Inventioneering Architecture
building a doubly curved section through Switzerland

Christoph Schindler, ETH Zurich PhD student, schindler@arch.ethz.ch
Markus Braach, ETH Zurich PhD student, braach@arch.ethz.ch
Fabian Scheurer, ETH Zurich PhD student, scheurer@arch.ethz.ch
in collaboration with Instant Architects, Zurich
Dirk Hebel and Jorg Stollmann, www.instant-arch.net

Inventioneering Architecture –
building a doubly curved section through Switzerland

"Inventioneering Architecture" is a travelling exhibition of the four Swiss architecture schools (Zurich, Lausanne, Geneva and Mendrisio) that was first shown at the California College for Arts and Crafts (CCAC) in San Francisco and is now touring the world. For this project the office Instant Architects in Zurich designed a stage, which resembles an abstract crosscut through Swiss topography. This doubly curved platform measures 40 by 3 metres with varying heights up to 1.5 metres. A footpath meanders along the surface, passing the exhibits.

In order to meet the budget requirements, the authors proposed to assemble the hilly platform from 1000 individually curved rafters that were milled out of 40mm medium density fibreboard (MDF). They are assembled in comb-shape, so that their overlapping sections form the closed surface of the path while the exhibition area is marked by gaps. By choosing a rather cheap material and implementing a continuous digital chain from the definition of the surface geometry in the CAD software Maya until the control of the five-axis CNC-mill that the parts are manufactured with, production costs could be lowered significantly.

The detailing was developed closely after the capabilities of a five-axis router. The platform is divided into 40 millimetre wide cross sections, each describing the upper surface path of one rafter. The milling tool follows this path and rotates around it at the same time, cutting out a so called "ruled surface" that follows the topography of the platform both along and across the section. Thus it is possible to manufacture a three-dimensional, doubly curved surface from two-dimensional sheet material at very low cost. The rafters are connected by dowels and supported by perpendicular boards.

Since the structure consists of roughly 1100 individually shaped parts, the crucial point was to automate the translation of the platform geometry into the geometry of the single parts and finally into the steering code (G-Code) for the computer controlled mill.
“Inventioneering Architecture” is a traveling exhibition of the four Swiss architecture schools that was touring the world during 2005/06. This doubly curved exhibition platform resembling an abstract crosscut through Swiss topography measures 40 by 3 meters. The authors proposed to assemble the hilly platform from 1,000 individually curved rafters that were milled out of 40mm medium density fiberboard (MDF). By implementing a continuous digital chain from the definition of the surface geometry in the CAD software Maya until the control of the five-axis CNC-mill that the parts are manufactured with, production costs could be lowered significantly. The detailing was developed closely after the capabilities of a five-axis router. The platform is divided into 40 mm wide cross sections, each describing the upper surface path of one rafter. The milling tool follows this path and rotates around it at the same time, cutting out a so-called “ruled surface” that follows the topology of the platform both along and across the section. In order to meet the budget requirements, the crucial point was to automate the translation of the platform geometry into the geometry of the single parts and finally into the steering code (G-Code) for the computer controlled mill.

The platform’s 1,000 rafters are automatically routed and optimized on 272 MDF boards. The G-Code was found as generated for the 5-axis router. The rafters are defined by spline-curves, but since the CNC-router only uses straight lines and circles, the curvature had to be approximated by polygons with a point distance of 96 mm.