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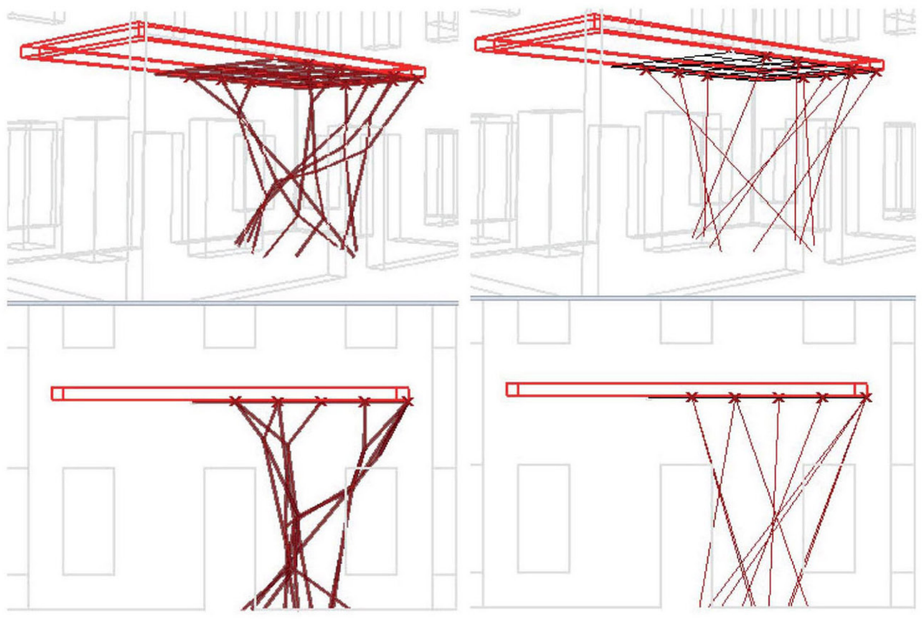
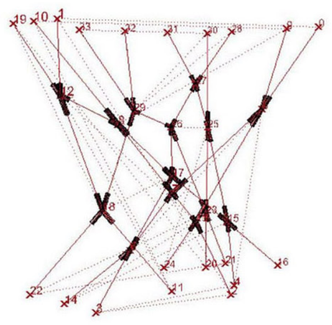
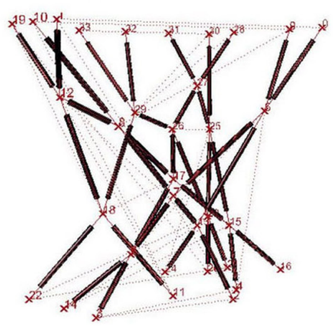
Design Process







Optimization of Internal Bending Moments

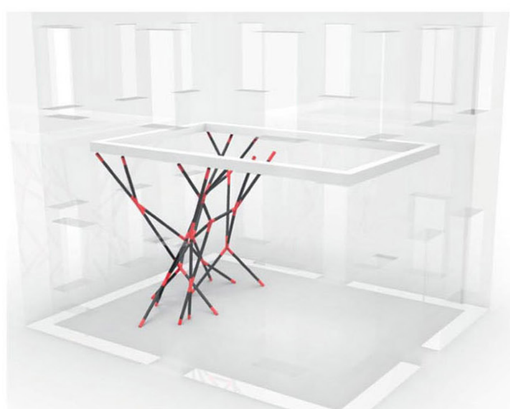
Structural Analysis in Karamba and Formfinding with Galapagos

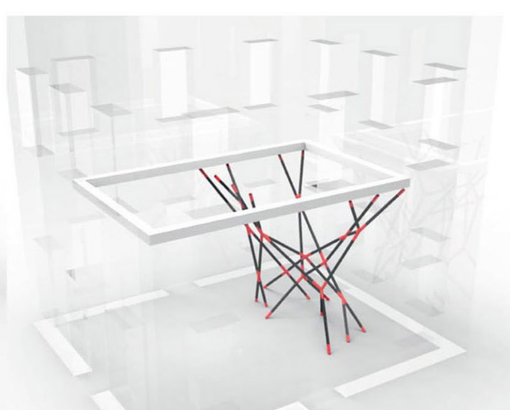
The “ARCHITECTURE CHALLENGE” program is an international design workshop series in collaboration with international experts and institutions. It is intended for architecture students interested in exploring integrated digital design and fabrication while simultaneously designing a full-scale built project within the teaching environment of the Institute of Architecture at the University of Applied Arts in Vienna (“Die Angewandte”). Architectural Design at “Die Angewandte” is taught as an integrated, multidisciplinary process. Following this tradition, the design process in the workshop was enriched with robotic design strategies combining Grasshopper plugins such as the HAL and KARAMBA platforms. The handling of virtual simulation methods and the engineering of full-scale structures using robotic manufacturing were a primary focus of the workshop. Three ABB industrial robots from REX|LAB were used for on-site fabrication. The workshop was taught by Andrei Gheorghe (Die Angewandte Vienna) with Georg Grasser, Kadri Tamre, Thibault Schwartz (TU Innsbruck) and guest experts Clemens Preisinger, Moritz Heimrath, Robert Vierlinger, Arne Hoffmann (Bollinger+Grohmann Engineers). Participating Students: Lu Jiaxing, Rhina Portillo, Matthias Urschler, Maria Valente, Yi Lin Vincent, Matea Ban.

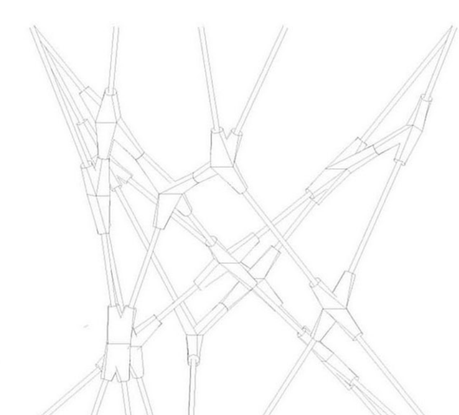
Structural Performance
Structural testing of PU foam mockups reveled a strong tension ability of the expanded material. Supporting points on the floor and suspension point on a moveable rack were defined locally taking into account the architectural site context. Possible connection lines between these points were optimized for internal bending moments using the structural plugin Karamba in combination with the genetic algorithm Galapagos.

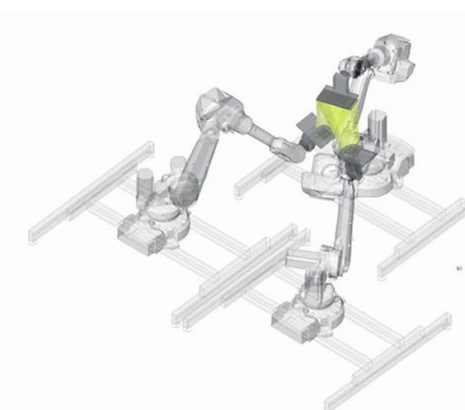
Intrinsic Material Qualities
The geometrically accurately defined design strategy reacts with loosely defined material behavior. The precise abilities of the robots correlate with the very uncertain geometrical condition entailing from the foam expansion process. This intuitive material behavior enriches the digital precision resulting in artifacts of one - time unique aesthetic design results. Experimental and final production of the structure merge in one single fabrication process.

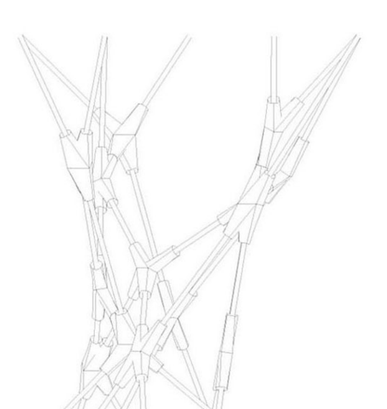
Fabrication Process
A Grasshopper Definition was developed to extract 4-point nodes and 2-point connections from the final design network. HAL was used to compute specific tool paths for the three robots. A specific material mixture (PU foam, gypsum, water and hardener) developed at TU Innsbruck combined with precise time management was required to produce the structural nodes.

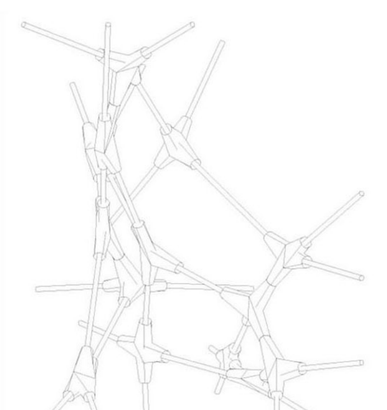




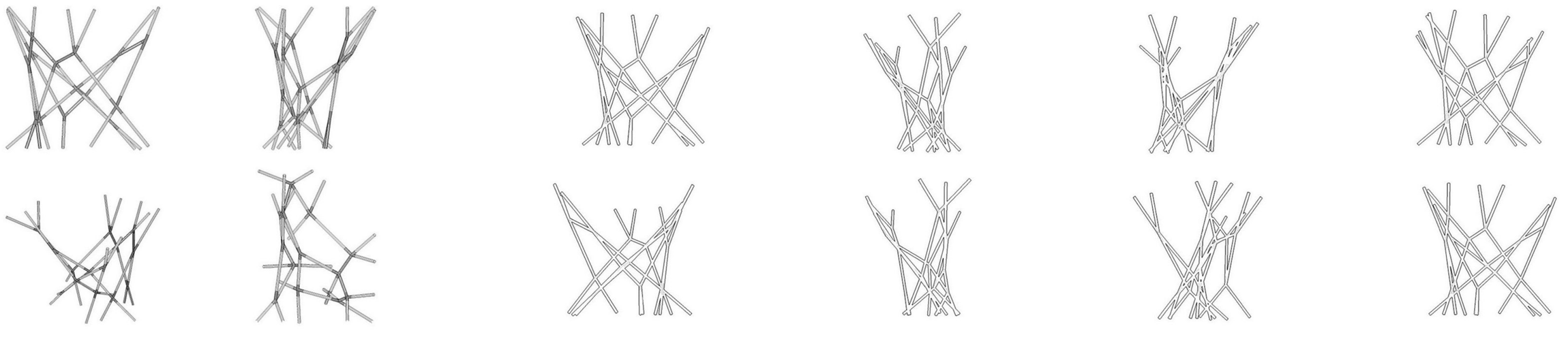








Robotic Production in HAL



Joints and Beams of Optimized Network

BOLLINGER + GROHMANN Ingenieure

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University of Applied Arts Vienna

universität innsbruck

HAL robot programming & control

REX|LAB ROBOTIC EXPERIMENTATION UNIVERSITY OF INNSBRUCK

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Karamba

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