 3 Summer, pp 1 ‘Proximate designers’ is a term coined to differentiate between professional designers and the ‘context and incentive structures largely shaped by others’ that influence design decisions.


6. ibid.,


8. The World Commission on Environment and Development, 1987


15. ibid.,
20. ibid, p.10.
21. ibid, p.3.
24. ibid p.203.
29. Information on the One Tree Project can be found on www.onetree.org.uk/home 14.08.06.
31. An example of this approach is the finger jointing machine specified by Gympie Timbers in response to an issue over the utilisation of small pieces. With a revolutionary, tapered saw blade, the machine uses
long finger joints to join small pieces of spotted gum timber to construction grading strength.


33. Factor x relates to the level of improvement in eco-efficiency that an industrial system needs to meet in order to work within sustainable limits. For more details, see Ryan, C 2004 *Digital eco-sense: sustainability and ICT – a new terrain for innovation* lab 3000, Australia, p. 38.


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