International Symposium

Transmaterial Aesthetics 1—2 October 2013

UNIVERSITY OF TECHNOLOGY SYDNEY

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ANCB THE METROPOLITAN LABORATORY

Experiments with Timber in Architecture and Technology
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Volker Schmidt / TU Berlin / Arup
Christoph Emenlauer / Jürgen Mayer H, Berlin
Arnold Walz / designtoproduction / Stuttgart–Zürich
Kaden Klingbeil Architekten, Berlin
and a host of international speakers

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Symposium Transmaterial Aesthetics

Dates: Tuesday 1st October - Wednesday 2nd October 2013
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Organisation: Sandra Karina Löschke UTS Sydney and Matthias Ludwig HS-Wismar

BACKGROUND

In the light of increasing environmental awareness, *timber* emerged at the forefront of material investigations in architecture over the past decades. Waste material from the end of the manufacturing process, or recycled material is fused with other materials to produce composites with changed structural, performative and aesthetic properties. Pulped, cast, bundled, 3D-printed, and robotically-stacked, new technologies enabled a radical shift away from traditional tectonics and towards articulations previously associated with other materials such as concrete, masonry and plastics. Together, these experiments give rise to a new techno-aesthetic paradigm that could be described as a form of *transmateriality*.

In nineteenth century architectural theory, Gottfried Semper's *Practical Aesthetics*already suggested a synthesis between artistic and technological developments brought about by processes of material transfiguration (*Stoffwechsel*). Today, new visual languages emerge alongside innovative technologies that permit the realistic study of material changes across structures: in folded plates, grid-shells and multi-reciprocal frames, structural integrity is achieved through grading, layering and fusing of surfaces. In practice, developments in timber range from Walter Gropius's and Konrad Wachsmann's *Packaged House*, which unsuccessfully attempted to sell the modern dream of technologically advanced living to the masses, to Jürgen Mayer H's *Metropol Parasol* whose captivating elastic forms promise the activation of public space.

Session 1 “Woodness” Moderation Sandra Karina Loschke

Wood unscripted potentials. How can material deficiencies become strengths

by Marcin Wójcik, Oslo School of Architecture and Design AHO, Norway

This paper proposes to investigate how the wood traits that are seen as shortcomings for construction can be used to advantage and what kind of design methods and techniques that would require. Wood has lost market shares as a raw material for mass production processes as a result of ist individualised characteristics and difficult to predict behaviours. Reaction wood, spiral grain and juvenile wood – present in almost all timbers -- are seen as deficiencies, causing lower strength and extensive warp during drying. It is proposed to look for design methods and techniques that utilise material information, such as the individual traits, rather than homogenise material properties with extensive use of energy, i.e. timber remanufacture. The proposed new tectonic logic is to be based on wood (i) self-organisational capacities and (ii) individual properties and behaviours. That entails development of form finding techniques based on digital tools taking account of material properties, prediction of its behaviour, appropriate construction details and manufacturing techniques.

(i) First case presents a potential of material self-organisation taking advantage of spiral grain in wood seen by some wood scientists as the most serious single defect in softwoods. The photograph depicting a twisted stack of timber as a result of the twist in the same direction in all the individual boards due to spiral grain shows how double-curved shapes can be achieved using minimum energy. It is proposed to devise design and production techniques that benefit from the twist phenomenon. Wood with left-handed spiral grain - particularly prone to twist - should be sorted out early in the supply chain. Spiral grain angle can be measured using the tracheid effect with a laser beam to predict twist during drying. Further this information can be employed in a digital form-finding simulation process to spontaneously achieve forms otherwise difficult and expensive to achieve. Undulation of walls performs acoustically – causing scattering and attenuation of sound waves, or structurally - providing for self-support. Moreover, in its equilibrium state wood becomes geometrically stable. The Hooke Park Workshop, design Richard Burton of ABK and Frei Otto, engineers Buro Happold, 1989.

(ii) Second case investigates the potential of using juvenile wood, the product of forest thinning. It is considered inferior in quality to normal wood, unsuitable for construction, composite panels or high-grade paper. Improving the growth rate and wood quality requires initial narrow spacing of trees and later thinning, a strategy that makes the remaining trees twice as expensive as planting to a wider spacing, unless a market would be found for the thinned material. While juvenile wood strength achieves about half the value of normal wood, its lower modulus of elasticity allows for bending it beyond the proportional limit, and even more so in green condition. Projects such as the Hooke Park buildings (ABK Architects, Frei Otto and Buro Happold; 1986-1990) point in an interesting direction for making use of the otherwise obsolete material. Compression structures, e.g. grid-shells, offer wide spans, quick construction and flexibility of shapes at low cost and low self-weight. The form-finding process can be controlled with digital tools taking into account bending behaviour based on precise material survey. Development of methods and techniques allowing application of juvenile wood in compression structures could become a catalyst to revolutionise world forestry.

Marcin Wójcik 1970 born in Szczecin, Poland; 1990 – 1996 studies at Technical University of Szczecin, Faculty of Architecture; 1996 – 1999 freelance architect in Szczecin, Poland; 1999 – 2002 assistant architect and architect at BPK, Szczecin, Poland; 2002 architectural license in Poland; 2002 – 2004 postgraduate studies at the Swiss Federal Institute of Technology ETH; Zurich, Switzerland (Chair of Computer Aided Architectural Design); 2004 – 2005 architect at Murray O’Laoire Architects, Dublin, Ireland; 2005 – 2012 lecturer at Dublin School of Architecture, Dublin Institute of Technology, Ireland; 2012 – research fellow and PhD candidate at AHO, The Oslo School Of Architecture and Design, Norway

Session 1 “Woodness” Moderation Sandra Karina Loschke

Covering Artschwager: An Encomium on Woodness and the “Perceptual, Real, and Faux”

by Margarita McGrath, Verginia Tech, U.S.A.

My first introduction to the hybrid artist|millworker Richard Artschwager was the Whitney Museum retrospective, **Richard Artschwager!** held October 25, 2012 – February 3, 2013. Artschwager’s use of domestic furniture as the canvas of his investigations – what Michael Torlen described as experiments in the “perceptual, real, and faux”[1] – will be used in this project as a conceptual frame to explore the contemporary nature of “woodness.” Artschwager died 10 days after the exhibit closed.

I am using “woodness” as a catchall term to describe materials that are wood-like –veneer claddings, synthetics and imitations. An object is commonly perceived and spoken of as wood if even less than millimeter of veneer is applied to the outer surface. Yet veneers today are themselves often manufactured or “reconstituted” versions of wood, including product lines like Shinnoki, Look’likes, and Character Wood by Decospan. Wood grain has always been stamped on vinyl siding, the ubiquitous cladding of new American suburbs, Hardi-panels (a cementitious board siding upgrade), as well as composite deck boards. Stamping (3-dimensional texture imprinted on the horizontal siding) and visual emulation (coloration and shape of the shingles) has recently migrated onto other materials including ceramics (for example, the faux wood floor tiles in Burger Kings). The attraction to wood is often attributed to its “warmness,” which rarely transfers with the migration of textural or visual characteristics.

Envisioned as a both a eulogy as well as an apprenticeship, my project will take the form of a text + a physical re-make of Artschwager’s 1971 “Untitled” box of five drawers, using each of the drawers as a signifier/category of the contemporary trans materiality of wood. The text accompanying the box will be subdivided into sections corresponding to an interpretation of the content and experience of the re-readings of each of Artschwager’s drawers: Formica, empty, glass, mirror, rubberized horsehair. In the 2013 “Untitled” box, woodness will be present as a thinning and simultaneous displacement of wood’s visual and tangible characteristics onto other surfaces (vinyl, tile, glass, paper). As a form of design research, the intellectual and physical process of re-making a piece can be revelatory – it reveals the underpinnings of a mentor’s approach, both methods and idiosyncrasies, lays bare the role of tools and techniques, requires an archeologist’s recreation or modernist translation, and evokes a challenge to the re-maker’s authorship – do you echo or interpret? In Postmodern art, remaking was often pursued as a dislocation of authorship – who made it. The thesis of this paper focuses on the dislocation of material – what it is – as another critical disruption of identity.

Margarita McGrath AIA | LEED BD + C; Associate Professor; School of Architecture + Design; Virginia Tech; Traveling and working abroad have defined Margarita’s professional career in practice and academics, including three years in Vienna and three in Seoul. Margarita has given lectures, workshops and served as a visiting critic at institutions in the States and internationally. **noroof** architects <http://www.noroof.net>, a Brooklyn-based firm which she shares with Scott Oliver, has received national and international recognition for delightfully designed small spaces. Her sponsored research includes participating in multi-disciplinary teams applying design thinking to learning in science and technology. Most recent published work includes a chapter, “Ghost Fishing” published in *feminist practices*, an anthology by Lori Brown (Ashgate, 2011). Margarita holds a MArch II from UCLA, and a 5-year BArch as well as a BA in Art and Art History from Rice University. She is currently an Associate Professor at the School of Architecture + Design at Virginia Tech in Blacksburg, VA.

[1] Michael Torlen, “EYEWITNESS: Reflections on Richard Artschwager’s ‘Untitled,’ 1971.”

http://www.brooklynrail.org/2012/12/artseen/eyewitness-reflections-on-richard-artschwagers-untitled-1971. Accessed May 27th, 2013.

Session 1 “Woodness” Moderation Sandra Karina Loschke

The antifragility of vegetal life and the provenance of timber in design

by Greg Nolan, Jon Shanks, Stephen Loo, University of Tasmania, Australia

A discussion about the interplay between aesthetics and technology in timber architecture is difficult. Timber is one of a suite of materials whose particular properties designers recognise and exploit in the resolution of a problem or expression of a concept. Timber is selected as a building material for its obvious natural or organic origins, with certain notions of visual appeal. Besides reasons of structure, function and appearance, there are also fundamental differences in the underlying ‘nature’ of timber, and its response to industrialisation, compared to other building materials.

Most building materials are manufactured from non-renewable resources through *transformative* processes while timber and other solid wood products are made through a *reductive* process from renewable organic resources. *Transformative* processes generally take a base resource, apply large amounts of energy, and change (*transform*) it physically into a different, more desirable material: bauxite to aluminium, iron ore to steel. Transformed materials generally have predictable performance, are homogeneous, manufactured as commodities in highly controlled, capital-intensive facilities, and importantly are anonymous. They can literally come from anywhere. *Reductive* processes are significantly different. Logs as units of resource are cut or peeled (*reduced*) into smaller shapes useful for particular applications. Production may be very low energy and use very simple, low-capital techniques, and the pieces may be used as recovered or reassembled. Importantly, the nature of the material is not changed.

The key characteristics of reductively-produced materials are almost exactly opposite to those of transformative processes. Their properties are largely determined by the resource. With wood, they are anisotropic, irregular, and in the resource unpredictable. The characteristics of a timber species, or the timber from an individual tree, are connected to and therefore hold the ‘memory’ of highly localised vagaries of environmental, social, economic and even political conditions. These characteristics are implicit in the material until the reductive industrial processes reveal them.

This paper adopts a method of thinking and practice with wood that is framed by the vegetal life of trees (Michael Marder, 2013) that reveal its characteristics rather than determining it. Within what can be called the *provenance* of timber are *singularities* that open up possibilities of what the material can do. These need to be protected from industrial thinking and practices that produce absolute consistency in material behaviour. Provenencial thinking, in its variability, connects the material to wider environmental and socio-cultural worlds allowing the material to thrive in the way it manifests and relates to design, production, manufacture and construction processes. The paper discusses how the consequences of reductively processing a renewable organic resource generate the key characteristics of timber that designers implicitly recognise and exploit in design. The paper will extend this argument by showing that it is this uncertainty and impreciseness in the characteristic of timber that generates new practices. Timber therefore has what Nassim Talib (2012) calls an *antifragile* property: it is not resilient and robust in that it resists shocks and stays the same; it is antifragile because it gets better with unpredictability. This is key to sustainable development through a unique, diverse and democratic renewable material.

Jon Shanks Jon is a Chartered Structural Engineer with international research and design experience. Jon has a PhD in timber engineering with a focus on all-timber connections. As an engineering consultant, he has been instrumental in the development, design and delivery of timber buildings and structures of varying scale and complexity from domestic dwellings to large span timber geodesic domes. Jon has worked in a range of timber materials from green oak to cross-laminated timber. He is currently building his own timber house in Tasmania.

Greg Nolan Greg Nolan is an Associate Professor at the University of Tasmania's School of Architecture and Design, and is the Director of the University's Centre for Sustainable Architecture with Wood. Between 1978 & 1995 Greg completed his Bachelor of Science (Architecture), Bachelor of Architecture, Master of Architecture and became a Registered Architect. In addition to past and current design with timber, Greg is involved in efforts to gain the most from Australia's plantation resources. Since 1994 Greg has researched and published copious amounts of books, journal articles, and conference publications, all with a key focus in sustainable design, environmental aspects of construction and building performance, as well as the broader use of renewable materials in the built environment. Greg is an experienced research manager and has directed and conducted numerous industry funded works.

Stephen Loo Dr Stephen Loo is the Professor of Architecture and Head of the School of Architecture & Design at the University of Tasmania, Australia. Stephen's research lies at the nexus between architecture and philosophy and has published widely on biophilosophy, posthumanism and ethics, human interface technology and computational architecture. Recent books include Deleuze and Architecture (ed. with Hélène Frichot, 2013) and Poetic Biopolitics (ed. with Peg Rawes, 2014). Stephen is a Founding Partner of award-winning architectural practice Mulloway Studio based in Adelaide, South Australia, with projects in Australia, Mexico, Western Samoa, India, China and Malaysia. He also has an installation and performance based art practice and has exhibited nationally and internationally.

Session 1 “Woodness” Moderation Sandra Karina Loschke

Minimal Materiality in Wood: Working with wood as a natural Material

by Patrick Fleming, Michael Ramage, Cambridge University, U.K.

The increasing complexity and automation of wood technology opens up new opportunities to designers:

these technologies can be used to support architectural intentions, an idealized form based on a personal aesthetic vision, or new structural prowess in wood. New wood technologies, however, often exploit the materiality and tectonics of wood (or ways of working with the material) in plastic rather than elastic ways, while employing the most sophisticated and distorted forms to perform some of the most meaningless structural tasks, such as covering space for a temporary pavilion or an installation. More relevant and common structures such as bridges or even basic alternatives for columns or beams in multi---storey buildings are rarely considered. In the cases when advanced wood technologies are applied to such basic structural elements, for example, as in the recently completed Pompidou Metz or Metropol Parasol, structural elements are transformed and fused into a simple covering of space. The question remains how to expand these new technologies towards more relevant structural problems, such that they may support an architectural rather than predominately aesthetic and formal response to an existing situation.

A minimalist approach to materiality is presented as a critical reaction to the common aesthetic approach supported by wood automation and technology. Working with wood as it is provided from nature in elastic as opposed to plastic ways encourages minimal energy input for making structural components, opportunities for reuse and recycling at the end of the building’s life, and meaningful challenges in structural design. Illustrative examples of material experimentation with 1:10 scaled structural models of post---tensioned massive timber panels are used to support the argument. The examples show how simple design decisions informed by the nature of wood itself can lead to complex forms that rival those of the aesthetic approach, but at the same time are rooted in structural principles and necessity. Rather than promoting the application of modern wood technology and aesthetic visions to radically transform wood and mimic other materials such as steel and concrete, the argument and examples reinforce a traditional understanding of wood. New ways of harnessing the unique and natural character of wood are suggested, and may be used to critically respond to existing situations through architecture rather than the application of aesthetics and technology together or alone.

Patrick Fleming Patrick Fleming is a PhD Candidate in the Cambridge University Department of Architecture. Having previously studied engineering in Canada, his general interests are in both architecture and engineering, and the relationship between the two disciplines. His current work in Cambridge involves the use of wood as an architectural material and new ways of using wood for structural purposes.

Michael H. Ramage Michael H. Ramage is a Senior University Lecturer in the Department of Architecture at Cambridge University. His specialties include designing and building structural masonry spans using traditional techniques and new materials. His current research is focused on developing low-energy structural materials and systems in masonry, better housing in the developing world and improved engineered timber.

Session 2 “Technology + Aesthetics” Moderation Matthias Ludwig

The re-emergence of the designer-maker in the new techno-aesthetic paradigm

By Jon Shanks, Peter Booth, Greg Nolan, Robin Green, Roberto Davolio, University of Tasmania, Australia and AWAWA

Introduction

Timber buildings were traditionally designed, fabricated, and erected by a master carpenter, the designer-maker. Contrastingly, contemporary building design and construction requires input from multiple stakeholders and consultants; fragmenting the process, requiring coordination and risk management between disciplines. This paper speculates that the direct nature of the digital design and fabrication process in timber requires a recombining of designer and maker to produce complete building solutions.

The role of designer-maker

The traditional designer-maker carpenter oversaw the entire building process from selecting material to building erection. The carpenter owned the risk through the process. Standardised supply lines and timber stress grades did not exist. Instead through careful selection of the standing tree or timber section, and connection design the carpenter made intelligent use of the material available to avoid knots, sloping grain, and other features in critical locations.

Contemporary building design and construction process is typically compartmentalised. In most cases the designers and makers work separately. Skilled makers (contractors) interpret designers’ details, often proposing alternative solutions; the designer and maker negotiate a solution. A consequence is that there is diminishing understanding of material origins, characteristics, and capabilities as designers and makers become further separated. Risk is managed at each contractual interface through creating simplified solutions with no room for misinterpretation, reducing the need for, or assumption of fabrication skill. Timber-framing systems and wood products have developed to mitigate for a lack of material knowledge and to remove the need for skilled labour.

The advent of the digital fabrication process has fundamentally transformed timber design and construction, reintroducing the need for designer-makers. Designers are developing detailed 3-D models of building components, often parametrically, which contain sufficient detail to be directly fabricated. In some cases digital models produce tool paths or G-code to directly drive computer-controlled routers. There is no interface with a craftsperson between drawings and construction, no opportunity for interpretation of details by skilled hands, and no scope contractor-designed details as in the fragmented design and construction process. This signifies the need for a new designer-maker with understanding of tree growth, timber characteristics, carpentry, manufacturing, programming, as well as more typical building design issues.

Exploring the emerging designer-maker role

Multi-disciplinary learning-by-making studios are a powerful vehicle for introducing designers and makers to the overall digital design and fabrication process with timber. The Centre for Sustainable Architecture with Wood (CSAW) at the University of Tasmania has developed a programme of Digital Fabrication with Timber Studios (DFTSs) in response to the increasing desire of designers and makers to gain experience across the digital design and fabrication process. During the DFTSs participants parametrically model, prototype, then manufacture timber joints and full-scale buildings for testing and exploration. Participants have access to additive printers, laser-cutters, computer controlled routing equipment, a workshop, and tutors from engineering, architecture, and those with skills in building, carpentry, computer programming, and fabrication.

This paper presents a case study of the multi-disciplinary DFTS as an example of an educational model that can facilitate the re-emergence of the new designer-maker.

Jon Shanks Jon is a Chartered Structural Engineer with international research and design experience. Jon has a PhD in timber engineering with a focus on all-timber connections. As an engineering consultant, he has been instrumental in the development, design and delivery of timber buildings and structures of varying scale and complexity from domestic dwellings to large span timber geodesic domes. Jon has worked in a range of timber materials from green oak to cross-laminated timber. He is currently building his own timber house in Tasmania.

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Session 2 "Technology + Aesthetics" Moderation Matthias Ludwig

Bended - Material and Process Informed Design Computation

By Hans Sachs, CIAD, Cologne Institute for Architectural Design, Germany

This research explores first the interplay between assembly processes and the properties of the components involved and secondly the potential of this interplay as a generative factor in architectural and structural design. More specifically, it examines how principles of textile assembly techniques, in combination with elastically deformable timber elements as components, can be employed for the development of an innovative unit-based timber construction system.

In this paper the research on the digital shaping tool „bended" will be presented as an example of several crafting-inspired design studies about user-, material- and process-informed, parametric design procedures within the context of mass customization. "Mass Customization means to offer products or services which meet the demands of each individual customer, but which still can be produced and delivered with mass production efficiency."[1] The development of this design and production tool was inspired by "Zip Shape", a design and production method "that makes it possible to fabricate single curved panels from any plain material without moulds or jigs"[2]. "bended" represents a user-routed digital wood forming tool which enables surface curvatures with possible changes in direction by applying different radiuses on the material's edges. To explore the full potentials of its application, a Python based software tool for Rhino 5.0 has been developed which generates G-Code for the CNC milling already in the design process. In return data about material properties and relevant manufacturing information is being integrated into the design process. In addition the generation of processing data directly depends on the user's input of various parameters regarding edge radiuses, angles and specific processing and material properties. Based on the resulting milling paths and pattern varying surface curvatures can be achieved. In various experiments the applicability of the tool was tested in order to explore its possible use in a range of design and architectural applications. Resulting shapes could be applied for individual furniture production but also to serve as moulds in architectural construction.

The research "bended" is oriented on various existing tools and concepts of computational design and production processes. In this context several cooperative studies with the self-founded research group „Design on Demand" (with Prof. Oliver Fritz and the "CNC Tischlerei Bächer Gmbh") have been developed. These works include the development of configurational software tools to link digital design and processing methods in order to (re-) form i.e. wood, paper, synthetics and high-tech composite materials. They particularly focus on synergies in design and production processes as the result from an enabled dialogue between user, designer, object and the process of creation. This linkage represents a powerful and highly efficient instrument for individual creation of shape. Furthermore "bended" mediates opportunities and challenges of a broader implementation of mass customization in architecture and design.

Hans Sachs Education: Diploma of Architecture final grade "very good" (1,5) with distinction, University of Karlsuhe (TH) Diploma Project "The Cone - interactive architecture for Burning Man" (realized project) grade: 1,0; Work: Partner at responsive design studio, Zürich / Cologne; Research and teaching assistant at Professorship,CAD/CAM, Prof. Oliver Fritz, CIAD, Cologne; Project architect at Constructs LLC (Joe Osae Addo), Accra, Ghana, Inno-Native® Design; Research and teaching assistant at the 'ifib' - Institute for Industrial Building Design, KIT, Karlsruhe Graduate assistant at the 'stba' - Institute for Urban Planning Design, Prof. Alex Wall, KIT, Karlsruhe Graduate assistant at the Institute for Building Construction, Prof. Rüdiger Kramm, KIT, Karlsruhe Graduate project architect at jila - Jane Irwin Landscape Architecture, Sydney, Australia, internship, Department for Development of Southern Karlsruhe, Urban Design Strategy; Studio 'Papillon Pictures' , production of video art, tv documentation, commercials , Karlsruhe; Mercedes Benz - Untertürkheim, internship at department vehicle development 'M Class'; Teaching: Teaching (assignment) and supporting several experimental computational design and production workshops and elective courses such as „Bauen mit Computern" (digital fabrication), „Entwerfen mit Computern" (design with computers), „Modellieren" (modelling), „Formfindung" (formfinding) at CIAD, Cologne;

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[1] Mass Customization & Open Innovations News – a blog by Frank T. Piller, Glossary, Key Terms Defined: http://mass-customization.de/key-words-defined.html, (accessed on: 29.07.2013)

[2] Design to Production: Projects, 2007, http://www.designtoproduction.ch/content/view/14/44/, (accessed on: 28.07.2013)

source images 1-2: Hans Sachs, Cologne, 2012

Session 2 “Technology + Aesthetics” Moderation Matthias Ludwig

The Project Reframed - Instigating change through light-weight timber structures

By Luis Feduchi, University of Queensland, Australia

The use of timber as a primary structural material has long been an iconic part of Queensland’s architectural and engineering tradition; one that has given a unique sense of form, tectonics and identity to the built fabric of this vast, diverse and remote subtropical region. However, in the post-war years, the supply and affordability of standardized and mass-produced building materials altered building practices, and ensuing regulatory codes have and continue to restrict the continuation and development of timber structural typologies at any scale beyond the low-rise built form. This historical shift towards dominant and globalised forms of materiality has not only restricted the continuity of timber structures but, more importantly, has contributed to a large-scale erosion of this once dominant fabric and its associated sense of ‘place’.

In light of emerging international research and development into new forms of engineered timber technology, the continuity of this shift towards dominant and globalised forms of materiality may itself be at a turning point - one whereby it could very well be reframed and transformed by the very tectonic it has challenged. In order to better understand the potential of this transformation, it is first necessary to consider the fundamental implications of such a change at the scale of the architectural project.

The focus of this exploration will centre upon a current and collaborative design research project (initiated between the University of Queensland´s Centre for Research on Architectural Design, ROAD, within the School of Architecture, and the School of Civil Engineering) investigating proposals utilising these new timber technologies for the renovation and expansion of a most singular if undervalued structure on campus, the School of Chemical Engineering Building.

Built in 1974 by John Andrews, one of Australia’s leading architects of the late modern movement and best known for his Scarborough College student housing mega-structure in Canada and Graduate School of Design at Harvard University, the building comprises of a finely articulated yet robust exposed concrete structure exploring the accommodation of surrounding pedestrian movement and flexible growth. Due to recent need to expand the capacity of the school, the original structure had become earmarked for demolition by the university. However, through an exploratory study into the possibility of reframing previous extensions of the building into light-weight timber structures, the future of Andrews’ structure was shifted from a strategy of demolition to retention. The proposal calls for an addition that would double the building’s capacity via a massing strategy of two highly serviced towers of exposed structural timber. This would take advantage of the existing structure's accommodation for flexible growth while both complementing and contrasting the tectonic of the original Andrews building beneath.

The decision to explore the use of structural timber in such a proposal was threefold. Firstly, as a detailed study into the incorporation of timber structural and material aesthetics and their link to place within new and contemporary building typologies. Secondly, as an instrument to initiate multidisciplinary research by integrating structural engineering, fire protection and learning innovation expertise into the use of new forms of structural timber through design. And finally, to illustrate the potential roles for universities and likeminded research establishments to challenge existing conventions within the construction industry via the realisation of benchmark projects. It is an exploration which in our opinion touches directly on the subject of this symposium.

Luis Feduchi Luis Feduchi is a practicing architect. His office, founded in Madrid in 1993 and relocated to Berlin since 2006, has won various awards and competitions, such as the design of the Carmen del Negro Historic Archives of Granada, Spain. He was Coordinator of the Master of Advanced Studies of Architecture of the Territory at the Accademia di architettura in Mendrisio, Switzerland, from 2004 to 2006. In 2006 he was appointed Chair of Urban Design at the TU Berlin. Among other academic positions he has been Visiting Professor at Penn Design, University of Pennsylvania, Philadelphia in 2010 and Roland Rainer Chair for Architectural Research and Design at the Academy of Arts in Vienna during the academic year 2010-11. He is currently Professor of Architectural Design and Director of the Centre for Research on Architectural Design (ROAD) at The University of Queensland. In 2010 he authored *Abroad / En el extranjero* (Jovis Verlag, Berlin) a book on contemporary Spanish architecture

Session 3 "Process" Moderation Stephen Loo

Timberfabric - Applying Textile Assembly Principles for Wood Construction in Architecture

by Markus Hudert, Swiss Federal Institute of Technology Lausanne, Switzerland

As traditional timber construction is inextricably linked with the use of linear elements, the use of multi-layer timber panels has established itself, above all others, in the building of multi-storey appartment or office blocks. In buildings realized up until now, the innovation potential of this relatively new material has, however, only been partly exploited. Material-specific properties, such as the elastic deformability of wood, as well as novel shapes of panel connectors, which could promote the use of these properties, have been neglected.

The research work *Timberfabric* seizes on this gap and examines how far the interaction of these parameters could be used for the generation of new supporting structures. It explores first the interplay between assembly processes and the properties of the components involved and secondly the potential of this interplay as a generative factor in architectural and structural design. More specifically, it examines how principles of textile assembly techniques, in combination with elastically deformable timber elements as components, can be employed for the development of an innovative unit-based timber construction system.

For this purpose, the research pursues an empirical approach that is organized in three parts. The first part determines the *Timberfabric Module* as basic unit for the modular structural system that it is the goal to develop. The second part examines the properties of this module and the implications of producing it in large size. The third part systematically explores different possibilities of combining multiple modules into more complex structures and examines how the connectivity between their components can be established and optimized. The production of physical models and prototypes plays a pivotal role throughout the process. Physical modeling allows for direct measurement of the material's elastic deformability and the impact of the proportions of the basic elements. It further contributes to a general understanding of the geometric foundations of the developed structures as well as of their mechanical properties.

The models and prototypes resulting from this process are examined with regard to a series of select evaluation parameters. Amongst others, the overall impact of transferring textile assembly principles, such as the interlacing and helical arrangement of elements, is discussed. Analogies and differences between the developed and actual textile structures are identified. The insights derived provide the basis for a modular construction system for self-supporting building envelopes. It is shown that the interplay between material properties and assembly techniques not only generates a specific architectural

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Session 3 "Process" Moderation Stephen Loo

Emergent timber - A tool for designing the growth process of Baubotanik structures

by Ferdinand Ludwig, Boyan Mihaylov and Tobias Schwinn; Research Group Baubotanik, Institute for Theory of Modern Architecture, University of Stuttgart, Germany in collaboration with Institute for Computational Design, University of Stuttgart, Germany

The basic idea of Baubotanik is to create buildings by combining technical joining and vegetal growth. Plants are being used as a living construction material and are connected with non-living building elements. In this way they merge into a vegetal-technical compound structure, to a great extent consisting of living wood. Thereby Baubotanik buildings exemplify the well known sustainable and ecological properties of timber in an exceptional way: The wood necessary for the construction is not produced in a forest, harvested and manufactured to structural elements – it grows directly on site. Thus the 'production' process does not end, but allows for further transformation of the material over time. As a design strategy, an initial configuration of both the technical construction and the artificially engineered Baubotanik plant-compound as well as its future development process needs to be conceptualised.

To design such a developmental process it is essential to work out design rules that are derived from botanical growth rules and to describe the structure as a material system that depends on botanical principles and responds to environmental conditions. The architectural potential of living plant structures can then be explored, with the ecological and aesthetical benefit of mature trees, which usually takes generations to manifest, becoming more immediately available.[1]

One of the basic rules of all natural growth processes – effectiveness – becomes the fundamental design factor. Only if living plant constructions follow this rule will their development meet architects' anticipations. Otherwise plants or plant parts will – sooner or later – die. For instance, the trunks and branches of trees are highly effective pathways for the transport of water and nutrients. If these naturally grown structures are artificially interconnected into a network-like structure, only the most direct connections between roots and leaves show a significant growth in thickness. All indirect connections are less effective and are not needed by the organism, they growth less or even die.

A project developed in the summer semester of 2013 at the University of Stuttgart focusses on this problem and aims to enhance the planning techniques of Baubotanik through the utilization of computational performance in the form of a digital simulation tool, which systematically analyses the complex relationships between different growth parameters. From the range of relevant principles, which were already recognized in previous research[2], initially two aspects were chosen to be integrated in the digital tool: the relative distribution of girth growth as influenced by water and nutrition transport in tree structures and the space competition between crown parts, connected to biomass production and foliage area. The aim of this research is to provide a broader overview of possible development scenarios through the tool and thus increase the design-freedom in the planning of Baubotanik structures in order to achieve new structural and aesthetical possibilities for living plant constructions.

Dr.-Ing. Ferdinand Ludwig Ferdinand Ludwig studied architecture and graduated with his PhD thesis " Botanical basics of Baubotanik and their application to design practice". He is a pioneering architect in the field of "Living Plant Constructions" (Baubotanik). In the recent years he designed and realized highly regarded projects that combine growth processes of living plants with an engineering approach. In his PhD-studies, he developed multiple horticultural construction techniques and analysed botanical rules of growth to deduce construction rules for living plant constructions. In 2007 he was one of the co-founders of the "Research Group Baubotanik" at the Institute of Architectural Theory at the University of Stuttgart. Since that time he organized different workshops and hold many lectures on Living Plant Constructions at the University of Stuttgart and worldwide.

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[1] Ludwig F, Storz O, Schwertfeger H: Living Systems. Designing Growth in Baubotanik. Architectural Design Journal. Volume 82, Issue 2, pages 82–87, March/April 2012

[2] cf.: Ludwig F: Botanische Grundlagen der Baubotanik und deren Anwendung im Entwurf. PhD. University of Stuttgart 2012

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Dipl.-Ing. Tobias Schwinn Tobias Schwinn is a research associate and doctoral candidate at the Institute for Computational Design (ICD) at the University of Stuttgart, Germany. In his research he is focusing on the integration of robotic fabrication and computational design processes. Prior to joining the ICD in January 2011, he worked as a Senior Designer for Skidmore, Owings and Merrill in New York and London applying computational design techniques to parametric form-finding, rationalization, complex geometry, automation and environmental design. Tobias studied architecture at the Bauhaus-University in Weimar, Germany and at the University of Pennsylvania in Philadelphia. He received his diploma-engineering degree in 2005.

Session 3 "Process" Moderation Stephen Loo

Structural analysis and optimisation of a computationally designed Plywood Gridshell

by Gregory Quinn and Christoph Gengnagel, Universität der Künste, Berlin Germany

In this paper the structural analysis of a third generation computationally designed plywood gridshell (4m*12m*4.5m) is explored in detail. It was established that on top of assembly and material wastage issues, the structural behaviour of the timber gridshell was extremely limited. In order to address the structural weaknesses of the system, new ideas and improvements were explored including: spatial hybrid structures, custom knitted restraining membranes and integrating assembly logic into earlier phases of design scripting. The plywood gridshell named "Dermoid" by its creators at CITA aims to generate interesting architectural spaces by means of digital fabrication technologies (e.g. laser cutting) and actively bent plywood sheets that can be assembled together with no additional materials or fixing agents (reversible jointing). The hexagon pattern in the system, coupled with its toothed connections, undulating "wishbone" beams and overall form led to a structurally weak system with large deformations and limited potential for up-scaling or architectural application.

Various non-linear structural simulation methods were investigated (FE models and an equivalent spring model) with their merits being assessed in terms of accuracy, speed and appropriateness within the project's constraints. Numeric simulations were compared and calibrated with physical test data. It was found that the system's structural behaviour varied greatly for in-plane and out-of-plane loading and that finding an FE model able to simulate both accurately was a challenge. A conclusion of the structural analysis investigations was that low-stiffness structures composed of complex and irregular architectural geometries require time-consuming and laborious simulation techniques as well as calibration from empirical data in order to be able to accurately predict their structural behaviour. This complexity of simulation not only highlights issues of appropriateness, data management and budget but also contradicts the nature of complex modelling, i.e. one in which the invention and manipulation of variables occurs almost constantly. A single change to the geometry script, for example, may render the entire physical test data redundant.

It is argued that the Dermoid plywood gridshell and many complex geometry projects similar to it, can suffer from a lack of contextual parameters that help to ground the project within the realm of architectural realism. The argument is made that while complex and parametric modelling can produce beautiful and engaging spatial qualities, the value of their contribution to architecture is at risk unless issues such as application, structural performance, scalability of material and connections are taken seriously. The main structural weaknesses identified in the system were bending and shear resistance of the shell-like structure. Once these had been clearly defined and understood, improvements were investigated through a workshop with SIAL at RMIT which would bring about significant structural improvement while maintaining the original architectural qualities of pattern, form and transparency. An effective way of doing this was soon found in the application of hybrid systems i.e. the combination of two separate materials or structural systems - in this case actively bent timber combined with restraining membranes. Investigations into restraining membranes were also coupled with the digital scripting and fabrication of knitted structures.

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Session 4 “Technology + Aesthetics” Moderation Luis Feduchi

Applying the Borrowed - Learning Through Making

By Clara Kraft Isono and Satoshi Isono, University of East London, U.K.

Whilst architectural education and practice has been transformed through the emergence of new digital tools and construction technologies, has a real understanding of how materials can inform this process been left behind?

Current trends in digital fabrication and construction have evolved from an exploration with computation, technology and machinery. Generally speaking architects have adopted a similar path when investigating emerging construction techniques as part of the design process. Firstly tectonics is explored through computation and digital tools with designs eventually customized into comprehensive building systems. The systems are tested against available technology and the processes they support. Finally a material is identified to suit all of the above. In this process the possibilities that materials offer is overlooked, subordinating them into pre-established designs. We would like to challenge this with a notion that ideas can be generated through an ongoing process of collaboration between materials and the digital environment.

The paper will present the work of Unit C, an architecture design unit at the School of Architecture, Engineering and Computing at the University of East London, taught by Clara Kraft Isono and Satoshi Isono. The unit encourages students to investigate how established modes of craft with an inherent understanding of materiality could inform emerging fabrication technologies. Research is based around recognized techniques and how this might be applied to new technology. The methodology of established master-builders, such as Eladio Dieste and Miguel Fisac, who have developed a rich body of work investigating material and technology in architecture, is used as a reference. Development is strongly based on testing ideas through making by building 1.1 prototypes developed using milling and casting techniques. Particular focus will be placed on the worked developed in 2012/2013, which concentrated on Timber.

Clara Kraft Isono AADipl, MA Clara is a qualified architect and award winning filmmaker. A graduate of the Architectural Association and the London Film School she has worked in practice both in the UK and India. She has taught architecture at the Architectural Association, the Bartlett, Westminster and UEL, where she holds the position of Senior Lecturer since 2001. As a filmmaker Clara has been involved as a Cinematographer and Director in projects in the UK, Spain, Japan and India. She is Director of the multidiciplinary studio Kraft Isono.

Satoshi Isono AADipl Satoshi is a qualified architect and furniture designer. Before graduating from the Architectural Association, Satoshi studied Furniture and Interior Design in Tokyo. Satoshi is a member of ARB, Associate at dRMM and was project architect for several projects including the award-winning MK40 Tower for Milton Keynes Gallery, Yard gallery at Modern Art Oxford and currently is project architect for the Hastings Pier redevelopment. Satoshi oversees dRMM’s ongoing material research.

Session 4 “Technology + Aesthetics” Moderation Luis Feduchi

Ply Project

By Kenichi Sato and Rodney Hayward, Architect, Berlin/Tokyo and Australian National University, Australia

"What is missing from our dwellings today are the potential transactions between body, imagination, and environment" (Kent C Bloomer and Charles W Moore). This observation leads on to the idea that the parameters in design are not only form and function, but sensitivity to address the potential of haptic qualities that a design can advantageously access through our “atlas of senses.” (Kenya Hara)

We began with the idea of how the potential of trans-materiality could be grown to become our experience of sitting say, in a chair —— in the mind, the absoluteness of the boundary between the body and the chair might be far from clear: "with a chair we extend our sense of territory beyond our skin...." (Peter Smithson). Over fifty years ago, the pioneer psychological anthropologist, A. Irving Hallowell argued, "Any inner-outer dichotomy, with the human skin as boundary, is psychologically irrelevant." Do we wear a chair? “We live our clothes as though they were alive. Your trousers do the walking. They are integrated into the body’s memory” (Roger-Pol Droit).

Materials, on the other hand, embody the values and characteristics of their fabrication processes: their potential emerges from the details of their shaping, refining and transformation. We touch plywood, it is hard, unequivocal, stiff —— what if we were to slice it, layer it, laminate and separate it? What would happen if we took plywood in its perfect solidity, and changed its material scale, re-constituted it so that it could torsion and flex. In these systematic changes to this old material, there emerged new bulk properties; or was it the revelation of a previously hidden inner soul? The hard, planar surface of plywood we have so privileged in the past becomes soft and deformable. There is brought about a new compliance: the boundary of the material is no longer simply a surface to be engaged with as the experienced world, it is thicker, deeper —— it is one responding, absorbing; dissipating the elastic deformations from the hand or body’s load (or maybe sound?).

In our search of the potential for psychological layering in trans-materiality, plywood became something of a playground for material reasoning. Like its use by modernist explorers of chair design such as Alvar Aalto, plywood proved a conceptually productive substrate to develop and explore ideas through observation and experiment. Here, FLEX was born.

FLEX is a "smart" structure composed of systematically CNC-slit layers of plywood and foam. Controlled, simple cuts re-scale it to be flexible. It is resilient, and to a degree, comfortable: “as buoyant as a spring cushion.” (Alvar Aalto, Armchair #41) Each element in FLEX distributes the impost of load by passing it on: resisting by mutual stages to attenuate, exhaust and finally accommodate it.

FLEX with its logic of simple cuts is not only a material transformed, but it also offers a material whereby the haptic qualities of seating surfaces might be explored. There is potential here that this new trans-material can create a psychological engagement for us to “act through” - Martin Heidegger - in our built environment.

Kenichi Sato In 2004 Kenichi Sato graduated with a Master of Architecture from the Rhode Island School of Design. During his time there he did internships in New York with Allan Wexler. After graduation he worked as a practicing architect with Skidmore, Owing & Merrill and Rafael Vinoly Architects. In 2010 he completed his Master of Design Arts at the Australian National University, where he researched and developed the product, Flexible Plywood.

Rodney Hayward Rodney Hayward PhD was formerly Head of the Furniture/Wood Design Workshop at the Australian National University School of Art, 2000 – 2010.

Session 4 "Technology + Aesthetics" Moderation Luis Feduchi

3F-Board

By Achim Hack, Frank Ackermann, Hochschule Wismar and Georg Ackermann Gmbh, Germany

This paper sets out to show the relationship and the interaction of design intention, technically feasible solutions and technical production-related requirements along with tangible and demonstrable results using as an example the development of a foldable flat material and the resulting furniture archetypes.

Background: Foldable furniture and objects that seem to generate a three dimensional structure, which results from process of simply unfolding a processed surface similar to a pop-up card, constitute an on-going theme when developing flexible, space-saving and convertible space situations. This particular advantage lies in the manifold functionally differentiated use of one and the same surface area, and thus in the targeted reduction of individual demand for space, especially in metropolitan areas and high-density urban structures.

State of the art: Traditionally, these particular solutions require considerable effort to be further transformed into producible and usable products or components. Primarily, existing approaches are based on the use of a large number of conventional hinges and correspondingly large material thicknesses needed for their installation, or even bear on the old textile hinge technique that needs to be applied manually, but does not require any extreme material thicknesses. In the first case, an obvious disadvantage is an extensive use of materials with high production costs, whereas in the second case the shortcoming relates to the low loading capacity and durability of the hinge connection due to frequent use. Alternatively, there exists a considerable number of consistently manufactured furniture and objects using foldable materials like steel or cardboard, which, in turn, appear to be either only partially reversible or slightly durable in use.

Objective: The 3f board project aimed to develop a material that allows production of folded spatial structures based on simple folded paper conceptual sketches possessing strength and precision of a commercial knit piece of manufactured furniture.

Methods: It was quickly revealed that a multi-layer flat material with a flexible middle layer produced as commercial formatted semi-manufactured product in the furniture industry meet threefold requirements: needs of designers requesting numerous and sophisticated folds, regulations due to technological limitations and a responsible use of resources. The following process was facilitated through developing a number of different application examples, which on the one hand should ensure verification, practicability and producibility, and on the other hand draw a growing interest for the material as illustrative examples at exhibitions and in publications. Combinations of materials and adhesives have been gradually tested and verified in terms of functionality and durability, and production methods step by step adapted to meet extremely high requirements for accuracy during the production processes.

Result: This material 3f board enables designers and developers to build complex folded structures consisting of principal surfaces that can be produced efficiently and cost-effectively by simple cutting and notching by means of optimized CNC milling technology. By avoiding traditional hinges the use of material can be significantly reduced without curtailing folding value and durability of the products. The first furniture based on this technology has been available for purchase for several years. The experience gained enables a continuous development in terms of material combination and processing technology.

Relevance: The results of the project are essential in the field of furniture manufacturing and interior construction. On the basis of the present results, new applications can be defined, and complex designs and manufacturing processes streamlined.

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Session 4 "Digital Wood and Production" Moderation Luis Feduchi

Prefabricated Housing in Australia, Past and the Future

By Mathew Aitchinson University of Queensland, Australia

Prefabricated timber housing in Australia has a long and illustrious history. From the time of European colonisation, prefabricated timber-framed 'kit' houses were exported from Britain to facilitate early nineteenth century settlement. The mid-nineteenth century gold rushes further exacerbated the demand for housing, and engendered an Australian timber construction industry, which provided a range of buildings to local and international markets. Although the technique of transporting pre-cut timber houses for assembly in the tropical north and arid west had been practiced in Queensland since the mid-nineteenth century, it wasn't until the first decades of the twentieth century that this construction technique reached its fullest uptake with the emergence of the so-called "Queenslander" and its more urban cousin, the "Worker's Cottage". Like most industrialised countries, Australia's post-war housing scene was dominated by materials shortages and the push towards the fuller industrialisation of housing construction, begun during the second world war. From the 1960s onward, the conditions of prefabrication in housing have remained relatively constant. On the one hand they are defined by an ever-expanding suburbanisation around Australia's coastal capitals, and on the other hand by an episodic boom-bust cycle associated with remote mining operations. In both situations, prefabrication has become a mainstream construction technique, whose attractiveness has risen sharply over the past decade within the context of Australia's national housing and skills shortages and the housing affordability crisis. Pre-empting and reacting to these conditions, Happy Haus Pty Ltd, established 2009, has become a market leader for prefabricated transportable housing in Australia. While transportable housing is generally understood to be at the bottom of the market in cost and quality, Happy Haus together with Hutchinson Builders and Donovan Hill Architects have confounded this expectation with houses that deliver high architectural quality at well below the usual price points for architectural design. Building on the rich tradition of prefabrication outlined above, in June 2013 a team led by Mathew Aitchison from the University of Queensland was awarded an ARC Linkage grant for the project entitled: "The Design and Construction of Quality, Sustainable and Affordable Pre-Made Housing in Australia – Optimisation and Integration." Set to begin in November 2013, and with a total operations budget of $2.1M, the interdisciplinary research team consisting of architects (BVN+Donovan Hill, UQ School of Architecture), engineers (Arups, UQ School of Civil Engineering), developers (Happy Haus) and a construction company (Hutchinson Builders) has the capacity to both design *and* construct new prototypes for prefabricated housing in Australia. The research will aim to show how an integrated approach by architects and engineers to the building system as an *ensemble* will allow for further economies in construction, at the same time as increasing flexibility in design. Innovative and optimised construction systems designed in integration will allow a greater specialisation with regard to client needs and site constraints and a wider potential for architectural expression. This same integrated approach to the building ensemble aims to optimise factory construction to reduce costs in materials, labour, time, energy and certification.

Mathew Aitchison Mathew Aitchison is Research Fellow and Centre Manger of ATCH at the University of Queensland's School of Architecture. Mathew received his PhD in Architecture from the University of Queensland in 2009.vHe has taught architecture at the Technical University Berlin, the University of Queensland, Syracuse University, and at Queen's University Belfast where he was Lecturer in Architecture and Urban Design from 2008-10. In addition to his academic work, he has practiced internationally as an architect: in Australia, Germany, Holland and Ireland, and received awards for competition entries. He has held fellowships at both the Center of Metropolitan Studies Berlin and Syracuse University's School of Architecture, where he organized an exhibition and conferences. In recent years he has also been engaged in the establishment of an international center for architecture and urban design in Berlin, a city in which he has lived predominantly since 1995.