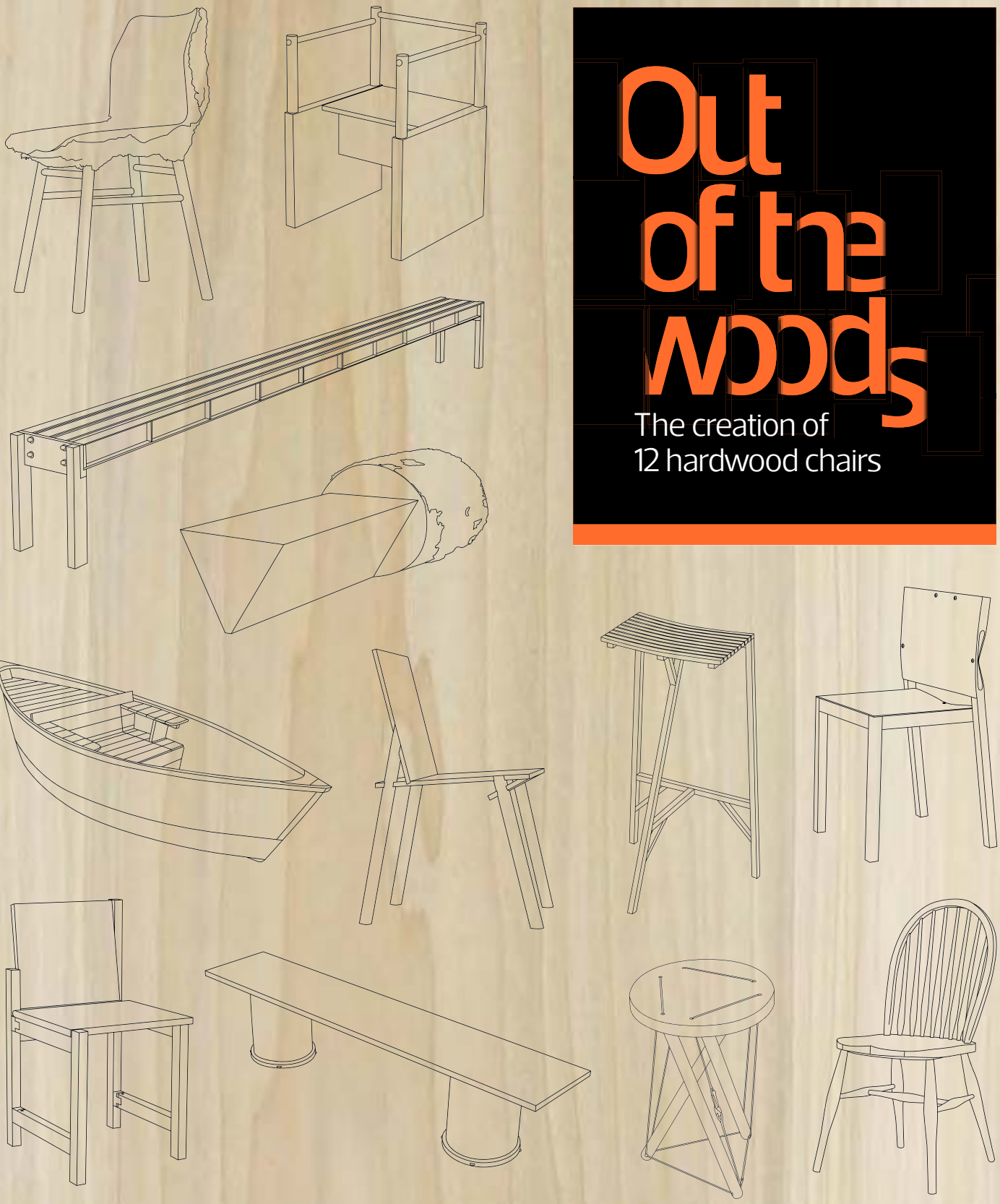
Out of the woods

The creation of
12 hardwood chairs



When Sebastian Wrong told me that he was discussing the idea of a student project with the American Hardwood Export Council (AHEC), it immediately seemed a great opportunity to explore designing with wood again.

Wood has a long tradition in furniture making. However, in the 20th Century, when industrial mass production reigned, wood was largely replaced in furniture production by plastic, metal and composites. Industrial usage often preferred sheet materials such as plywood, chipboard or MDF to the tricky solid woods. Today, as industrial production is changing and becoming more diverse, environmentally and socially conscious, computer controlled and often smaller scaled, new possibilities are emerging.

The project explores the potential for solid hardwood again as a serious material for furniture. AHEC enabled us to access the environmental impact that this material has, including its processing in the workshop as an integral part of its design possibilities. From this notion, the project was born.

In the Design Products course at The Royal College of Art, we encourage the students to experiment, to think about cultural context in design, to explore materials and be inventive. This is a risky approach to design; there are no predictable outcomes of these processes.

The proposals that were presented in response to the brief were very varied and were personal expressions by the individual designers about wood and its relevance to furniture today. As with most other materials, the designer is no longer the expert. For this expertise, we were fortunate to collaborate with the woodworking company Benchmark on this project. Helped by their super-skilled and knowledgeable team, the designers were able to realise their ideas in a hands-on manner. As good crafts teach us, ideas change and adapt once we start touching the materials and tools. Benchmark provided a unique environment in which the designers could immerse themselves in the physical qualities of the material and the processes of making.

There are some wonderfully inventive and creative uses of wood in these pieces of furniture and they also have that special quality which will give them longevity: a great design.

“Ideas change and adapt”

Professor Tord Boontje Design Products, Royal College of Art

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Produced by UBM Client Solutions for The American Hardwood Export Council

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Learning through making

RCA students designed seating and spent a week making it

The Brief

> “To design a seat for function. This could be a chair, stool or bench or anything else that can be sat upon. Materials to be used are American hardwoods and veneers.”

A dozen students (or pairs of students) at the Royal College of Art have designed chairs that both rethink the notion of sitting and teach important lessons about sustainability. All of the students were following a course on product design, some of them had experience of furniture making and working with wood, while others did not. They all enjoyed a special experience – camping for a week in July at Benchmark in Berkshire, where they were able to work with craftsmen to make their chairs. During this time they carefully documented the materials and tools that they used, so that they could come up with a detailed life cycle analysis (LCA) of their designs. The finished chairs all went on exhibition at London’s Victoria & Albert Museum from 14 to 23 September, as part of the London Design Festival.

The project was the brainchild of David Venables, European director of the American Hardwood Export Council, and Sebastian Wrong, a founding member and design development director of Established & Sons as well as a tutor for Platform 15 of the Design Products programme at the RCA. ‘I can see very clearly that the real application of environmental sustainability will rise to the surface,’ said Venables. ‘I wanted to use the opportunity to challenge the students a degree further, to get them to explore what is coming and where we are going.’

Work that the American Hardwood Export Council has carried out on life cycle analysis (described in detail on pages 10–13) has made it possible to apply hard data to the use of timber. The students, who received lectures on this as well as on furniture making, all used American hardwoods in their designs, and were therefore able to calculate exactly the environmental of the objects that they were making.

But this analysis was always intended as an adjunct to rather than the sole driver of their creativity. This was spelt out in the brief given to the students, which was as follows:

‘To design a seat for function. This could be a chair, stool or bench or anything else that can be sat upon. Material to be used is American hardwoods and veneers.
The project aims to explore the versatility of hardwood as a production material and the consumption of energy and associated resources that

the production of your design demands, from the felling of the tree to the product's end of life scenario. Therefore, consider issues relating to robustness, efficiencies both material and production, and of course aesthetic. It is one thing to design a chair/seat that will physically survive the wear and tear of a long life, it is quite another to design a chair/seat that has the aesthetic qualities that will remain relevant long in to the future.'

For Sebastian Wrong the strength of the project lay not only in the life cycle analysis, but also in the opportunity for the students to make their designs in a professional environment. 'The platform presented to the students, particularly the work of making, is something that has never been experienced before,' he said. 'They are balancing design ideas with schedule and timing. They have very little experience of engaging with materials.'

The potential of wood as a natural material is great, he believes, and said, 'There are some great ideas – that is what I find so inspiring. The benefit to the students, to the RCA and to AHEC is tangible on a number of levels.' And, he added, 'The project is opening a discussion about life cycle. It is making wood a very contemporary material.'

Harry Richardson, who teaches the course with Wrong and is co-founder of product design studio Committee, said, 'It seems that the reality AHEC is dealing with through the use of LCA is one that we must all come to understand more and more if the market is to find a sustainable future, and so I think this has been a very stimulating learning experience for the students.'

One can see just how valuable a learning experience it has been by looking at the work that the students have produced.

1 Nic Wallenberg in the workshop.
2 Petter Thörne with his finished beeeench
3 Anton Alvarez working out of doors
4 Lunch al fresco
5 Assembling the Phyllida bench
6 Camping in the Benchmark garden

American hardwoods provide abundant, green materials

Nature's renewable resource

Timber is unique among the major materials used in construction and design in that, as a living material, it stores carbon during its growth, and continues to store that material for as long as it remains in a piece of furniture or a building. If the components are re-used or recycled at the end of life, the storage continues. If no other use can be found, the best thing to do with the timber is to burn it for fuel, exploiting the 'embodied energy' that is stored within it, rather than allowing it to rot in landfill.

In this way timber can be seen as a 'carbon sink,' a means of locking up carbon dioxide. Although there will be some expenditure of energy in the felling, drying, process and transport of the timber, the amount of energy that is stored in the tree is greater than the energy that is used in processing and transporting. Many of us are familiar with the idea of carbon sinks, since forests themselves are often described as such. So wouldn't it be better just to leave the trees in the forests, and store the energy that way?

Research shows that this is not the case. In forests that mature 'naturally' without any harvesting, the rate of carbon sequestration slows down to a maximum level of free carbon. This has caused the UN Intergovernmental Panel on Climate Change to write in its Fourth Assessment Report that, 'In the long term, a sustainable forest management strategy aimed at maintaining or increasing forest carbon stocks, while producing an annual sustained yield of timber, fibre or energy from the forest, will generate the largest sustained mitigation benefit.'

When the report refers to 'a sustainable forest management strategy,' it is addressing the concern that forests should not be depleted by excessive harvesting. In the case of American hardwoods, this is not an issue. Between 1953 and 2007, the volume of hardwood standing in American forests more than doubled from 5 billion m^3 to 11.4 billion m^3. It is therefore a resource that we can exploit with impunity.

All the timbers that have been used in the Out of the Woods project are American hardwoods, from forests that are typically managed by small owners, and which regenerate naturally. The students have used as wide a range of materials as possible, which is also important from a sustainability point of view. American hardwood forests, contain a range of species. The most sustainable approach is to harvest timbers from all the main species. By exercising their imaginations, the students have approached the use of timber in the most sustainable way possible.

But however good intentions are, if we want to be certain that we are making the right decisions, we need hard facts. In order to really understand what we are doing, in terms of sustainability, we need to be able to make a rigorous analysis, based on reliable data. This is what life cycle analysis can offer.

Summer sunrise in Owen Park, Madison, Wisconsin, with young saplings regenerating

Measuring the impact

Rigorous technical analysis allows exact evaluation

Life cycle analysis is the vital tool that makes the difference between hand-waving good feelings about sustainability and exact knowledge that allows one to make well-founded decisions about selection and use of materials. It looks at all the environmental inputs and impacts throughout the life of a product, making it possible to make informed decisions. Often this is vital because choices have a range of impacts, and a selection that has a good result in one direction may be problematic in another way. In order to choose which is the more significant, one needs data rather than just feelings.

The timber industry has not in the past had thorough life cycle analyses, putting itself at a disadvantage. Proponents of the use of other materials have produced detailed studies which they have then employed to promote the use of their materials, sometimes using data selectively and skewing the facts. It was to address this lack that the American Hardwood Export Council invested in a thorough life cycle analysis of all the timbers that it promotes, looking at variables throughout the production process and covering them until the point where they arrive at the place where they will be used - the factory or the building site.

This research was carried out by PE International, a company that specialises in this field, and was done to the highest standards, with an independent critical review of its findings. It established that the main source of global warming impact comes from the kiln drying of the timber, contributing between 8% and 32% of the global warming potential of the production process. It also had a significant impact on other environmental markers, providing 6-26% of the acidification potential, and 78-86% of the POCP (photochemical ozone creation potential).

These results vary between species, since some take longer to dry than others, and there is also an important impact that relates to the thickness of the sawn timber. Since thicker planks take longer to dry, and hence use more energy, they will have a greater environmental impact – something that designers and specifiers may like to consider at an early stage in their work.

While kiln drying has more of an impact than many would have expected, the impact of transport is less. In terms of global warming potential, road transport from the United States to Canada has a larger impact than transport by ship from the United States to Western Europe. However, other impacts are higher for ship transport, such as the acidification potential, mainly as a result of the sulphur contained in the fuel and the ensuing emissions of SO_2. This impact will largely be at sea rather than over land.

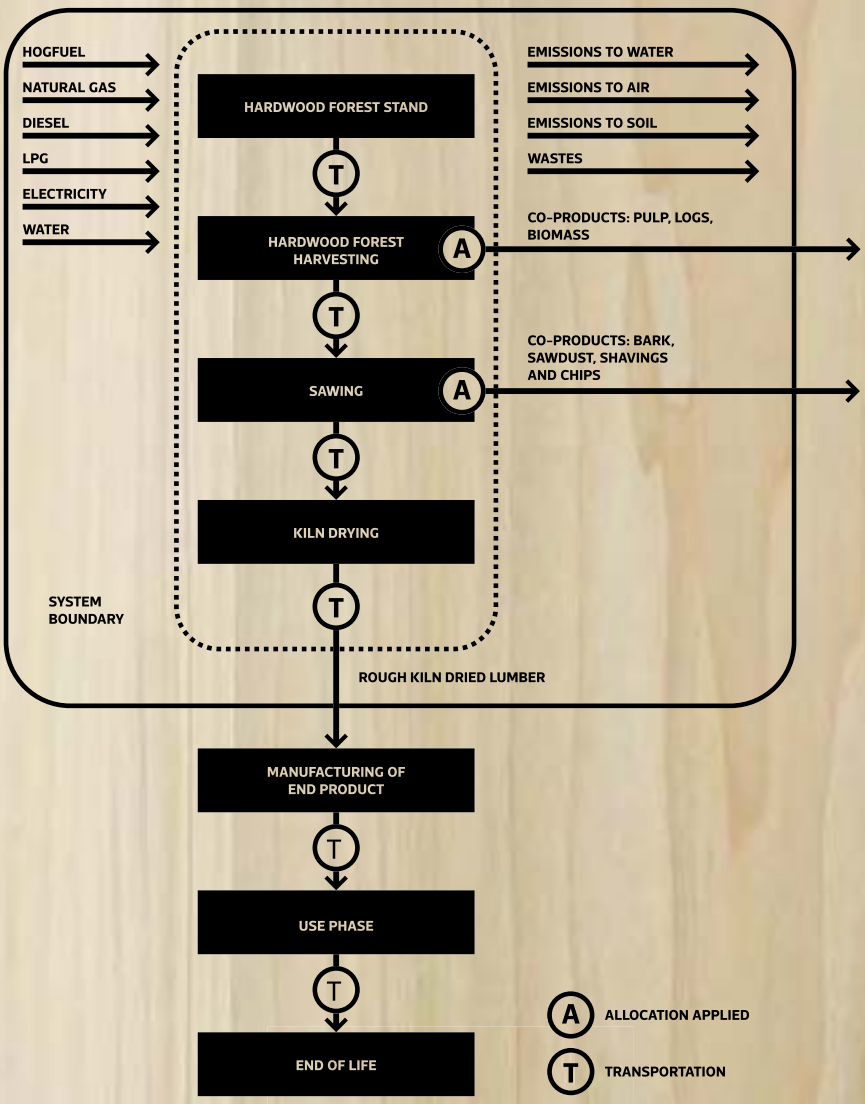
There are improvements that could be made in processes, such as more efficient kiln drying and the possibility of pre-drying of lumber. Other improvements are outside the industry's control, but being considered as world legislation, such as a reduction in the allowable sulphur content in marine fuel. None of this should blind one to the fact that a considerable amount of carbon dioxide is 'locked up' in timber, where it will remain throughout its life and through any secondary life that is found for it.

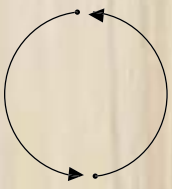
The work that PE International has carried out for AHEC is as thorough as possible, but it is restricted in that it ends at the point

of delivery. This is unavoidable as it is not possible for the producers to know how their material will be used. Treatments, fixings, further processing, life-span and method of disposal will all have an influence, as will the other materials that are used in the final products. To make it possible to carry the work further, PE International has created a tool called an i-report, into which it is possible to enter all the variables and produce scores on a number of counts. This is what it has done for the designs of the 12 chairs, and it is one of the elements that make the project so exciting.

It is not possible to make a direct comparison between the designs in terms of sustainability, since each has addressed a very different problem, and solved it in a very different way. You cannot compare a church chair, designed to give an appearance that is deliberately as heavy and permanent as possible, with a slender stool that has deliberately been made as lightweight as possible. A portable bench and a GPS guided boat are similarly not directly comparable, and nobody would choose to have one when they wanted the other. But the very different choices ▷

LIFE CYCLE FLOW DIAGRAM OF AMERICAN HARDWOODS





LIFE CYCLE ANALYSIS

This graphic shows the processes that American hardwoods pass through, from growing through harvest, sawing and kiln drying, through to manufacture, use and the end of life. It shows inputs and outputs (waste and pollution), transport and potential allocation of waste products. The area defined by the system boundary represents the limits of AHEC's LCA study on rough-sawn kiln-dried lumber. In technical terms this study is a 'cradle-to-gate plus transport' study. The Out of the Woods project addresses the stages after the report boundary for specific applications, use and end of life in a pathfinding manner.

◁ that the students made shine a spotlight on many of the issues of sustainability.

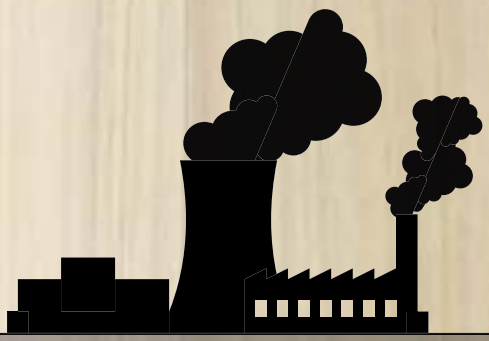
Producing the i-reports

Marc Binder of PE International gave the students a lecture at the start of the design process explaining the main sustainability issues, which they took into account as they were developing their chairs. Dr Richard Murphy of Imperial College London, who was one of the members of the Critical Review Panel of the LCA report, also lectured the students. He talked about the principles of life cycle assessment and provided early guidance on design implications.

When the students were making the chairs at Benchmark, they measured all the materials that they had used in volume, and also the time that they had spent on each of the machines. These formed the basis of daily reports which were fed into the i-report. This drew on not only the life cycle analyses for American hardwoods, but also PE International's substantial database covering all other materials used.

At the end of the week, the i-reports could then be generated. They looked at every stage of the process of making the chair, from materials to processing, use, waste and end of life. Normally such a report would include packaging but in this case it was omitted as being beyond the scope of the project. Transport was calculated from Benchmark to the Victoria & Albert Museum. The i-reports covered the six impacts shown opposite. □

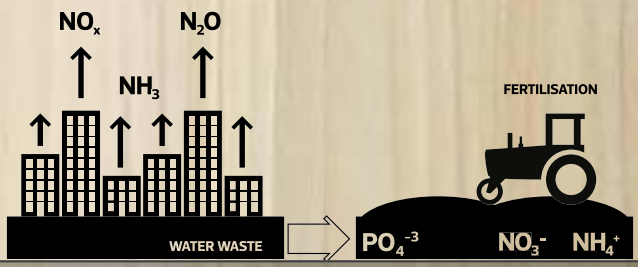
1



PRIMARY ENERGY DEMAND (NON-RENEWABLE RESOURCES)

This is a measure of the total demand of primary energy that comes from non-renewable resources, such as oil and natural gas. Measured in MJ, the primary energy demand takes into account the conversion efficiencies from the primary energy to, for example, electricity. The generation of carbon dioxide from the production of energy is one of the major causes of global warming.

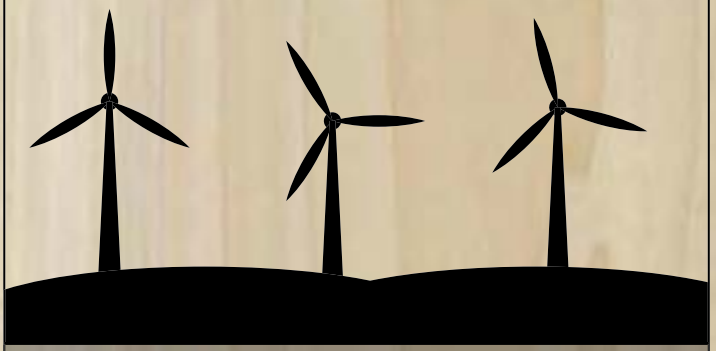
4



EUTROPHICATION POTENTIAL (EP)

A far less common term than global warming, eutrophication is the process by which water receives an excessive amount of nutrients, particularly phosphates and nitrates. These nutrients, which typically come from run-off from fertilisers, lead to algal blooms which in turn deprive the water of oxygen and lead to imbalances and deaths in the aquatic populations. Eutrophication is measured in terms of kg of phosphate equivalent, and kg of nitrogen equivalent.

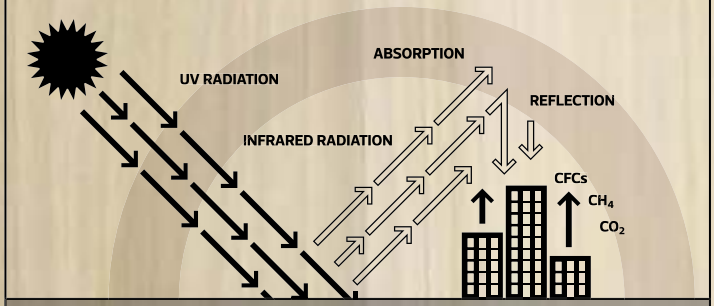
2



PRIMARY ENERGY DEMAND (RENEWABLE RESOURCES)

Like the primary energy demand from non-renewable resources, it is a measure of the total amount of primary energy but in this case derived from renewable sources such as hydropower and wind energy. Again it takes conversion efficiencies into account where appropriate. Total primary energy demand can be measured by adding the figures for energy from non-renewable and renewable resources.

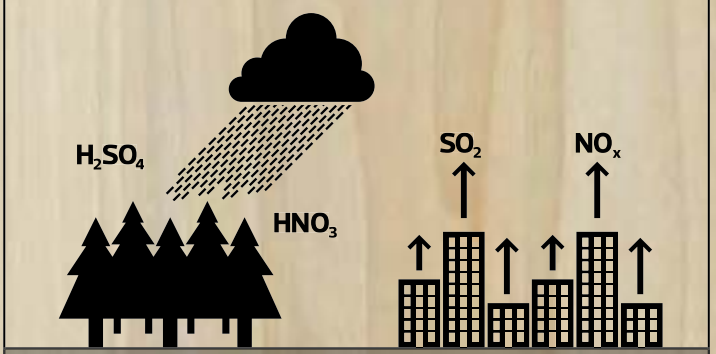
3



GLOBAL WARMING POTENTIAL (GWP)

Global warming potential, measured in kg CO2 equivalent, is the measure about which we are all most concerned, and it is a good marker for other environmental issues. It is not however the only important measure, and the i-report therefore focuses on a number of others as well. Global warming potential is calculated from the volumes of greenhouse gases, such as carbon dioxide and methane, which are emitted by a process.

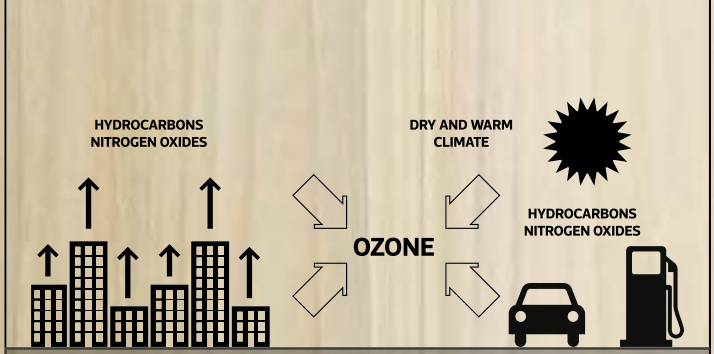
5



ACIDIFICATION POTENTIAL (AP)

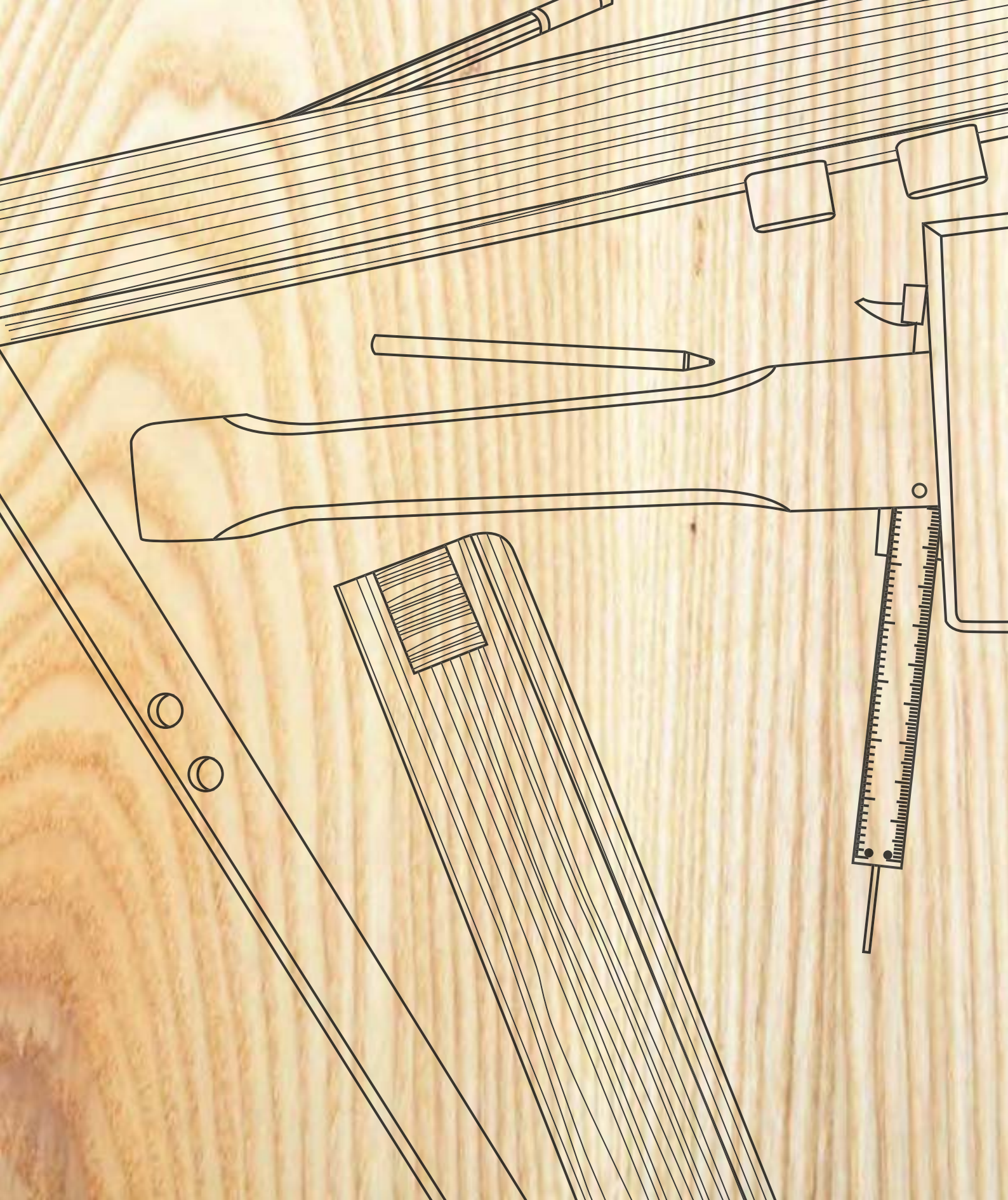
This is a measure of the emissions that cause acidifying effects to the environment, which can cause imbalances and the death of species. Emissions of sulphur dioxide and nitrous oxide result in acid rain which can fall some way from the place where the emissions occur. Acidification potential is measured in kg of sulphur dioxide equivalent.

6

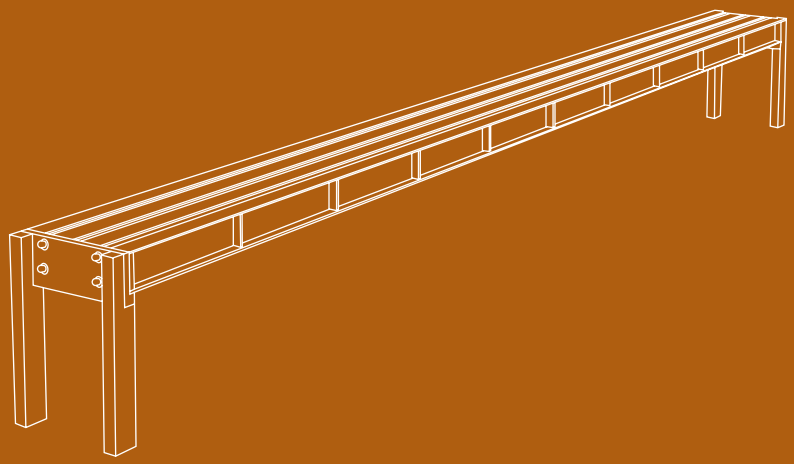


PHOTOCHEMICAL OZONE CREATION POTENTIAL (POCP)

This is a measure of emissions or precursors that contribute to low-level smog. It is measured in kg of ethane equivalent. Ozone layer depletion potential (ODP) is also part of the i-report but is not included in the charts because the effect is negligible. There may seem to be a contradiction between these two impacts but, put simply, high-level ozone is good and should be protected, whereas ozone at ground level is a pollutant.



The designs



BEEEENCH

CONCEPT:
Long simple bench with demountable legs

ANTICIPATED LIFESPAN:
10 - 20 years

Petter Thörne's first degree was a BA in interior architecture and furniture design which he took at Konstfack in Stockholm. After this he worked as a freelance designer in Copenhagen, and also spent half a year working in Hanoi on product design with local craftsmen, which he saw as a great contrast to his European experience. He finished at the RCA this summer and hopes to work on a number of different products with a network of different people.

At a stretch

A long bench that is strong, light and portable

THE DESIGNER

Name:
Petter Thörne

Born:
Jörnköping, Sweden, 1984

RCA year:
Second

THE CHAIR

As the name suggest, the defining characteristic of Beeeench is its length, coupled with extreme lightness. Spanning 3.5m (and it could even have been longer), it is made up of slender strips of American ash just 5mm thick, which work in three dimensions to build up a beam structure. The vertical slats are 75mm wide, and those forming the horizontal seating surface are just 50mm wide. Separate legs can be bolted on, and removed for transport.

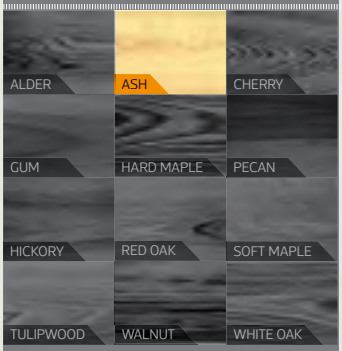
Thörne showed his designs to a structural engineer, who said that all the elements should be much thicker for stability, but he was confident that his design would be strong enough to support weight, even if it twisted slightly in use. He chose to use ash because of its high strength and flexibility.

Thörne sees museum seating as an ideal application for Beeench, since it is a modest solution, remarkable only for its length, and so would not distract attention from the exhibits.

The legs can be removed for transport

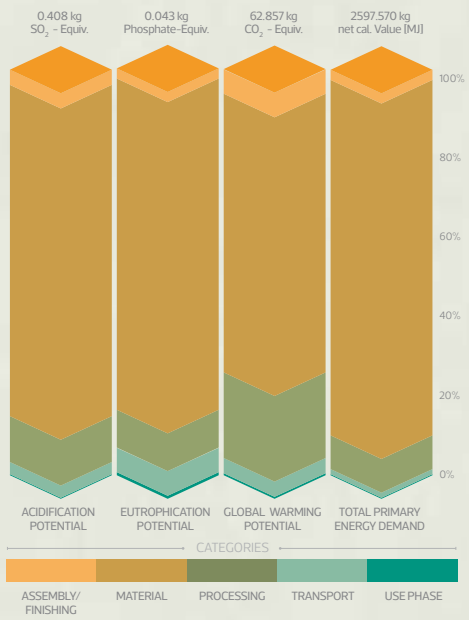
A three-dimensional arrangement of slats gives the bench its stability

HARDWOOD SPECIES USED



For more information on U.S. hardwood species, turn to p70

LIFE CYCLE IMPACTS (MAKING)



Although this bench is very lightweight, it is not economical in materials because of the amount of finishing involved, as seen in the impacts. There is a question mark over its durability, which could limit its lifespan. If this were a solution for commercial manufacture, it would be subject to some repetitive testing to see how it behaved over time. More data is available on pages 72 - 77.

> “He was confident his design would be strong”

The lightest touch

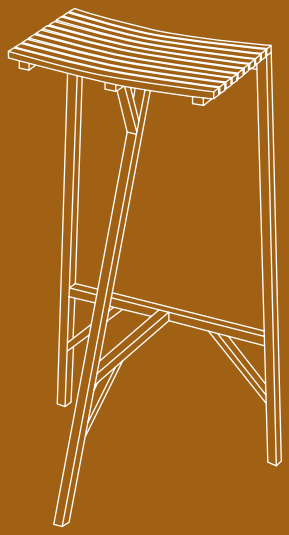
Lightness pushed to the extreme

THE DESIGNER

Name:
Michael Warren

Born:
London
England, 1981

RCA year:
Second

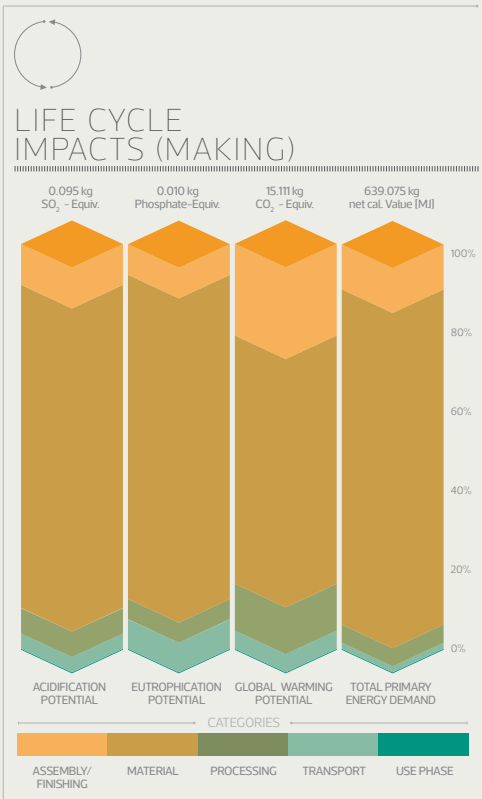


DESIGNED LEGACY

CONCEPT:
Minimising the environmental footprint

ANTICIPATED LIFESPAN:
1 - 2 years

Michael Warren's first degree was at Brighton University in three-dimensional design for production. Since then he has worked both for himself and others, on industrial design and events. He has just completed his course at the RCA but will be returning next year since one of his graduation projects, a portable CNC router, won a Dyson Fellowship. This will allow him to develop the design, which he hopes to licence, for two days a week over six months.



This design deliberately pushed down the embodied carbon as far as possible, by focusing on extreme economy of materials. Nevertheless materials account for a large proportion of the impacts. This is a fascinating exercise, but the end results, while intriguing, are decidedly fragile. So although each stool has a light footprint, there would in real life be a need for frequent replacements – not to mention the trauma and possible danger of breakage.
More data is available on pages 72 - 77.

> “I am the only one who wanted to win”
>
> Michael Warren

THE CHAIR >

It was made clear that the design programme was not a competition, but nevertheless Warren said ‘I am the only one who wanted to win’. He set out to design the chair with the lowest possible environmental impact. He used a minimal quantity of materials in thin sections, since he was impressed by the fact that additional carbon dioxide was generated by kiln-drying thicker sections. He designed a stool that could be cut out from a piece of timber measuring 25mm by 145mm by 1.6m long.

The simple connections developed from much larger scale joints that Warren had studied on green timber building frames. Because of his desire to minimise the environmental footprint, he was very ‘purist’, for instance eschewing steam bending to create a curve, instead using two laminations glued together. He also rejected accepted wisdom that no elements should be less than 20mm thick, paring them down to just 18mm.

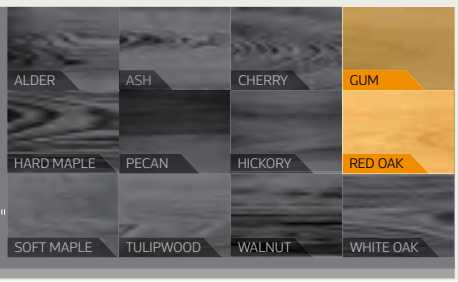
Warren made several stools during his week at Benchmark.

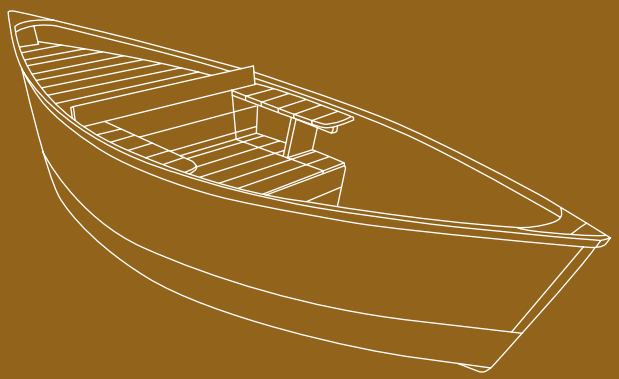
The slender elements are fixed with joints derived from timber framing

Twin laminations form a curve

HARDWOOD SPECIES USED

For more information on U.S. hardwood species, turn to p70





FLOATING CHAIR

CONCEPT:
Single seater boat guided by GPS

ANTICIPATED LIFESPAN:
15–25 years

After a first degree in wood-oriented furniture design at the Steneby school, Sweden, Bobby Petersen came to London and set up a design collective with some friends for a year. When he graduates from the RCA, he hopes to work in both Sweden and London.

Thomas Gottelier studied design at the Design Academy in Eindhoven, the Netherlands, and then was a designer/consultant for Design for Sustainable Development in Sri Lanka. He also worked as a set designer for television commercials and with fashion label Libertine-Libertine. After graduation from the RCA, he would like to continue to design installations as well as products.

Reflections on water

A floating getaway for a dreamy trip

THE DESIGNER

Name:
Bobby Petersen

Born:
Sweden, 1984

RCA year:
First

THE DESIGNER

Name:
Thomas Gottelier

Born:
London, England, 1988

RCA year:
First

“They wanted to create an experience”

THE CHAIR

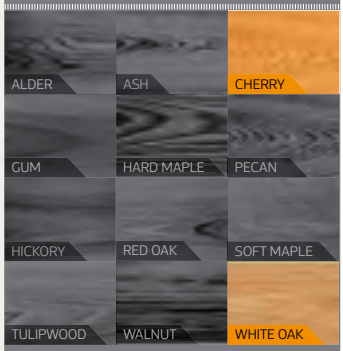
Petersen and Gottelier wanted to create an experience rather than just a seat, and they have done this by designing a boat that will carry a single passenger in comfort on a pre-determined journey punched into an iPhone, that will then drive the propulsion system. Developed and programmed by Jonas Halfdan Jongejan, the propulsion system was one of the attractions for the students. There is no rudder, simply a small motor set to either side of the boat. Putting one motor on and the other off will drive the course. The idea evolved from a coracle-like form, which has too great a tendency to spin, into a more conventional boat shape. Boat builder Will Reed spent the week at Benchmark to assist with the making,

The boat has been built in marine ply and veneered in American cherry, chosen both for its high strength-to-weight ratio and for its colour, which will darken in sunlight. The keel is in American white oak, which is both durable and heavy.

At 2.4m long and 950mm wide, the boat is small but quite large enough to offer a haven in which to drift meditatively across the water.

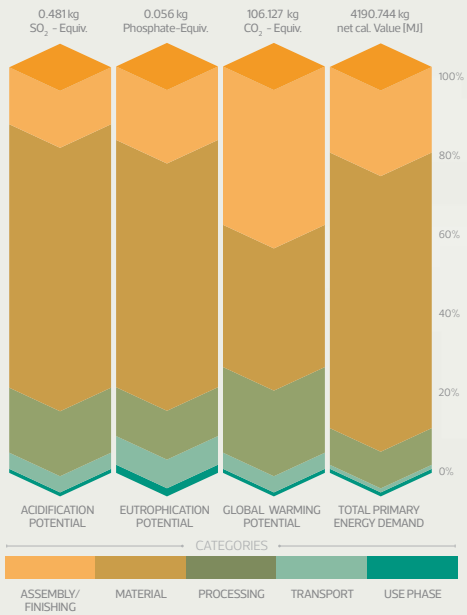
Two small engines guide the boat

HARDWOOD SPECIES USED



For more information on U.S. hardwood species, turn to p70

LIFE CYCLE IMPACTS (MAKING)



The boat evidently used a greater volume of materials than most of the other solutions, it also however offers an entirely different experience. It is the most extreme indication that projects cannot be compared directly but that each must find the most sustainable solution on its own terms – in this case by using sustainably sourced timbers to create a beautiful and durable object. More data is available on pages 72 – 77.

The art of folding

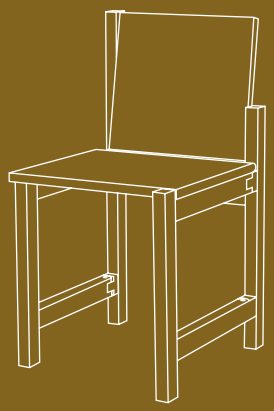
Asymmetric folding creates a beautiful object

THE DESIGNER

Name:
Norie Matsumoto

Born:
Tokyo, Japan, 1978

RCA year:
Second



FOLDED CHAIR

CONCEPT:
A beautiful object you can sit on

ANTICIPATED LIFESPAN:
60 - 80 years

Communication technology was the subject of Norie Matsumoto's first degree, taken in Tokyo. She then worked as an accounting assistant, but she was always interested in crafts, and it was this passion that brought her to the UK to take an art foundation course in Greenwich and then a BA in fine-craft furniture making at Buckinghamshire New University. Having graduated from the RCA, she hopes to make her own designs, focusing on furniture.

1 The light and dark colours of ash and walnut emphasise the asymmetry

2 The seat lifts up

For more information on U.S. hardwood species, turn to p70

THE CHAIR

This design was intended to be a beautiful timber object that could also work as a chair, rather than the reverse approach which is more common. Matsumoto was particularly interested in how it looked when it was folded up and leaning against a wall. From this she developed an asymmetric design which unfolds in a surprising but elegant manner.

Matsumoto made a prototype of the chair which was all in ash, but chose to use a mixture of ash and walnut in the final piece, to further point up its asymmetric nature. There were challenges in the design and a lot to be learnt in the making process but, despite the fact that this chair has an unconventional starting point, this is a desirable and 'sittable' piece of furniture, which one could imagine working well in a number of different environments.

The intention may be that it should spend much of its time resting against a wall as an object to be enjoyed, but few will be able to resist the temptation to pick it up and fold and unfold it several times.

3

Legs fold to the back to create...

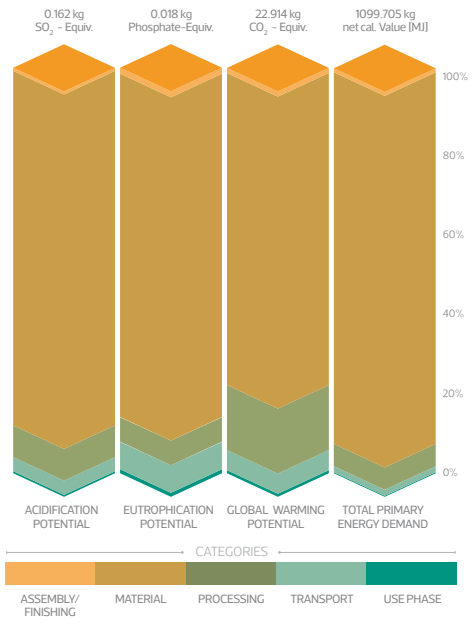
4

....an elegant object to lean on the wall.

"It unfolds in a surprising but elegant manner"

LIFE CYCLE IMPACTS (MAKING)

Material has had the biggest impact on this chair because there was so little processing involved, thanks to the decision to use square sections and rectangular elements. The chair has been designed for a long life, with carefully considered joints which can, if necessary, be repaired. The fact that it can be folded away when not in use also makes it more versatile, helping to guarantee its longevity. More data is available on pages 72 - 77.



LEFTOVERS CHAIR

CONCEPT:
Waste not want not
plus natural dyes

ANTICIPATED LIFESPAN:
80 - 100 years

After studying illustration at Brighton University, Lauren Davies worked for four years as a set designer, and also had her own design company doing photo-shoots and window designs. It was frustration with the temporary nature of her work which led her to apply to the RCA, where she has just completed her first year. She wants, she says, 'to create products that have more of a lasting life'.

Fruit and nuts

Kitchen chair with culinary elements

THE DESIGNER

Name:
Lauren Davies

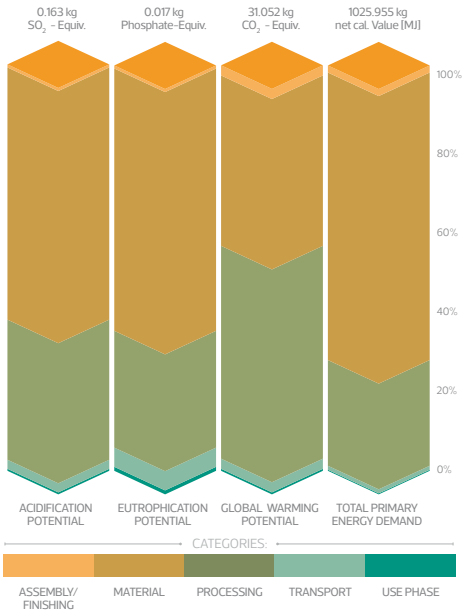
Born:
Brighton, England, 1982

RCA year:
First

HARDWOOD SPECIES USED

For more information on U.S. hardwood species, turn to p70

LIFE CYCLE IMPACTS (MAKING)



Using offcuts to build up the seat would reduce the footprint of this chair by employing 'free' waste materials, but this was not allowed for in the LCA. Processing had a high impact on this chair, largely due to the steam bending of the back and the use of a blowtorch. All treatments are natural, from the vinegar which brings out the tannins, to the fruit and spice flavours. Some of these may prove to be fugitive in light – Davies was eager to carry out more tests. The form of the chair is classic, and this sturdy object should have a long and - dare we say - fruitful existence. More data is available on pages 72 – 77.

"The seat is pickled with vinegar"

THE CHAIR

Davies' interest in food and cooking led her to design a chair that could be described in the form of a recipe. It is made up from a variety of American hardwoods that are imported to Europe, several of which are nut-bearing species. The seat, made by Windsor chair specialist Sitting Firm and subsequently shaped by Davies, is 'pickled' with vinegar, the legs are 'smoked' and the spindles of the back are 'flavoured' with fruit essences. The whole design is based on the form of a kitchen chair with the seat built up from offcuts of numerous timbers. The legs are of hickory, chosen because of its strength and straightness, and also because this use suits the fact that it is only available in relatively small widths. The 'H' structure joining the legs is in the related timber, pecan. Maple was used for the spindles, and the hoop of the back is in straight-grained cherry. The flavourings, which supply colour, include saffron, paprika, blueberry, strawberry, raspberry, beetroot, blackberry, pomegranate and onion skins.

Vinegar with rusty metal in it brought out the tannins, highlighting grain pattern and texture. Fruit dyes coloured the spindles

Legs were blackened with a blow torch – rather like spit roasting

THE MAKING PROCESS

1 Vinegar wash
Painting the vinegar onto the chair to darken it

2 Hot work
Using a blow torch to blacken the base

3 Kitchen work
Spices, fruit and vegetables were used to create colour treatments

4 Colour palate
Every food mix imparted a different colour

All about the jig

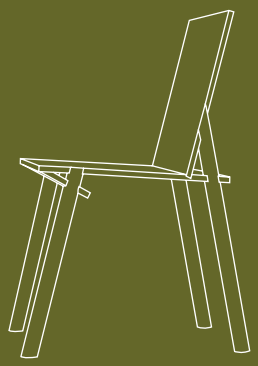
A deceptively simple design relied on having accurate jigs

THE DESIGNER

Name:
Santi Guerrero Font

Born:
Girona, Spain, 1981

RCA year:
First



NUM. 4

CONCEPT:
Simplicity. honesty. hidden complexity

ANTICIPATED LIFESPAN:
30-50 years

Santi Guerrero Font has just completed his first year at the RCA. He took his first degree in industrial design in Girona and then worked for technical and sound engineering companies in Barcelona, including designing robot arms for undersea work.

He would like to set up his own design studio in London, and has already worked with other studios there. He is also looking at projects in Barcelona which would involve the re-use of empty spaces.

“I wanted to hide the complexity of the issues”

Santi Guerrero Font

THE CHAIR >

This slender chair, with glued joints, reflects Guerrero Font's interest in Danish style, which typically showcases construction techniques. 'I wanted to work with something visually very simple and honest,' he explained, 'and to hide the complexity of the issues involved.' You can see where the legs pass through the structure, and where their ends become flush with the seat.

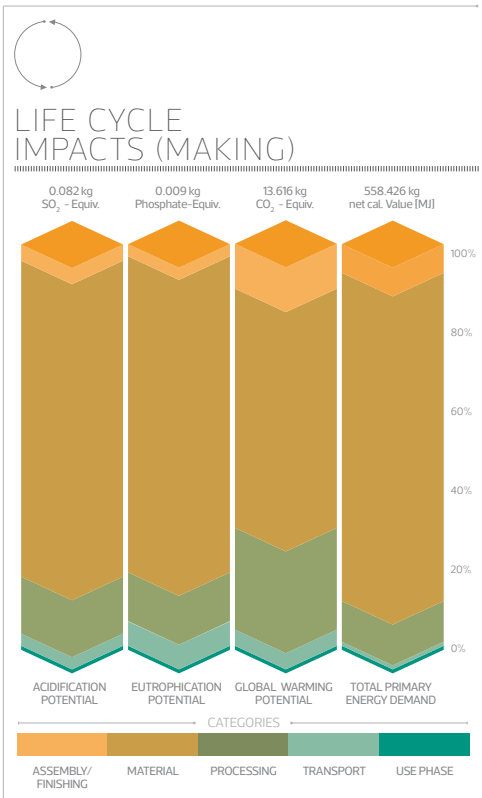
This may not be the most comfortable chair, but Guerrero Font was more interested in investigating the process of making, rather than having a finished comfortable chair. He has created an elegant object, and one that would repay further exploration.

During development of the design, Guerrero Font managed to slim down the thickness of the timber from 20mm to 12mm. 'I realised that the complexity of the chair lay in making the jigs,' he explained. 'I learnt a lot about ways to work with wood at Benchmark, that I hadn't even thought about. Just having an idea and drawing it is very different to seeing it through to a final piece. There are so many different solutions you can use to make one thing. You have to learn which is the most accurate.'

A textural change where the legs meet the seat

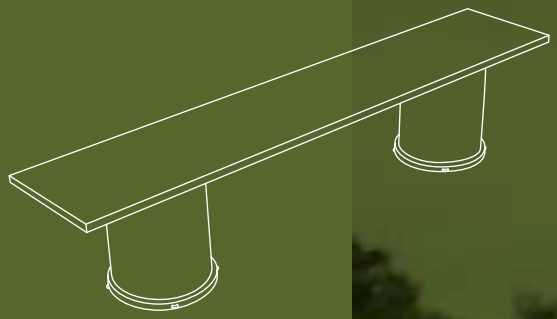
Elements are slender, made possible by the strength of American ash

For more information on U.S. hardwood species, turn to p70



By choosing ash, one of the strongest hardwoods, Guerrero Font has managed to slim down his initial design, and so use less wood. Since most of the effort involved was in making jigs that could create the simple-looking but difficult joints, this would be a relatively straightforward chair to make. The jigs would be reusable, and the making of repeated chairs would involve relatively small amounts of energy.

More data is available on pages 72 – 77.



PHYLLIDA

CONCEPT:
A plank, veneers
and bungee cord

ANTICIPATED LIFESPAN:
5 - 10 years

The first qualification for Nicholas Gardner was a diploma in arts and furniture design at RMIT in Melbourne. He started making furniture and sculpture as commissions, as well as doing some of his own work, and came to the RCA in order to get a more conceptual grasp of design. He has just completed his first year, and is particularly interested in work where he wraps folded metal to create volume.

David Horan started his career with a certificate in mechanical engineering, followed by an art foundation course in Coventry and then a BA in transport design. He has just completed his first year at the RCA and is interested in having the freedom to follow a range of interests, including graphic, product and furniture design. He would like to work internationally as a freelance designer.

A bench that packs flat for transport

Have bench, will travel

THE DESIGNER

Name:
David Horan

Born:
Dublin, Ireland, 1982

RCA year:
First

THE DESIGNER

Name:
Nicholas Gardner

Born:
Melbourne, Australia, 1988

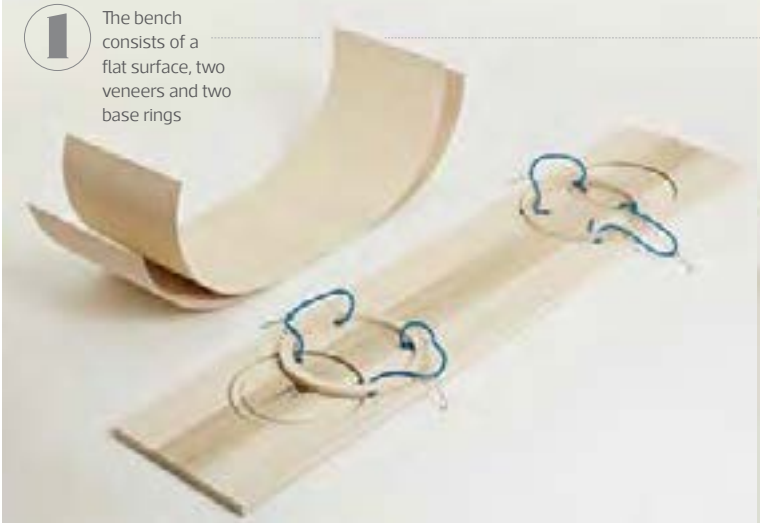
RCA year:
First

THE CHAIR

This design was inspired by a work by the sculptor Phyllida Barlow, in which she uses a single screw to fix a piece of MDF and create volume. Horan and Gardner's design also wraps a thin material to create not just volume but also a surprising amount of strength. Pieces of ply just 1.5mm thick are rolled to create the legs of a 2m long bench in solid tulipwood. The legs fit in to tulipwood base rings, and to a circular groove in the underside of the bench. When the bench is carried, the 'legs' unroll to become flat, and the base rings slot in to another set of grooves under the bench. The whole assembly is held together with cords, which when the bench is assembled join the rings to hooks on the underneath of the flat seat. One person can carry the disassembled structure. Horan and Gardner chose tulipwood for its high strength and light weight. It is also a material that can easily take stains or be painted.

"A thin material wraps to create volume and strength"

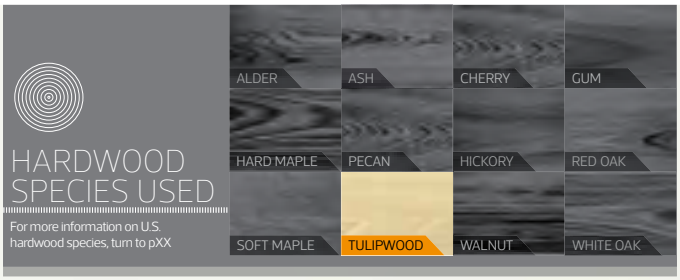
1 The bench consists of a flat surface, two veneers and two base rings



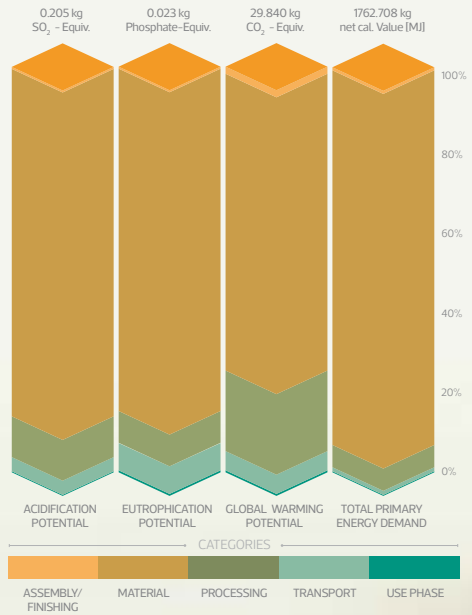
2 The veneers are curved and slotted into rings in the base

HARDWOOD SPECIES USED

For more information on U.S. hardwood species, turn to pXX



LIFE CYCLE IMPACTS (MAKING)



Initially Horan and Gardner designed the bench with aluminium rings for the feet, but switched to timber because of its much lower environmental footprint. The surface of the bench will be durable, as will the feet. If the plywood for the legs requires more frequent replacement, it will be compensated for by the fact that it is so light in weight. Overall, this is a solid solution created with great economy of materials, and can pack away to a minimal volume for transport. More data is available on pages 72 - 77.

3 Solid rings are added to form the feet

4 Bungee cords hold the assembly together

String theory

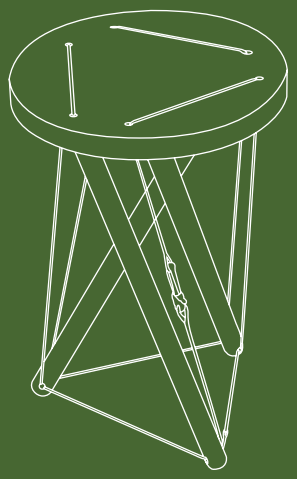
Tensioned strings hold discrete elements together

THE DESIGNER

Name:
Sam Weller

Born:
Bath, England, 1985

RCA year:
Second

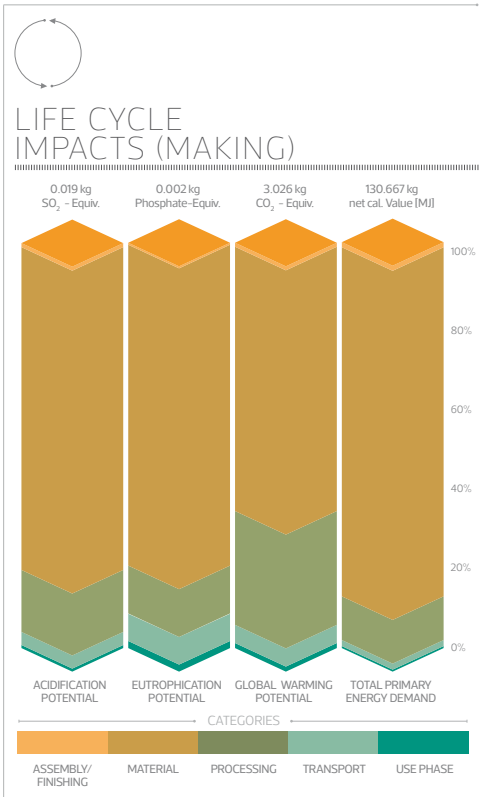


SNELSON

CONCEPT:
Stool based on idea of tensegrity

ANTICIPATED LIFESPAN:
10 - 20 years

Sam Weller's first degree was a bachelor of science in industrial design and engineering at Brunel University, which also included a seven-month period in San Francisco studying typography and graphics. He worked in Scotland on the development of a transport incubator for neonatal babies, and now carries out freelance design work in lighting and electronics. Having just graduated from the RCA, he hopes to work in furniture design.



Manufacturing processes for the stool are simple, so that the energy that goes into making it is kept to a minimum. Weller, who had studied a module on designing for sustainability in his first degree, was also aware that it would be relatively easy to replace any part if it became damaged. More data is available on pages 72 - 77.

THE CHAIR

The stool is named after sculptor Kenneth Snelson, whose sculpture Needle Tower II inspired Weller when he saw it in the Netherlands. Snelson's ideas were the foundation of Buckminster Fuller's tensegrity designs, which are structures that are held together entirely by tensile behaviour. Weller's design is for a three-legged stool that uses string under tension to hold together the elements, which do not even need to touch. Following advice from Sean Sutcliffe at Benchmark, Weller used a marine rigging called Dyneema which does not creep (stretch under continued loading). The rigging is tightened with a lashed pulley arrangement that is more commonly used to tighten the stays on a yacht.

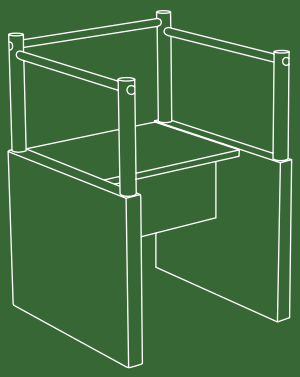
The rigging makes the appearance complex, and so Weller deliberately kept the other elements as simple as possible – a disk for the seat of the stool, and circular legs with rounded ends that are deliberately evocative of broomsticks. It is possible to disassemble and reassemble the stools, although doing this presents a daunting intellectual puzzle.

Because manufacture was relatively straightforward, Weller had the time to make stools in a variety of timbers. The light stools could work as occasional seating in a home, or be taken outside for special events.

Weller created stools in a variety of hardwood species. Snelson can easily be disassembled

“It is possible to disassemble and reassemble the stools”

A lashed pulley with a half hitch tightens the rigging. This stool is in ash



SOLITUDE

CONCEPT:
Solidity creates a special space

ANTICIPATED LIFESPAN:
100+ years

After an art foundation course in Surrey, Mary Argyrou studied product and furniture design at Ravensbourne College in east London. She worked in London and Amsterdam, and spent some time in Cyprus with traditional craftsmen who worked in wood and ceramics. She has just graduated from the RCA and would like to work for a small studio where she could reinterpret craft-based techniques with traditional influences.

In touch with history

THE DESIGNER

Name:
Mary Argyrou

Born:
Limassol, Cyprus, 1985

RCA year:
Second

A chair inspired by Cypriot church furniture

THE CHAIR

Based on the chairs that are used in Cypriot churches, Argyrou's seat has a deliberately solid design that gives the occupant a sense of permanence and defines their position in space. In this way it gives them a feeling of privacy even though they are among other people. Made in cherry, it has solid sides that use the full two-inch (5cm) thickness of the wood, with a hinged fold-down seat between them. With the seat down, the user can step back entirely into their own private space.

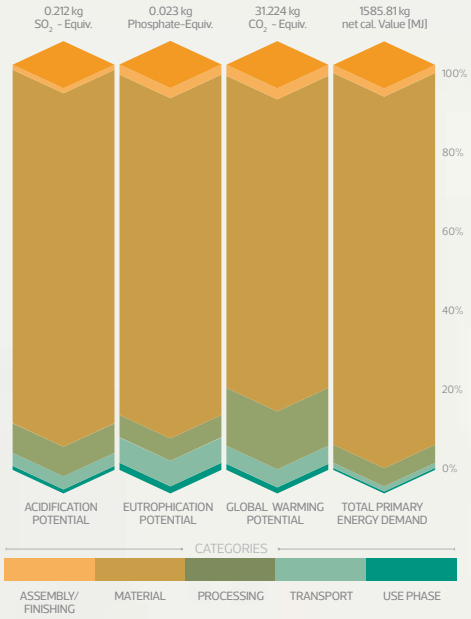
Four turned-wood posts rise from the corners, joined by narrower turned members to create a back and armrests. This use of turning echoes one of the skills of traditional Cypriot craftsmen. Cherry is a timber that is relatively easy to turn, and Argyrou also chose it because it is one of the timbers that is frequently used in Cypriot church furniture. She liked its warm colour which still allows you to see the elements of the workmanship, unlike the dark hue of walnut, another traditional timber, which tends to obscure details.

"The user steps back into a private space"

The seat folds up to allow the user to be contained in the space that is defined by the sides

LIFE CYCLE IMPACTS (MAKING)

The design of this chair requires the use of a relatively large volume of wood, and while it would be possible to reduce the quantity of timber, for example through the use of lamination, this would contravene its aesthetic purpose. It is intended to be weighty and durable. In sustainability terms the durability is an important factor. Church furniture can easily last for over a century, and there is no reason why this chair should not do the same. It is robust and will not fall out of fashion. With no delicate parts that could fail, it should ensure a long lifespan in this form for the timber that it embodies. More data is available on pages 72 - 77.



Turning echoes traditional Cypriot skills

HARDWOOD SPECIES USED

For more information on U.S. hardwood species, turn to p70

Pinch with a punch

An asymmetric joint lets straight timber bend

THE DESIGNER

Name:
Nic Wallenberg

Born:
Wimbledon, England, 1983

RCA year:
Second

SQUEEZE

CONCEPT:
A special joint and carefully selected timber

ANTICIPATED LIFESPAN:
5-10 years

Nic Wallenberg first studied industrial design at Rhode Island School of Design in the United States. Following internships with furniture designers Tomoko Azumi and Front, he carried out a number of freelance commissions, and had his own shows at Designers Block. He has just finished at the RCA and hopes to collaborate with other graduating students in a shared studio.


“The seat flexes to an ergonomic shape”

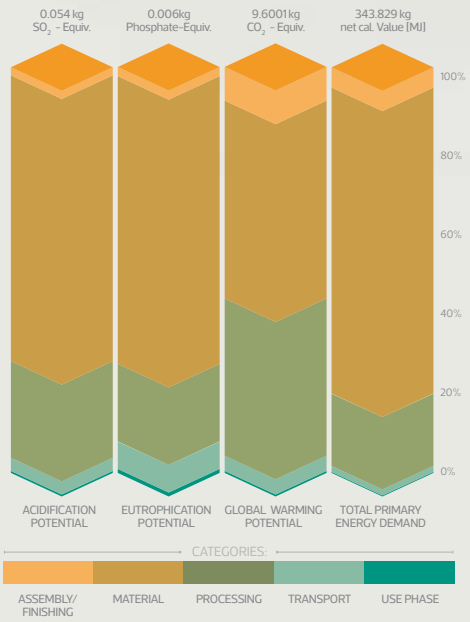
THE CHAIR

The idea behind this chair is to create asymmetrically positioned slots set within the thickness of the timber in each of the axes. Under the load of a seated person, these joints will bend, becoming concave on the side of the thinner piece. In this way, the seat and back can flex into an ergonomic shape that is comfortable for sitting, allowing straight pieces of timber to be used that would create curves in operation.

The chair contains just five bolts. Although the idea is simple, the making of it was less straightforward, because selection of timbers needed to ensure that the grain ran straight in the areas where the slots were placed. The squeeze chair was made in hickory, a flexible material that allowed Wallenberg to work it by hand rather than requiring steam bending.

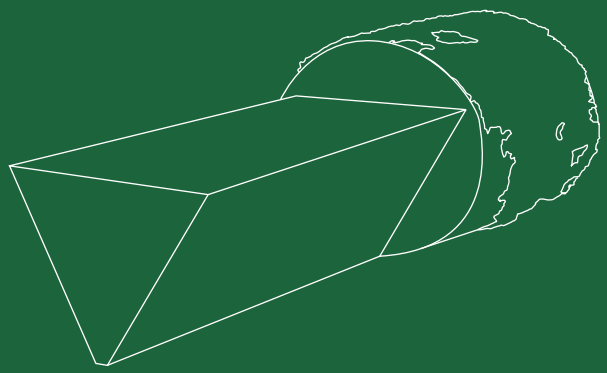
LIFE CYCLE IMPACTS (MAKING)

This approach reduces the number of operations needed to make a comfortable chair, such as steam bending. Its dependency on very accurate grain selection does, however, mean that a lot of material will be rejected – not a problem if other uses can be found for it. More data is available on pages 72 – 77.



HARDWOOD SPECIES USED

For more information on U.S. hardwood species, turn to p70



TREE FURNITURE

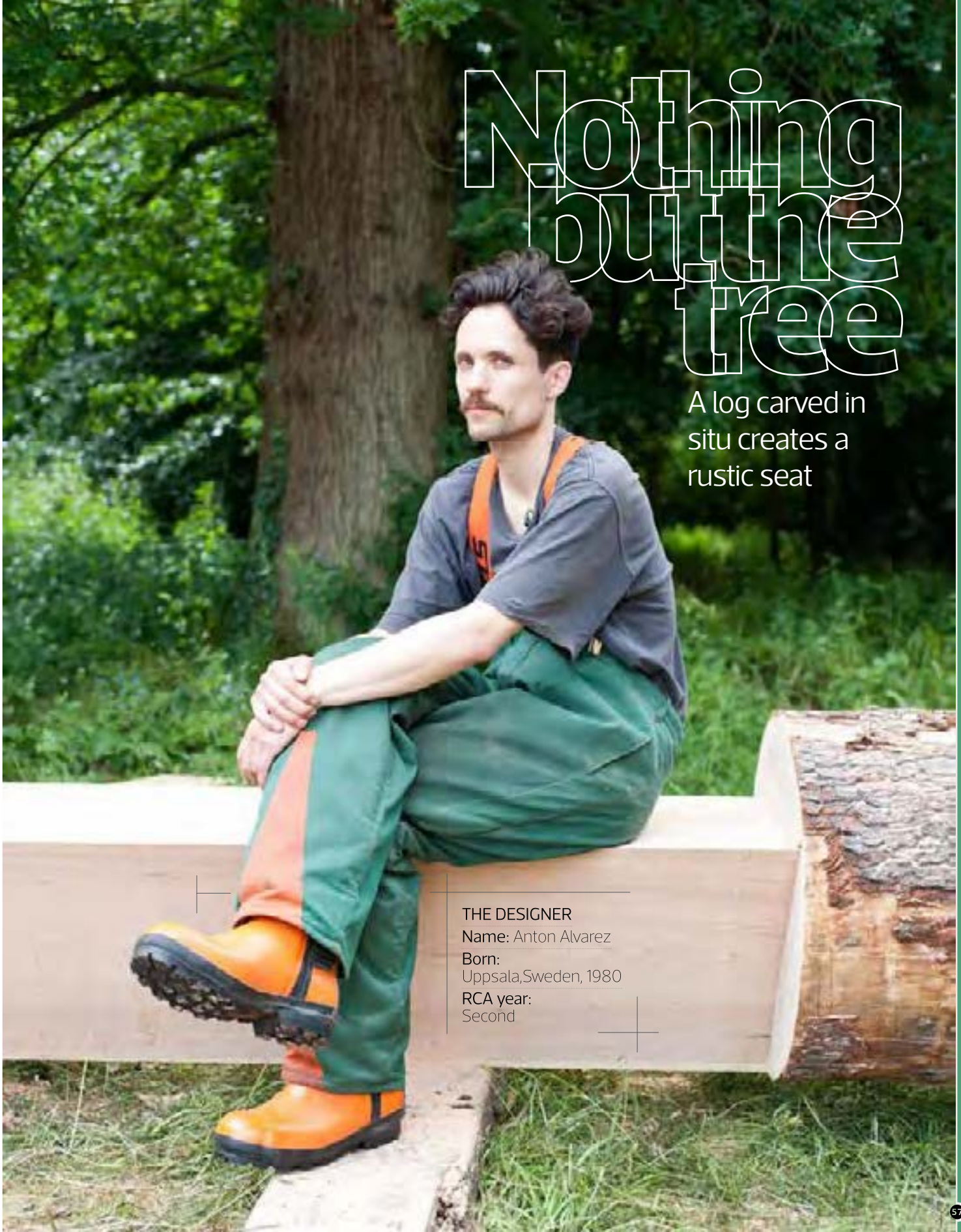
CONCEPT:
Three cuts with a chainsaw

ANTICIPATED LIFESPAN:
30 years

The half-Chilean Anton Alvarez took his original degree, a BA in interior architecture and furniture design, at Konstfack in Stockholm, and spent a year freelancing before coming to the Royal College of Art, from where he has just graduated. For his final project he developed a machine that wraps threads around furniture components to bind them together. Alvarez already has some design commissions and has taken part in several exhibitions.

Nothing but the tree

A log carved in situ creates a rustic seat



THE DESIGNER

Name: Anton Alvarez

Born: Uppsala,Sweden, 1980

RCA year: Second

HARDWOOD SPECIES USED

For more information on U.S. hardwood species, turn to p70

"One end of the bench remains uncut wood"

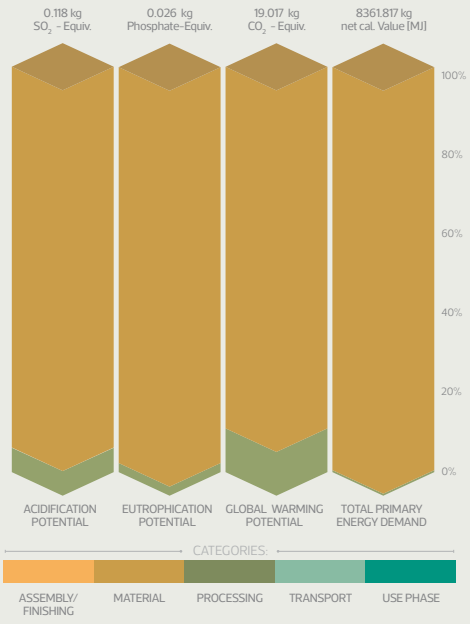
THE CHAIR

The concept for this seat was that it should be carved simply from a tree cut down and left on the forest floor where it had been felled – an idea that had to be adapted slightly since Alvarez was working with American hardwood in England. He did carve his bench from a single untreated log of American cherry, outside in the grounds of Benchmark. One of the things Alvarez particularly likes about the timber is that it is one of the few that becomes darker with time, rather than fading.

His intention was to achieve simplicity, and this is what he has done, using a portable saw mill and a chainsaw to create his bench with just three cuts. One end of the bench remains as uncut wood, with the bark still on. Alvarez' idea is that it would be a pleasure to happen on such a bench during a walk through the woods. While a tired walker could happily perch on a tree stump, there is a special magic in finding something that has been specifically made.

LIFE CYCLE CONSIDERATIONS

Almost all of the impacts associated with this bench relate to the material, since there is in theory no transport to site, and no finishing. The bench is not comparable to other solutions, not least in terms of durability. The unseasoned timber will dry and split quite dramatically but Alvarez is happy to accept the cracks as part of the 'natural' aesthetic. And of course, at the end of its life, the bench, like the offcuts, will decay on the ground and give up its nutrients to the soil. More data is available on pages 72 – 77.



THE MAKING PROCESS

1 On a roll
Human power positioned the log on the edge of the wood

2 On the right lines
The cuts were marked out exactly on the log

3 No going back
Actually making the cuts was a relatively rapid process

4 Moment of truth
Removing the cut material to reveal the final form

Explosion of delight

Wood chips and resin create unpredictable results

THE DESIGNER

Name:
James Shaw

Born:
Newcastle, England, 1987

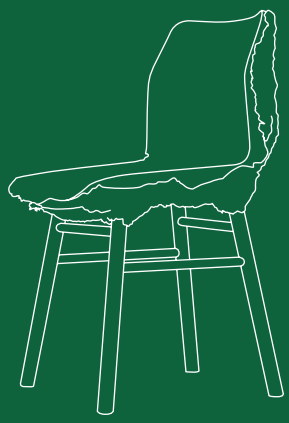
RCA year:
First

THE DESIGNER

Name:
Marjan van Aubel

Born:
The Netherlands, 1985

RCA year:
Second



WELL PROVEN

CONCEPT:
Experimentation with resin and waste materials

ANTICIPATED LIFESPAN:
10–15 years

In a first degree at the Design Lab of the Gerrit Rietveld Academie in Amsterdam, Marjan van Aubel focused on process and development. This started her interest in research into materials, which she carried through several years working. She has now graduated from the RCA and hopes to start a studio.

James Shaw studied product and furniture design at Kingston University and absorbed from there the idea of intelligent making – of how to make objects in a simpler, more interesting way. He has just completed his first year at the RCA, and hopes to continue his collaboration with van Aubel.

THE MAKING PROCESS

1 Testing, testing
The pair created numerous samples

2 Hands on
Applying the resin mix to the chair 'mould'

3 Art or science?
The workspace was like a laboratory

4 No two alike
Every chair has its own character

"The mixture creates a kind of controlled explosion"

HARDWOOD SPECIES USED

For more information on U.S. hardwood species, turn to p70

THE CHAIR

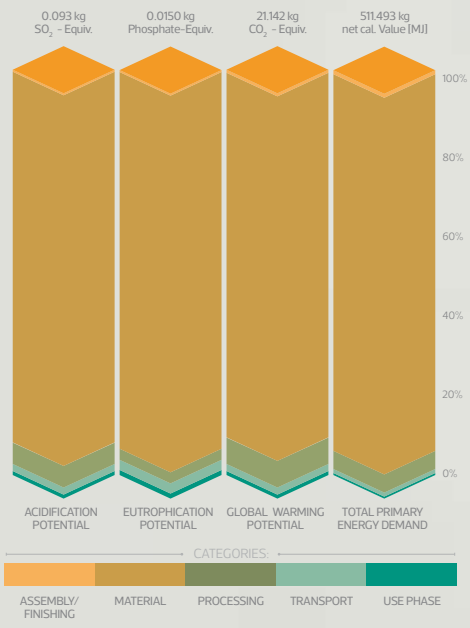
The starting point for the design of this chair was the fact that, even in a well-run factory, between 50 and 80% of the timber becomes waste. They therefore looked at ways of incorporating the lowest form of timber, the shavings, into the design of the chair. Following extensive testing, they came up with a combination of a bio-resin, water, and shavings of a mixture of lengths (generated by different operations), that created a kind of controlled explosion.

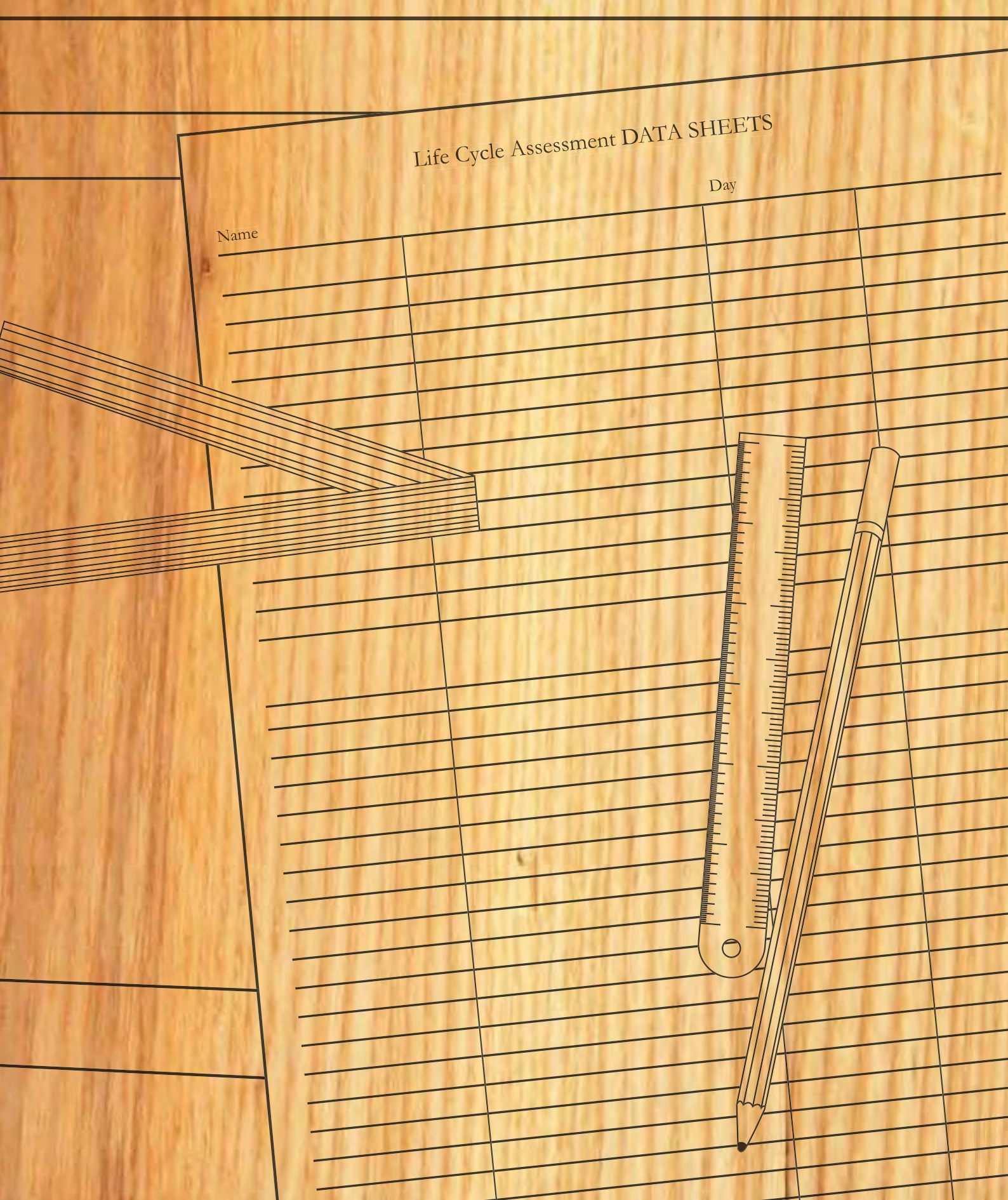
The resin, mixed with a colour, forms a porridge-like mass, which can be moulded against an existing classic polypropylene chair to create a seat form (why create a mould when such an excellent one is already available?) and is fixed to simple but elegant legs of turned ash – a deliberate contrast to the exuberance of the seat.

This is a method for creating unique chairs, since the behaviour of the mixture is unpredictable, and the colours do not mix evenly.

LIFE CYCLE CONSIDERATIONS

The idea of using waste materials within the body of a chair is appealing, although the need to select the materials carefully limits the amount that can be used. Shavings from different timbers give different effects – for instance, cherry shavings impart a definite reddish hue.
The biggest uncertainty is with the bio-resin for which little clear data is available. Van Aubel and Shaw have used it in a very different way from the manufacturer's recommendation, and so it is hard to judge how durable the chair will be. The pair are eager to continue their researches. More data is available on pages 72 – 77.




Life Cycle Assessment DATA SHEETS
Day
Name

The process

Design becomes reality

During their week at Benchmark, the students worked hard, learnt lots and had fun

For a week in July, the Benchmark plant at Kintbury, Berkshire was turned upside down, as 14 students descended, along with their tutors and mentors. Space was found for 13 of them in the main woodworking shop, with the 14th working outside, chainsawing a log, while surrounded by trees. Some of their fellow students also came to help.

In an incredible feat of organisation, manufacture continued at this company, founded nearly 30 years ago by Sean Sutcliffe and Sir Terence Conran. While some of the workforce were seconded to help students, most continued to make the furniture for which the company is known, designed either internally or by renowned or newly discovered designers.

The complex, a mix of converted farm buildings with others of an agro-industrial aesthetic, houses not just the workshops but also a showroom, and little disturbed its smooth running - apart from an encampment of tents in what was virtually Conran's back garden. A pair of striped blue underpants appeared on a stone gatepost to dry out after a photographer had strayed too far into a stream to photograph the test launch of the floating chair, but otherwise it was business as usual – until one walked into the shed.

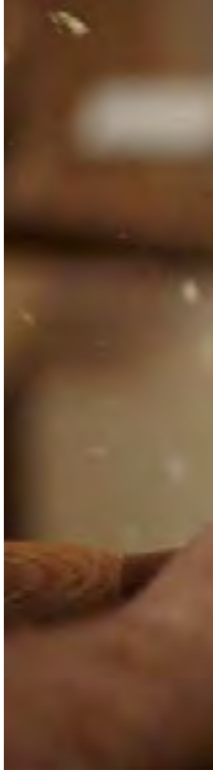
Among the craftsmen calmly making high-quality furniture were the more excitable, but closely focused students, concentrating on the best ways to make their designs work and being guided where necessary through the tasks involved. In addition to two of his own team, Pete Everest and Mark Hinton, Sean Sutcliffe had brought in specialist wood turner Mike Bradley and boat builder Will Reed. Independent furniture maker/designers Sebastian Cox and Liam Treanor also helped, as did RCA tutor Harry Richardson.

Richardson said: 'The week at Benchmark gave the students an immersive experience that saw them exploring their ideas within the context of a busy ▷

◁ commercial workshop which made for a wonderful and highly charged week of work. The collective skills and experience of the team that supported this work from all corners (design, making, scientific) represented a once in a lifetime opportunity that the students relished. They are very lucky! I think the results speak for themselves as we have a fantastically diverse range of ideas that have all achieved a high degree of resolution.'

Sean Sutcliffe was determined that, at the end of each arduous day, every student should fill in the sheets they had been given saying how much time they had spent on each machine and how much material they had used. This was vital for the life cycle analyses. 'It is the LCA that gives the project proper relevance and gravitas,' he said. 'It takes it way beyond just another student project.' He also felt the workshop experience was invaluable. 'The best designers I work with have a good sound knowledge of how to make stuff,' he said. He described the process of working with the students as 'like going to a party and dancing with 12 different girls – fascinating, infuriating but ultimately lovely.'

The week involved some early starts, but also the excellent lunchtime catering enjoyed by the Benchmark staff – including paella cooked out of doors - and the opportunity to swim in lieu of a shower. They all appreciated the setting – one even regretting that there were no laundry facilities because London offered so few opportunities for line-drying his clothes. □



“Just having an idea and drawing is very different. There are so many different ways to make one thing. I need to learn which is the most accurate”

Santi Guerrero Font

“I was blown away by the workshop they have here – it’s an amazing workshop in an amazing location”

Sam Weller

Sharing timber knowledge

Out of the Woods is AHEC's latest initiative to promote understanding

The American Hardwood Export Council is the leading organisation promoting the sales of American hardwood and hardwood products around the world. It represents producers of timber and associated products such as veneers, plywood and mouldings. And while its primary purpose is to promote the wider use of American hardwoods, it is aware that one important way to do this is through encouraging a greater use of timber in general.

AHEC's work in Europe has therefore centred on providing information on American hardwoods and their applications, on increasing the level of technical information available through thorough testing of structural timbers, and on providing inspiration. This ranges from case studies and lectures through commissions with leading architects that have been showcased in Milan and London.

This latest initiative represents yet another strand of the organisation's work – encouraging students to engage with timber in general and American hardwoods in particular. It can help the designers of tomorrow to develop an understanding of the beauty and potential of the different timbers which they can take with them throughout their careers. 'We are particularly delighted to be working with the Royal College of Art,' said David Venables, European director of AHEC, 'as the students there are the best of the best, and many will go on to have glittering careers.'

Combining a design project with life cycle analysis fits these students for the challenges of the future, as well as highlighting the strengths of American hardwoods and of the data that has been collected. Economy of materials may seem to go against the grain of an exporting organisation but, said Venables, 'we are not trying to encourage people to use more timber in their designs. Instead we are trying to encourage them to use less – but to make sure that more people are using it.'

Each species has its own particular characteristics, which are summarised opposite.

Cherry

The heartwood of this beautiful timber varies from rich red to reddish brown, and darkens on exposure to light. It is easy to machine and fix and, when sanded and polished, produces an excellent smooth finish. It is of medium density with good bending properties.

Hickory

In fact this is a family of timbers which includes pecan (see above) and they are commonly sold together. Hickory is increasingly used for flooring, thanks to its hardwearing properties. The timber has a coarse texture.

Pecan

This member of the hickory family is found in the Mississippi Valley region (further south than the timbers labelled hickory). It is however commonly sold with hickory because the qualities are so similar.

Hard maple

This strong and hard wearing wood with creamy-white sapwood and darker heartwood has high resistance to abrasion and wear and good steam bending properties.

Ash

This timber has one of the best strength-to-weight ratios. It has excellent shock resistance, and is ideal for steam bending. In appearance it is light coloured (particularly the sapwood) with a coarse, uniform texture and a straight grain.

Gum

This attractive species has a white to light pink sapwood and a reddish-brown heartwood. The moderately hard, stiff and heavy wood is used for cabinet making, furniture parts, doors and internal joinery. Availability is limited.

Alder

A relatively soft hardwood of medium density, red alder is excellent for turning and polishing, and is easily fixed. The light-brown wood has a relatively straight grain. It can be painted or stained, and has good dimensional stability after drying.

Soft maple

Very similar in appearance to hard maple, soft maple is more susceptible to regional colour variations. The straight-grained timber is about 25% less hard than hard maple, has medium bending and crushing strength, and is low in stiffness and shock resistance. It has good stream bending properties. It can be stained to resemble other species.

Red oak

The most abundant species in America's hardwood forests, red oak is hard and heavy, with medium bending strength and stiffness and high crushing strength. It is very good for steam bending. It is attractive with distinct reddish-pink tones, making it popular for furniture and building applications.

Tulipwood

One of the best value and most versatile U.S. hardwood species, tulipwood is widely used in construction, furniture and interior joinery. Although relatively light in weight and soft, it has excellent mechanical properties and a very high strength to weight ratio, making it ideal for laminated beams and structures.

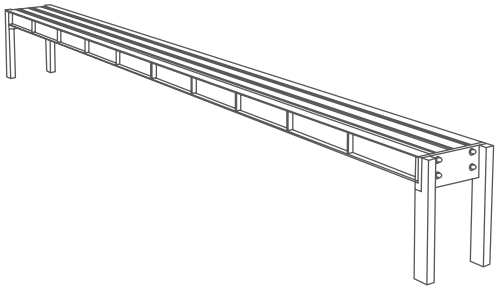
Walnut

The light brown to dark chocolate brown heartwood, sometimes with a wavy or curly grain, makes walnut a fashionable timber for furniture, architectural interiors and high class joinery. It has moderate bending and crushing strengths and low stiffness.

White oak

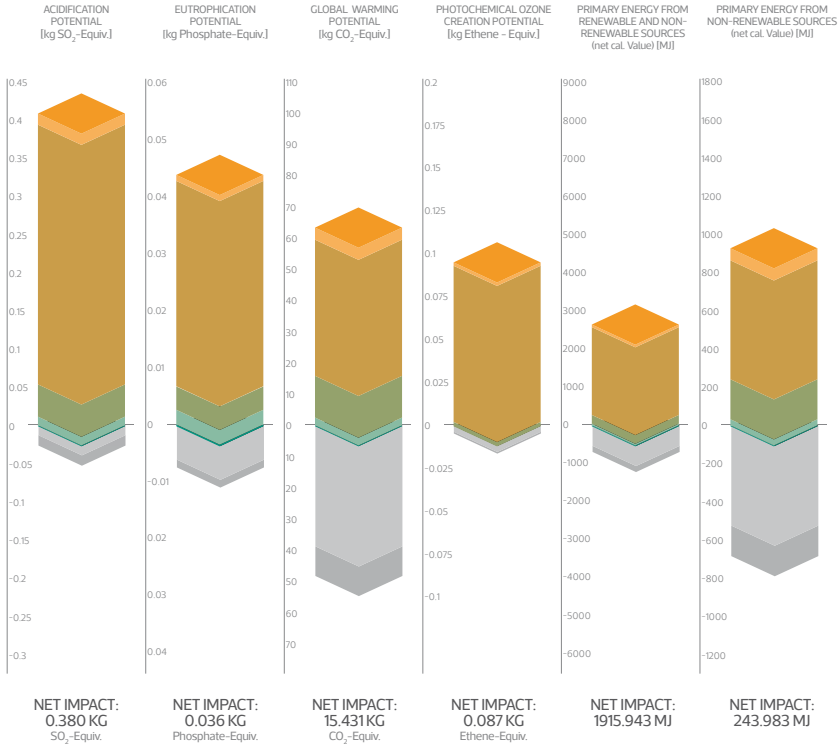
Wide availability makes white oak a popular choice for furniture, flooring and joinery. It has good colour consistency and is hard and heavy, with medium bending and crushing strength. It is low in stiffness, but very good for steam bending.

BEEEENCH



There is a large credit assigned to waste for this bench. Although this seems an advantage, it is offset by the fact that a larger volume of wood was used which has an impact. It is surprising, at first, that this bench is so wasteful with its flat pieces of wood. But all have to be cut and prepared. More than half of the processing energy was on the sander. Materials and process have a greater influence on life cycle than transport which is affected by weight, so the desire for lightness was not necessarily going to reduce the environmental footprint. Estimated lifespan is only 10–20 years because of concerns about rotational stability.

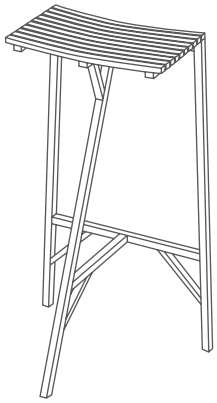
Waste and end of life are assigned as credits (negative values of impact) as we assume the chair at end of life and the waste generated in production will both be incinerated and used as a bio-fuel for generation of heat. This substitutes energy created from fossil fuels which of course has a great environmental impact.

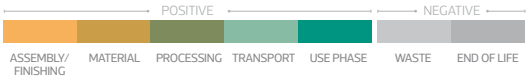


NET IMPACT:	NET IMPACT:	NET IMPACT:	NET IMPACT:	NET IMPACT:	NET IMPACT:
0.380 KG SO_2-Equiv.	0.036 KG Phosphate-Equiv.	15.431 KG CO_2-Equiv.	0.087 KG Ethene-Equiv.	1915.943 MJ	243.983 MJ

DESIGNED LEGACY

The impacts of this stool are pretty low, as one would expect from a designer with an expressed desire to 'win' at the life cycle analysis. While this was definitely not a competition, it is therefore worth noticing that the design did not have the lowest impact in every category. It clearly shows that it is not the final weight; it is the overall amount and selection of materials needed for making the chair that drives the LCA. Having a design that is fit for purpose is also crucial. Lifespan is estimated at only one to two years.





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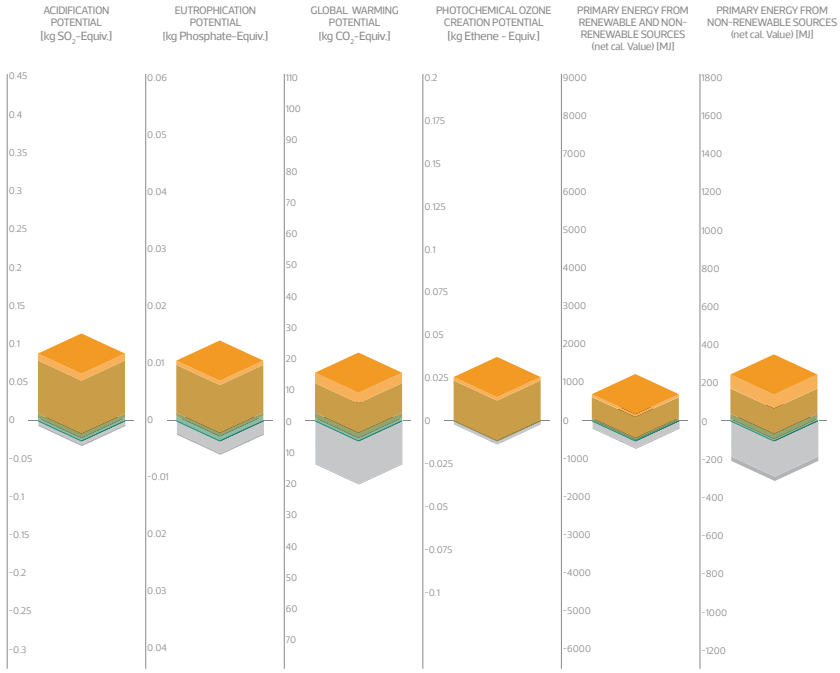
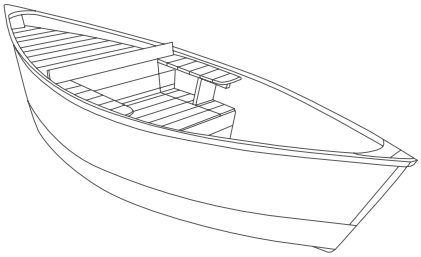


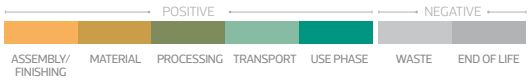
NET IMPACT:	NET IMPACT:	NET IMPACT:	NET IMPACT:	NET IMPACT:	NET IMPACT:
0.088 KG SO_2-Equiv.	0.008 KG Phosphate-Equiv.	1.291 KG CO_2-Equiv.	0.023 KG Ethene-Equiv.	433.599 MJ	30.945 MJ

The full i-reports prepared by PE International are available at: **www.americanhardwood.org/out-of-the-woods/**

FLOATING CHAIR



It is no surprise that this design had the highest environmental impacts. It used a lot of material and required a great deal of work. The skills needed in boat building are reflected in the relatively high impacts of processing and finishing. It does not mean however that this was a 'bad' solution, just that its purpose was different. The designers paid as much attention to impacts as their colleagues but that has to be set in the context of what they were trying to achieve. Lifespan is estimated at 15-25 years but one can imagine this lasting longer with loving repairs and patching up.



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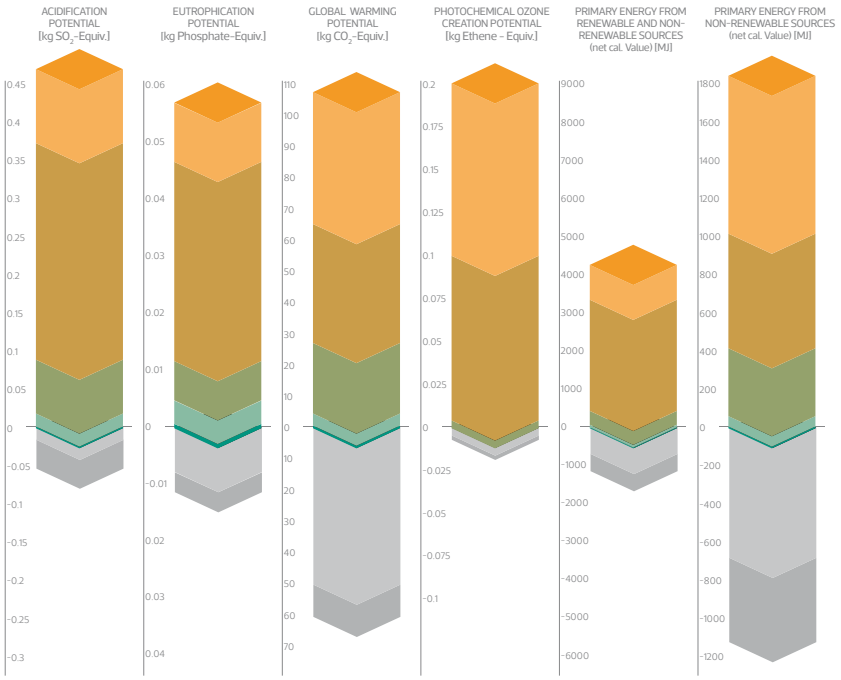


NET IMPACT: 0.423 KG SO_2-Equiv.

NET IMPACT: 0.045 KG Phosphate-Equiv.

NET IMPACT: 46.386 KG CO_2-Equiv.

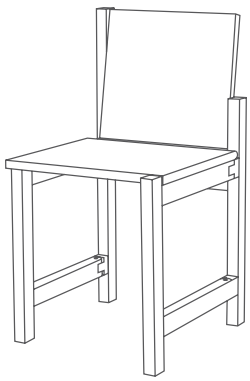
NET IMPACT: 0.187 KG Ethene-Equiv.

NET IMPACT: 3066.582 MJ

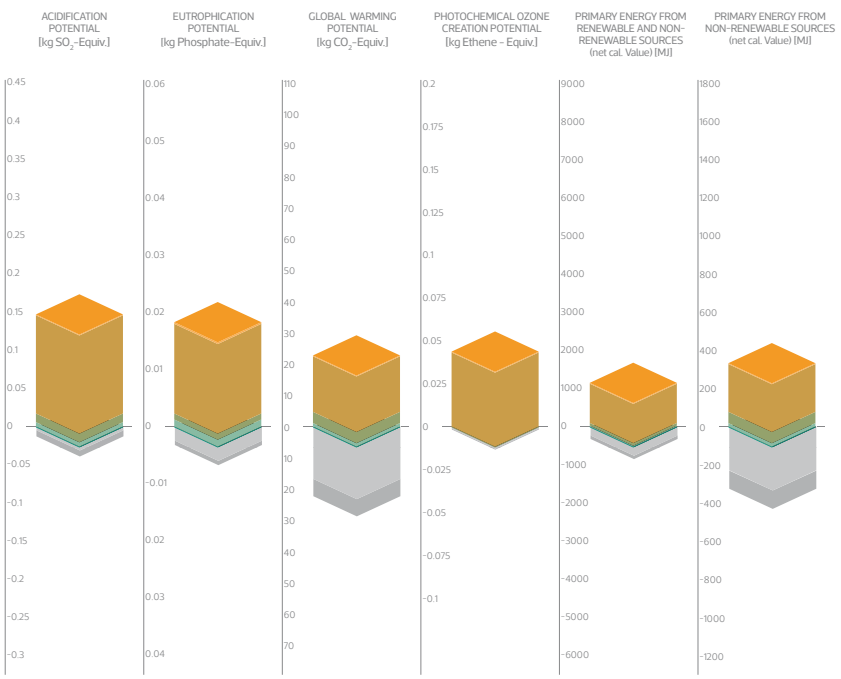
NET IMPACT: 710.288 MJ

FOLDING CHAIR

With a relatively low environmental footprint and an estimated life span of 60 - 80 years, this chair achieves an impressive balance in life cycle terms. The overall energy consumption, in terms of tool use, was fairly low, and although the chair took a full week to complete, this was in terms of precision rather than a lot of working. The decision to use square sections of timber, though primarily aesthetic, reduced the time for labour as well as energy use and waste at the workshop and subsequently the environmental footprint.



Waste and end of life are assigned as credits (negative values of impact) as we assume the chair at end of life and the waste generated in production will both be incinerated and used as a bio-fuel for generation of heat. This substitutes energy created from fossil fuels which of course has a great environmental impact.



NET IMPACT: 0.147 KG SO_2-Equiv.

NET IMPACT: 0.015 KG Phosphate-Equiv.

NET IMPACT: 0.891 KG CO_2-Equiv.

NET IMPACT: 0.039 KG Ethene-Equiv.

NET IMPACT: 775.56 MJ

NET IMPACT: 2.747 MJ

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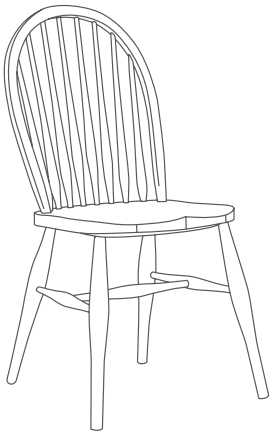
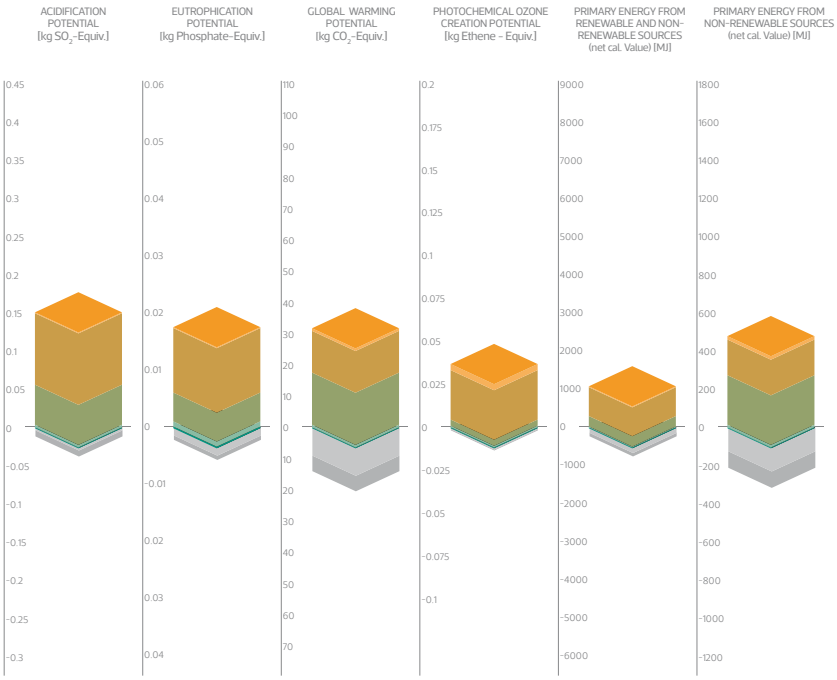
LEFTOVERS CHAIR

The concept of this chair allows the use of off-cuts instead of 'new timber' which has the potential to reduce the environmental footprint significantly from the calculated impact here. Nevertheless, the overall impacts in the production of this chair seem high compared to some of the other projects. The glue content is high (all those elements to stick together) and there was also steam bending of the arch of the back. But of all the chairs, this has the second-highest estimated life at 80-100 years.





NET IMPACT: 0.153 KG SO_2-Equiv.

NET IMPACT: 0.015 KG Phosphate-Equiv.

NET IMPACT: 17.288 KG CO_2-Equiv.

NET IMPACT: 0.032 KG Ethene-Equiv.

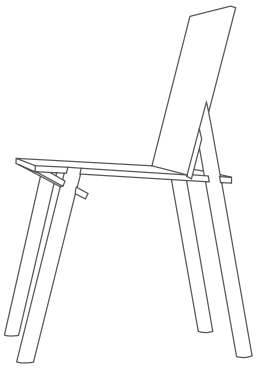
NET IMPACT: 818.622 MJ

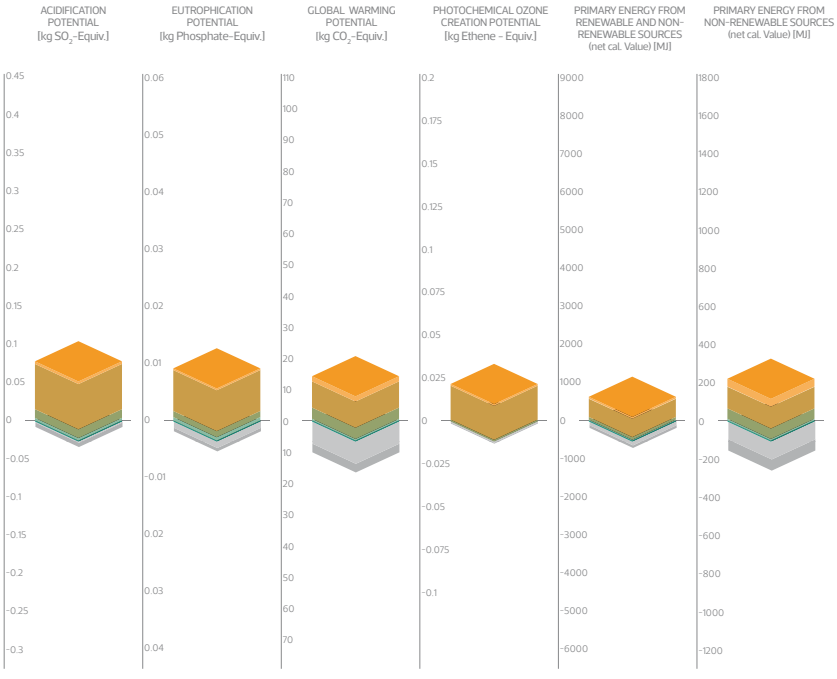
NET IMPACT: 263.129 MJ

Waste and end of life are assigned as credits (negative values of impact) as we assume the chair at end of life and the waste generated in production will both be incinerated and used as a bio-fuel for generation of heat. This substitutes energy created from fossil fuels which of course has a great environmental impact.

NUM. 4

Santi Guerrero Font's determination to cut down the material content of his chair paid off in environmental terms, with it having one of the lower footprints yet still being a sturdy chair, with an estimated lifespan of 30-50 years. It is interesting to note that in a chair which seems to be nothing but wood, the glues and wax which were used actually account for around one-eighth of the total global warming potential – an indication that conscious material selection has significant influence on environmental performance.





NET IMPACT: 0.075 KG SO_2-Equiv.

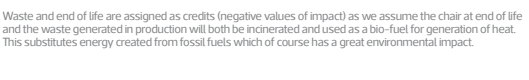
NET IMPACT: 0.007 KG Phosphate-Equiv.

NET IMPACT: 4.033 KG CO_2-Equiv.

NET IMPACT: 0.019 KG Ethene-Equiv.

NET IMPACT: 405.016 MJ

NET IMPACT: 62.513 MJ



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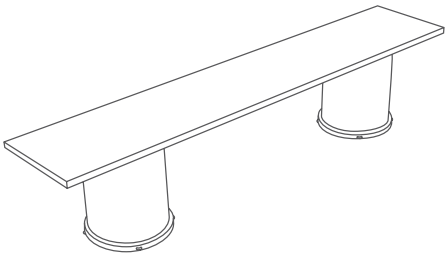
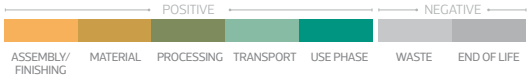
PHYLLIDA



The travelling bench has one of the lower carbon footprints and use of fossil resources, which is related to the high share of bio-based materials used – even the bungee cord is made of natural rubber. It is interesting to compare with Beeeench – here there was only one large piece of wood to plane and sand and this is reflected in the overall energy use – and the fact that the designers had time to make more than one bench. One might question the environmental credentials of the bungee cord that plays such a vital role, but in fact its contribution in environmental terms was fairly minimal. However if a bungee cord in synthetic rubber had been used, this would look different.



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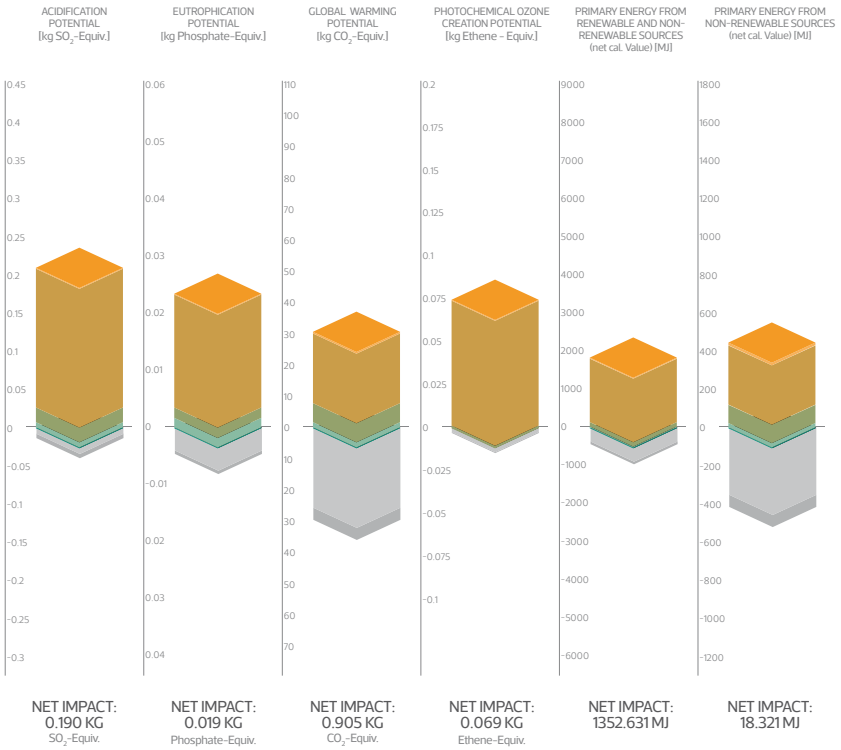
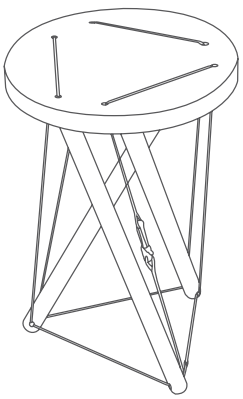


NET IMPACT:	NET IMPACT:	NET IMPACT:	NET IMPACT:	NET IMPACT:	NET IMPACT:
0.190 KG SO_2-Equiv.	0.019 KG Phosphate-Equiv.	0.905 KG CO_2-Equiv.	0.069 KG Ethene-Equiv.	1352.631 MJ	18.321 MJ

SNELSON

This is a stool that is held together by tensioned string. It is interesting to note that the primary energy demand of fossil resources related to that string, because it is made of polyester, is about a tenth of that associated with the wood – a not insignificant amount and an indication that choice of 'secondary' materials in the design of timber furniture is important. However, the overall environmental footprint is one of the lower ones owing to the efficient use of raw materials, as well as the low final weight. Although there is a temporary feel to the stool, the lifespan was estimated to be around 10 to 20 years.



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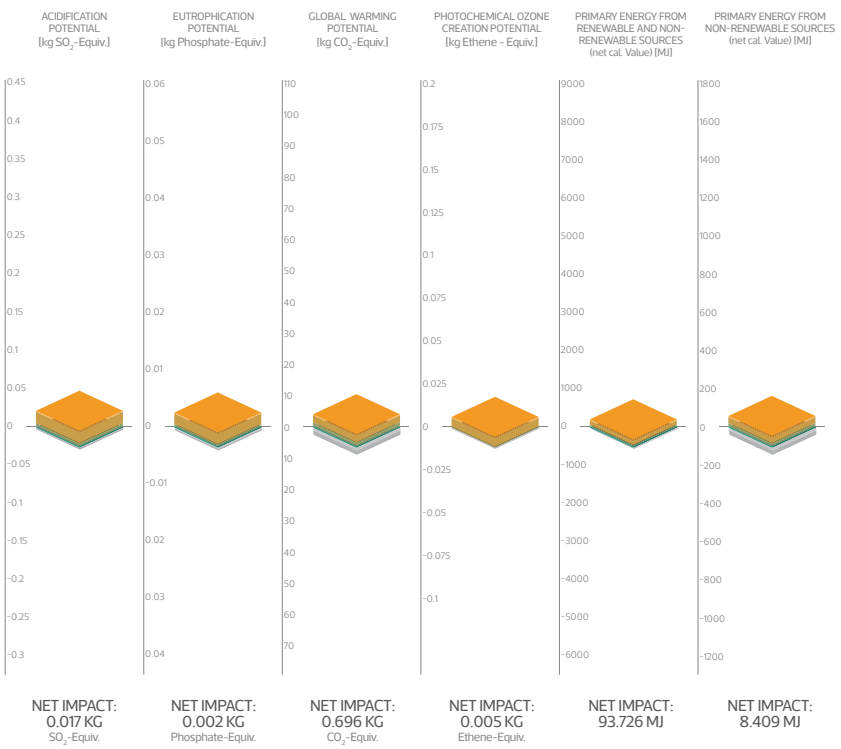

NET IMPACT:	NET IMPACT:	NET IMPACT:	NET IMPACT:	NET IMPACT:	NET IMPACT:
0.017 KG SO_2-Equiv.	0.002 KG Phosphate-Equiv.	0.696 KG CO_2-Equiv.	0.005 KG Ethene-Equiv.	93.726 MJ	8.409 MJ

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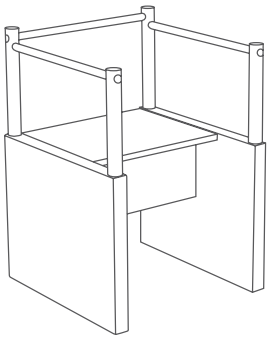
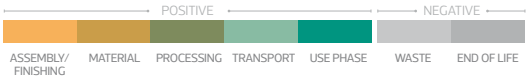
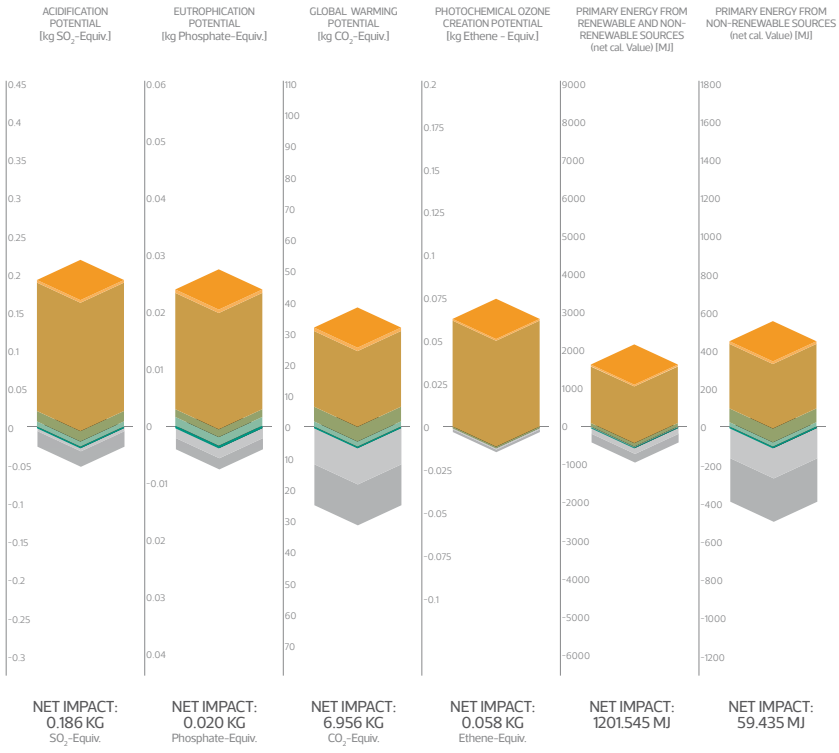
SOLITUDE

Relatively simple to manufacture, and with few components other than the timber, this chair has almost all its impacts in terms of the materials. There is little else – just a few fixings, and some oil. And because it uses so much timber, it is one of the higher-scoring chairs in most of the environmental impacts considered. Set against this is the fact that this chair's estimated design life is the longest of all, at over 100 years.





Waste and end of life are assigned as credits (negative values of impact) as we assume the chair at end of life and the waste generated in production will both be incinerated and used as a bio-fuel for generation of heat. This substitutes energy created from fossil fuels which of course has a great environmental impact.



NET IMPACT: 0.186 KG SO_2-Equiv.

NET IMPACT: 0.020 KG Phosphate-Equiv.

NET IMPACT: 6.956 KG CO_2-Equiv.

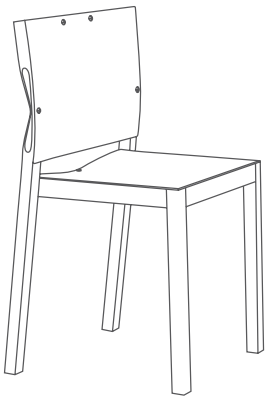
NET IMPACT: 0.058 KG Ethene-Equiv.

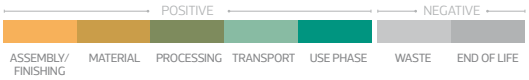
NET IMPACT: 1201.545 MJ

NET IMPACT: 59.435 MJ

SQUEEZE

This chair has a relatively low environmental footprint which is related to its low weight and the fact that it uses very little apart from timber and a certain amount of plywood. The chair was very complex to make but processes were low impact showing that complexity of making a chair does not necessarily result in a high environmental footprint. However there is a question mark over its durability as users will impose quite high stresses on thin material. As a result, its lifespan has been estimated at only 5 - 10 years.





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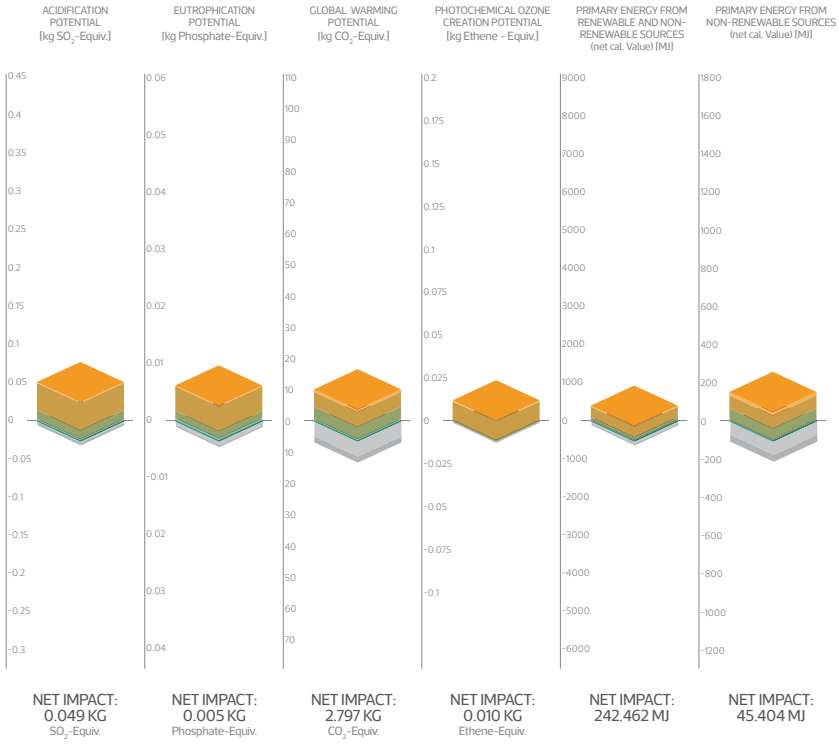


NET IMPACT: 0.049 KG SO_2-Equiv.

NET IMPACT: 0.005 KG Phosphate-Equiv.

NET IMPACT: 2.797 KG CO_2-Equiv.

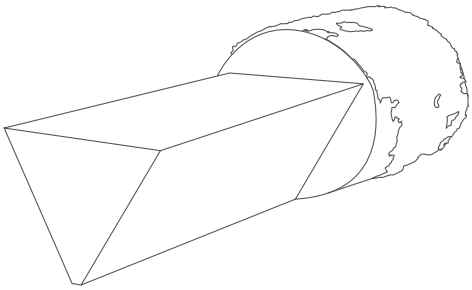
NET IMPACT: 0.010 KG Ethene-Equiv.

NET IMPACT: 242.462 MJ

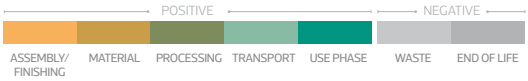
NET IMPACT: 45.404 MJ

The full i-reports prepared by PE International are available at: **www.americanhardwood.org/out-of-the-woods/**

TREE FURNITURE



The concept of this piece of furniture is to use the material where it is originally available – in the forest. At its end of life, the bench decays in the same way as trees in a forest. Therefore no impact or credit is assigned to it unlike other waste which is seen as making an environmental contribution, with both the waste generated in manufacture and the bench at end of life being used as fuel. The lifespan of Tree Furniture is estimated as 30 years – this is one piece of furniture that will still be serviceable when no longer pristine.



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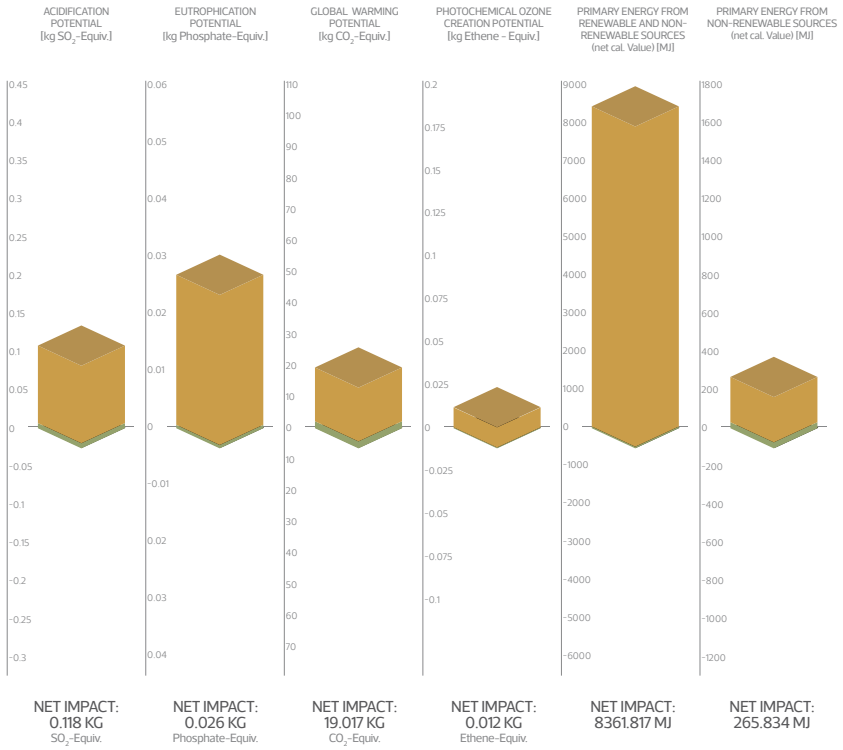
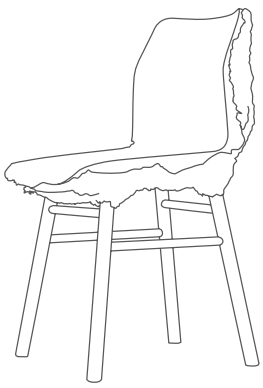


WELL PROVEN

This chair is unique compared to all the others, as it uses a resin based on bio-materials combined with American hardwood chips and sawdust. As no adequate information could be compiled on the bio-resin in time, the team at PE International made an assumption that it is made from a crude-oil-based chemical., the contribution from this being between 25% (GWP) and about 60% (EP). To reach a final conclusion, this would have to be investigated further. The other uncertainty is the lifespan – estimated at 10-15 years but hard to tell with such a new material. The designers are aware of this and would like to carry out further testing.



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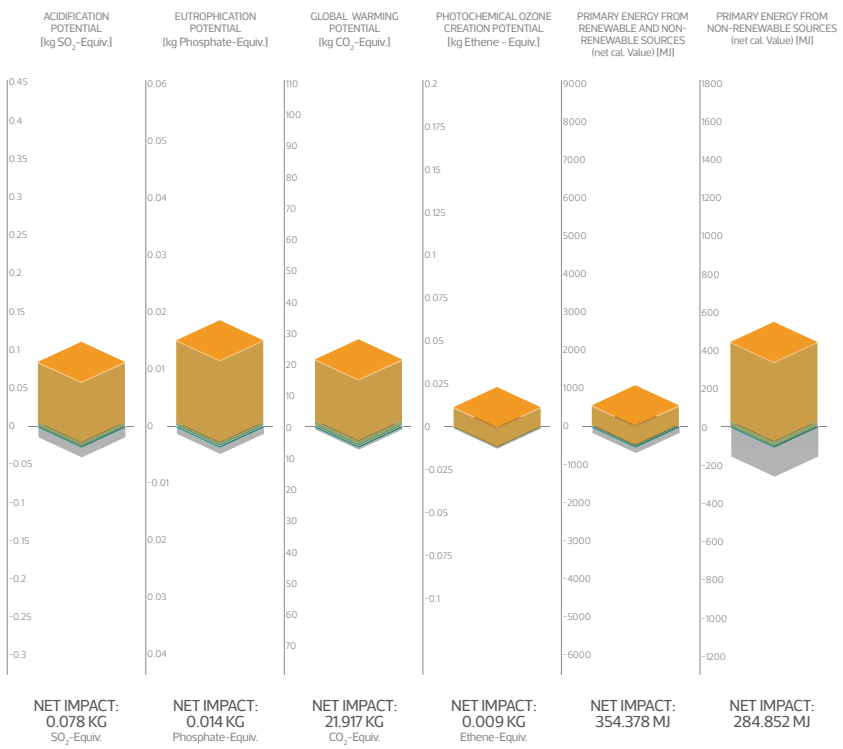

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This publication documents a unique collaboration between the American Hardwood Export Council, the Royal College of Art, Benchmark Furniture and PE International in which 12 sets of students designed chairs, manufactured them, considered their life cycle analyses and exhibited the finished work at the Victoria & Albert Museum as part of the London Design Festival 2012. The project is not only an extraordinary flowering of creativity, but also addresses some of the environmental issues that will face the designers and makers of the future.