WORKSHOPS

Parametric Design, Optimisation and Testing of lattice structures using densified engineered bamboo
Hector F. Archila, Jed Long, Dragos Naicu

Digital Fabrication of Timber-Composite Shell Structures
Joe Gattas, Yousef Alqaryouti

Rotational Erection System (RES): Origami extended with cuts, Digital fabrication experience
Yoshinobu Miyamoto

Optimization of Statically Informed Grid-Shell Patterns
Clemens Preisinger, Moritz Heinmuth

MASTER CLASSES

Computational Structural Design based on Force Patterns
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Parametric Modeling and Optimisation of Complex Structural Systems
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Optimized Material Distribution with Discrete Building Blocks
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Exploring Software approaches in simulating bending-active systems
co-organised as Training School by COST Action TU1303 ‘Novel Structural Skins’
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Interfacing Architecture, Engineering and Mathematical Optimization
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The HafenCity University Hamburg is a truly metropolitan university, not just because the range of subjects on offer gives an ideal typification of the complexity inherent in the phenomenon of metropolitan regions, but also because of its location. The HCU is an important element in one of Europe’s largest and most ambitious urban development projects, the HafenCity, a development that will see the total area covered by the city centre of Hamburg increase by 40% by 2025.

On around 60 ha of net building land, apartments for between 10,000 and 12,000 people will be built and 40,000 jobs created, primarily in the service and retail industry.

As a public site of cultural significance as well as a seat of learning, research and debate, the HCU will help meet one of the central challenges of the HafenCity: to transform an area that was customs territory and a monofunctional port for 120 years and, as such, off limits to the urban development of Hamburg, into a vibrant urban district.

The new building for the HafenCity University will act as a forum in which the development of this urban district and of the city as a whole can be critically assessed.

A university in dialogue Questions on the future of the built environment and our cities must be answered in dialogue between experts and the public. The HCU sees itself as a laboratory for building and urban development. It invites a broad exchange of ideas on questions of the metropolitan future – a place of research and debate on architecture, building, urban culture and urban development.

Specialisation and breadth: the disciplines at the HCU New solutions for metropolitan problems demand disciplinary excellence as well as an openness to neighbouring disciplines. This disciplinary and professional excellence is based on the five undergraduate programmes, which cover the spectrum from “house to city”: Architecture, Civil Engineering, Geomatics, Metropolitan Cultures and Urban Planning.

Interfaces of knowledge Questions on the future of building and metropolitan development occur at the interface of professions. The Masters courses at the HCU are exactly at this interface – where existing professions are challenged and new ones born: Resource Efficiency in Architecture and Planning (REAP) and Urban Design.

The HCU is currently home to roughly 2,400 students learning from around 50 professors.

THE PLACE: HAFENCITY UNIVERSITY HAMBURG

The aim is to encourage new solutions to future challenges in metropolitan development.
FEES, CONDITIONS & REQUIREMENTS

The IASS 2017 committee invites professionals, PhD-candidates and students to participate at Pre-Workshops and Master Classes taking place between September 20th-24th, 2017, at HCU Hamburg (three to five days before the IASS conference).

Workshops and Master Classes will explore the role, design and critical reflection of computational design methods, design tool environments and fabrication techniques with special focus on simulation of complex geometries and structural systems. Master Classes (MC) address specialists and aim at the exchange of knowledge on an advanced level. In Workshops (WS) experience will be gained together and exchanged.

Both formats – MC and WS – explore specific structural types, the interlinking of material systems, as well as fabrication methods. The means are hands-on knowledge and tool-sharing. The approach can be based on software or hardware, creating digital and | or physical design studies and | or prototypes.

The results will be presented as part of a warm-up event on Sunday evening prior to the conference. We anticipate the Workshops will include 10 to 20 participants from industry, research as well as architectural and engineering study programs. Master Classes should include 8 to 15 participants from academia and industry.

Find all further information about contents, specific requirements and conditions of Workshops and Master Classes on the following pages.

The fee for each Workshop and Master Class amounts 595 €. For students (only workshop participation possible) we offer a special rate of 385 €.

It includes material costs, two coffee breaks and lunch during each event-day, but not the participation at the following IASS symposium.

All Workshops and Master Classes contain the use of specific software. Please bring your own electronic devices, i.e. laptops. To each Workshop and Master Class are the required software proposals mentioned associated with its description. You don’t need more than the trial version of the software, otherwise licences will be distributed by the lecturers. Prior to the Workshop or Master Class, the software has to be installed on your laptop. For offered events with a fabrication component, all required tools and materials will be distributed by the lecturers and tutors.

The registration for Workshops and Master Classes has to be done until July 15th, 2017! If the required number of participants is not reached by then, the Workshop | Master Class won’t take place. You will get a notification by at least July 31st, 2017.

The minimum number of participants for Master Classes is 8 persons.

Workshops is 12 persons.
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Hector F. Archila
Amphibia BASE, Visiting Research Fellow at University of Bath
Hector is a specialist in bio-based architecture and structural engineering with extensive experience in the use of round and engineered bamboo in construction. He is cofounder and CEO of Amphibia BASE Ltd, a professional services firm based in the UK that provides state-of-the-art design, engineering and R&D solutions with sustainable construction materials such as bamboo and timber.

Jed Long
University of Tasmania, Cave Urban
Jed Long works at the intersection of art and architecture. As a co-founder of Sydney-based architecture collective Cave Urban, Jed approaches design through an emphasis on sustainability, community engagement and the continuation of vernacular tradition. He views the fluid relationship between art and architecture as a means to explore, create and test new structural systems outside the confines of the architectural profession. The current recipient of a Churchill Fellowship, Jed is investigating the translation of traditional bamboo construction into contemporary building practice.

Dragos Naicu
Computational Design Specialist, B + G Ingenieure Bollinger und Grohmann GmbH

Bamboo has a high potential for utilisation within the construction industry as a building material with strong environmental credentials. However, its application in this capacity is currently limited due to issues regarding the lack of standardisation, structural unpredictability, temporality and high craftsmanship associated with bamboo construction. With the aim of tackling these issues and unlocking the potential of bamboo in the modern built environment, this workshop explores state-of-the-art processing technologies, digital modelling techniques and novel building techniques applied to bamboo.

The workshop will explore the performance of bamboo lattice structures using Densified Bamboo Strips by challenging participants to design, model and build a structure of densified bamboo. Working in close consultation with experts over a period of four days, participants will have a hands-on experience with the material by building a 1:1 scale prototype, inspired by vernacular bamboo woven structures and computational form-finding approaches. Structural testing will be carried out on the structure and compared to predicted computational outcomes. The results of this work will be presented at the IASS and the structures left on display for the duration of the conference proceedings.
Computer-aided manufacturing uses automated workshop machines such as computer-numerically controlled (CNC) routers, laser cutters, or waterjet cutters to produce building components. Such machines have a precision and speed which enables more complex components than would be achievable by traditional manufacture, and this has led to the design of structural systems with integral attachments in the manufactured parts. These are typically in the form of mechanical joints between elements, for example through a fine control of connection tolerance to achieve friction-only fit, or through interlocking geometry which prevent the movement of two parts in all but one direction to prevent disassembly. Integral mechanical attachments thus remove the need for tools or skilled labour during assembly and so enable the delivery of innovative structures which are easy to construct and are highly cost-efficient.

This workshop will allow participants to develop an integrated, end-to-end digital design and fabrication workflow for production of timber-composite shell structures. It will include the following activities:

- parametric design of integral mechanical joints suitable for different CNC cutting machines;
- calibration of joint parameters to account for manufacturing tolerance and desired mechanical behaviour, for example friction-only fit; and
- digital fabrication of thin-walled structural sections, sandwich plate components, and sandwich shell components.

Participants are recommended to have a basic understanding of Rhino/Grasshopper parametric 3D modelling tools on commencement. They are also required to bring their own computer with a Rhino/Grasshopper installation.
ORIGAMI EXTENDED WITH CUTS, DIGITAL FABRICATION EXPERIENCE

Yoshinobu Miyamoto

Architect / Professor, Aichi Institute of Technology, Japan

Yoshinobu Miyamoto is popular on Flickr. The Japanese architect and paper engineer has a strong following on the site, due to the beautiful images of his intricate paper creations which he frequently uploads. His regular job is as a professor at the Aichi Institute of Technology, Aichi, Japan where he lectures on spatial design, but his other passion lies in furthering his application of paper design.

RES examples and documents are posted at the links below:
https://www.ickr.com/photos/yoshinobu_miyamoto/albums/72157626010136184
https://www.researchgate.net/profile/Yoshinobu_Miyamoto/contributions

Pop-up technique for cards and books has the long history over centuries both in the East and the West. It was used in preliminary design course taught by Josef Albers in 1927 at Bauhaus. The course method has spread all over the world from elementary schools to universities today. Ninety years after Bauhaus we push the educational design tool forward to a thinking tool for geometrical and structural design with digital fabrication technology and Rotational Erection System (RES). RES is a simple and efficient technique to make a self-standing 3D structure out of a single sheet of paper with systematic cuts and folds. The workshop attendants will make agile design experiments in structural morphology through the synthesis of the computational and the physical modeling.

Firstly the attendants will learn how RES works by folding ready-cut sample RES paper templates. They will understand that the constraints of the inextensible property of the material bring RES the bi-stable characteristics. Secondly they shall make their own models from the sample digital templates with cutting plotters. Lastly the teacher will instruct how to use software tools to generate the cut and fold patterns. The attendants will try to make their own design with the software tools. The duration of the session shall be 180 minutes long including tea break discussions.

Anyone who wants to learn how to make RES is welcome to join the session. The skill set with GeoGebra and digital fabrication tools are preferable but not necessary because the teacher could give sample ready-cut sheets to those without the skill set. Those with advanced skills in computation could get the software tools in GeoGebra from the teacher for their preparatory study prior to the workshop.
OPTIMIZATION OF STATICALLY INFORMED GRID-SHELL PATTERNS
parametric design with Grasshopper, Karamba and Octopus
Clemens Preisinger, Moritz Heimrath

Objective of the workshop is the generation of grid-shell geometries and grid-shell patterns. Rhino and Grasshopper (parametric NURBS modelling) will be used to create shapes and different tessellations which will be tested and evaluated in Karamba (finite-element analysis in real-time). Octopus (evolutionary optimization) will be used to increase the structure’s performance, manage and select optimization results and push the generation into specific phenotypic or genotypic directions. The workshop offers a playful approach to parametric structural design and guidance by Karamba developers and engineers from Bollinger + Grohmann. Results of the workshop will be visualized as 3D printed models and animations showing the process of generation and the structure’s performance.

Target audience is architects, engineers, designers interested into experimentation, digital simulation and structural performance. We expect knowledge about Grasshopper3d on a medium | professional level, medium level in digital fabrication (3D printing) and digital design, basic knowledge about structural design.
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The aim of this proposed three-day Master Class is to introduce to the participants a novel design method for the generation of equilibrated structures in three-dimensions based on Combinatorial Equilibrium Modelling (CEM). CEM is an innovative approach to structural design grounded on 3D graphic statics and graph theory that allows the designers to take full advantage of the relationship between topology, form and structural behavior during the early stages of the design process. To make this approach operative, an interactive, computer-aided design tool has been developed within the 3D software environment McNeel Rhinoceros and Grasshopper. The tool enables the designers to work in real-time and in an intuitive way to generate pin-jointed force networks in space starting from customizable force patterns. Examples of projects designed using the CEM approach are shown in the pictures below (Tokyo 2020 Olympic Stadium and Swimming Pool, designed by D’Acunto, Ingold and Ohlbrock).

It is proposed that the Master Class consist of two halves: a taught part discussing principles and containing simple exercises and demonstrations; a second part where participants are to apply and develop the knowledge and skills attained, by tackling a design exercise.

The first day shall include an introduction to the theoretical background of CEM, including some basic elements of graphic statics and graph theory. A brief overview on the software environment McNeel Rhinoceros and a detailed explanation of the design tool will follow, together with a few demonstrations of its main functionalities. Secondly, different types of computationally based optimization techniques (topological, stress and strain-based, etc.) shall be introduced and discussed, with particular emphasis on the challenges of optimization for construction.

These taught sessions shall extend to the first half of the second day, after which the Master Class participants will be asked to develop a design exercise to get familiar with the CEM approach and the design tool. Specifically, the aim will be to design a covered boat slip to be located in the area of Hamburg. Participants shall develop their proposals with help from tutors, and discussions shall be held about the construction of the proposals, looking at adjustment of the form to eliminate or minimize the need for temporary construction-related support or formwork, rationalization of element geometry and type, or accounting for specific fabrication techniques.

The Master Class shall conclude with brief presentations from the participants on their proposals, and a group-wide discussion on the different results and approaches taken.

Patrick Ole Ohlbrock
ETH Zürich
Ole holds a degree in civil engineering since September 2013. In his master’s thesis Ole discussed the topic of digital performative structural design. He is currently Research Assistant and PhD student at the Chair of Structural Design at the Swiss Federal Institute of Technology (ETH) in Zurich. His research interests lie in the interplay of intuition and algorithm for the design of structures.

Pierluigi D’Acunto
ETH Zürich
Pierluigi D’Acunto is currently PhD student and Lecturer at the Chair of Structural Design at the Swiss Federal Institute of Technology (ETH) in Zurich. His research is primarily focused on exploring the convergence of architecture and engineering through geometry and graphic statics.

Vincenzo Reale
ARUP London
Vincenzo Reale places himself in the area where architecture meets and overlaps multiple, different fields, from design to engineering, from biology to computer science, from theater and video-performance to building workshops. Passionate about technology he has a wide experience digital tools, especially in connection with parametric and generative techniques for architecture.

Giancarlo Torpiano
ARUP London
Giancarlo currently forms part of a London-based multi-disciplinary engineering team which collaborates with many leading and emerging architectural practices. He is specialised in parametric design and dealing with complex three-dimensional geometries. He is passionate about innovative architectural design and how cutting-edge engineering is crucial to its realisation.
This master class will cover essential strategies for setting up a framework to carry out structural optimisation of complex systems.

The first step in this process involves defining flexible parametric relationships, with variables in mind for later design manipulation. We will cover a number of techniques for intelligent modeling set-up of typically complex tasks such as irregular space-frame, truss, and shell forms. The course would also cover principles of optimisation for many typologies, such as shell, plate, arch, catenary, etc.

The next step requires an analysis workflow - assigning structural properties (loads, fixities, materials) and establishing a two-way exchange between a parametric modeling environment and a structural analysis platform. We would propose GH – Karamba because it is the most common and easily accessible, but could also accommodate a Dynamo – SAP or GH – SAP workflow if IASS thinks any of these will be more popular or participants have specific needs.

The final step, the optimisation, would investigate both ‘material’ optimisations (section sizes, thicknesses, topology) and ‘geometric’ optimisation – pattern, angles, locations, etc. We will cover different stochastic engines, easily designed iterative processes, and the potential for machine learning application.

Following these tutorials we would propose a full day devoted to project exploration | the design of a custom process by individuals or teams. This allows for a sort of hackathon where participants can invent a unique process for their own specifically defined problem – potentially a problem they have or expect to encounter.
AGGREGATED STRUCTURES: APPROXIMATING TOPOLOGY OPTIMIZED MATERIAL DISTRIBUTION WITH DISCRETE BUILDING BLOCKS

Andrea Rossi, Philipp Eisenbach

The Master Class aims at exploring the combination of current developments in voxel-based design, focusing on topology optimization of material distributions, with research into novel concepts of materials as “digital” entities, composed of discrete elements that can be reversibly assembled in an aggregative process. The participants will be introduced to a custom design and structural optimization design process: relying on voxel-based approaches, topology optimization algorithms will be used to determine density distribution of material under user-defined load and support condition. The resulting density field will be used as driver for the aggregative growth of modular components, approximating the optimized material allocation by combining repetitive modules.

In a masterclass format, the program will focus on the digital workflow of generating topologically optimized material distributions and approximating them with discrete assembles of modular units. Given a finite set of ready-made physical components with snap-fit connections, participants will explore how the same components could be reused to assemble different structures, generated in response to different structural loads and supports conditions. Such explorations will inform the aggregation processes used, as well as potentially lead to the production of new components designs, to be manufactured and tested during the masterclass. The final output will consist of a series of physical aggregations of modules, representing a response to specific structural constraints.

Through the masterclass, the participants will be introduced to computational methods to generate discrete structures from the aggregation of basic modular units (custom DDU-developed Grasshopper library), as well as to tools to generate optimized material distributions under custom stress conditions (through Millipede), and to strategies to integrate these two separate processes into one coherent design-to-production pipeline.
EXPLORING SOFTWARE APPROACHES IN SIMULATING BENDING-ACTIVE SYSTEMS

The workshop will explore and compare 3 different software and simulation approaches in form-finding and analyzing bending-active structures.

In the first half of the Masterclass 3 different numerical approaches for form-finding large deformations in bending-active systems are introduced. For each approach we will give a brief theoretical background to the method and introduce its functionality through a variety of short tutorials. In the second half of the Masterclass we will compare the approaches in the format of a ‘round robin exercise’ to highlight and evaluate similarities, differences, strengths and weaknesses of the individual methods.

The three methods introduced in the Masterclass are
- Mesh based  FEM Sofistik
- Nurbs based  IGA Carat++
- Vector based  DR Kangaroo

All 3 simulation methods use Rhino Grasshopper as an interface. This will facilitate the generating and comparing of input and output geometries for the form-finding process.

Riccardo La Magna
University of Stuttgart, Institute of Building Structures and Structural Design (ITKE)
Riccardo La Magna is a structural engineer and PhD candidate of the Institute of Building Structures and Structural Design (ITKE) at the University of Stuttgart. In his research he focuses on simulation technology, innovative structural systems, bending-active and lightweight structures. He played an active role in the development and realisation of several research pavilions, as well as developing and building full-scale bending-active plate structures as part of his doctoral thesis. He’s been author and co-author of several scientific publications, including the 2013 IASS Hangar prize winning paper.

Philipp Längst
str.ucture GmbH
Philipp Längst received a B.Sc. degree (2012) in Civil Engineer from the University of Stuttgart, Germany. In 2013 he was part of Foster + Partners, Structural Engineering Department, London, UK. He graduated from University of Stuttgart with a M.Sc. degree in Civil Engineer in 2015, which included a research visit to the Chair of Structural Analysis, Prof. Dr.-Ing. Kai-Uwe Bletzinger, Technical University of Munich. His studies focus on linking architectural design with new technologies in finite element analysis in order to explore new approaches in lightweight design. Currently, he is part of structure GmbH, Stuttgart as a Structural Engineer.

Gregory Quinn
Berlin University of Arts, Department for Structural Design and Engineering (KET)
Gregory Quinn is a structural engineer and researcher based in Berlin. Gregory’s field of research is broad covering novel material technologies, actively bent systems and simulation techniques as well as virtual and augmented reality teaching aids. Gregory’s doctoral thesis explores the pneumatic erection of elastic gridshells making use of novel simulation methods based on dynamic relaxation techniques. Having worked as a freelance structural engineer and previously employed by Arup Berlin, Gregory has substantial experience in high-rise, earthquake and specialist material engineering projects.

Riccardo La Magna is also a member of COST Action TU1303 ‘Novel Structural Skins’.
Philipp Längst is also a member of COST Action TU1303 ‘Novel Structural Skins’.
Gregory Quinn is also a member of COST Action TU1303 ‘Novel Structural Skins’.

September 22nd - 24th, 2017
Rhinoceros, Grasshopper, Soöstik, Carat++, Kangaroo
The masterclass explores applications of mathematical optimization to architectural design. Participants will learn about major classes of black-box optimization algorithms – Metaheuristics (including Swarm Intelligence), Direct Search and Surrogate Model-based Optimization – and experiment with algorithms from each category: Genetic Algorithms, Particle Swarm Optimization, DIRECT, and optimization with Radial Basis Functions. Participants will use state-of-the-art optimization tools in Grasshopper and test them on benchmark problems. In a second step, they will develop customized optimization objectives, such as structural or environmental performance, and apply them to a predefined parametric geometry. Participants also are encouraged to bring optimization problems from their own practices and research to the workshop.

The objective of this workshop is to provide participants with both the conceptual background and technical skills required to integrate optimization into their architectural practice and research. The masterclass will yield benchmark results for the test problems and provide examples of how different formulations of optimization objectives can inform conceptual architectural design process.