Objects in Mirror are closer than they appear
Part I: Reciprocal Structures

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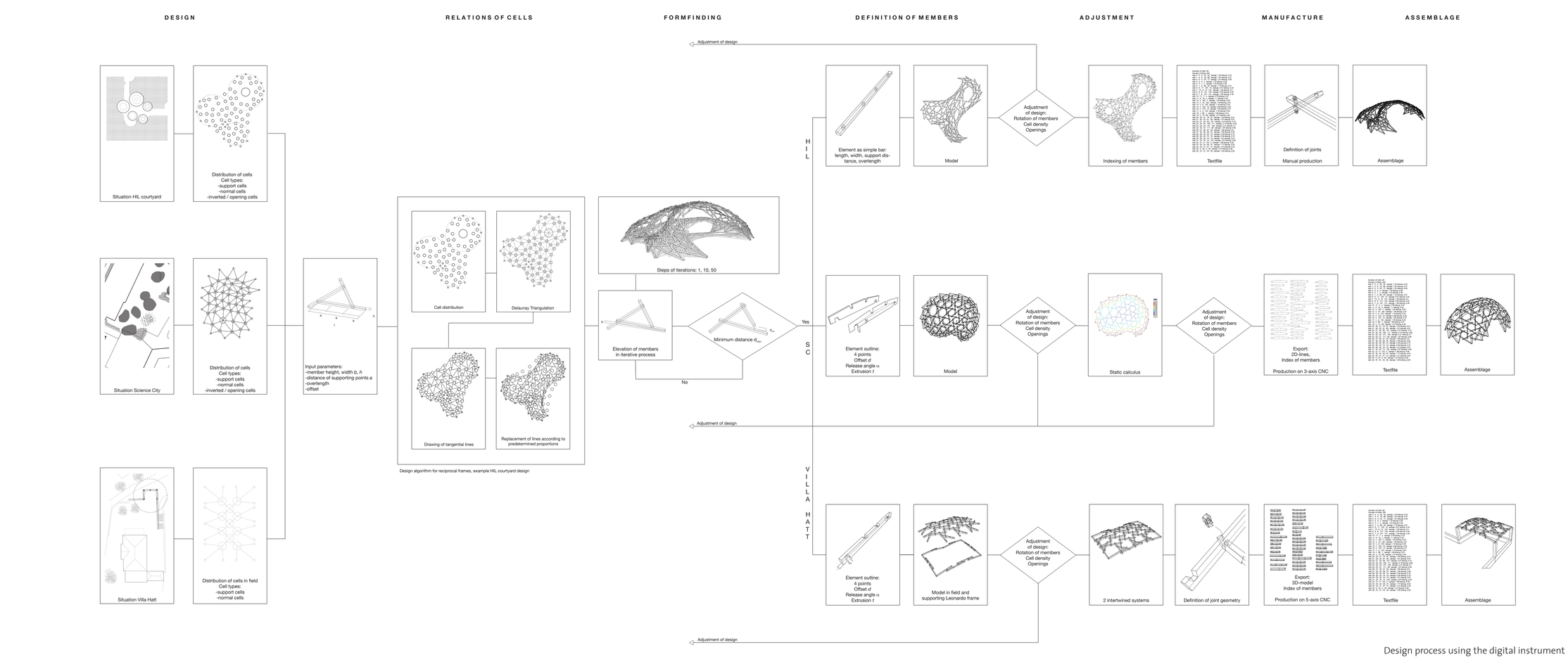
Within the framework of the research project *Objects in Mirror are Closer than they Appear* the Chair of Architecture and Construction at the ETH Zurich deals with research into and the advancement of historical construction techniques. The first sub- project concerns the examination of construction methods deploying short wooden elements to efficiently bridge large spans.
The focus is the principle of the reciprocal frame – firstly because it allows a reduction of the constructive form to a small number of parameters, and secondly because it has a great developmental potential in combination with new technologies.
It is attractive for buildings where rapid assembly and dismantling are required, and where geographical circumstances impede the use and transportation of longer construction elements. The short length of the elements also enables the use of hardwood – a local building material that has previously been neglected in construction, and which is increasing in importance with the course of climatic change.

Reciprocal frames are particularly well suited to project-orientated teaching because they encourage experimentation and make the relationship between structure and form easily comprehensible.
The aim is to introduce the students to the tactility of building via full-scale works, and to sharpen their understanding of the physical constraints involved – a progression that takes on a greater significance specifically in working with computer models and script-based designs.In different workshops the fundamentals of the reciprocal frame system were introduced, whereupon five small construction assignments were set, of which three will here be presented. Each of the assignments specifically deepened an aspect of building with reciprocal framework systems in order to both test the various techniques of development and realization and to gauge the relation between traditional projects and modern technologies. A design instrument developed by the chair played a key role in teaching and the development of the three constructions. It is based on a rhinoscript, and enables the guided generation of irregular reciprocal frames.

The design and erection of an experimental structure in the entrance courtyard of the ETH Zurich's Faculty of Architecture constituted the first small construction assignment. A precondition in realizing the supporting framework was to work using a squared timber type and the simplest of joints. The design was undertaken exclusively using the digital instrument, whereas production was undertaken manually.
A second project, a pergola for the ETH Zurich campus, was initially designed using the digital instrument and statically optimized during the design process using physical and digital models. The one-of- a-kind elements were then cut from wooden boards using a CNC milling machine.
The third construction, a pergola for the ETH guesthouse Villa Hatt, was undertaken to test the use of hardwood. Today, due to its low-cost, the use of short hardwood elements as a building material has promising potential. A prerequisite for its use is the development of simple joints and rational manufacture.



Design process using the digital instrument

Photos: Peter Hauser, Björn Sigrist

Science City (SC), April 2011

Courtyard HIL, April 2011

Villa Hatt, June 2012

Science City (SC), April 2011

Courtyard HIL, April 2011

Villa Hatt, June 2012

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