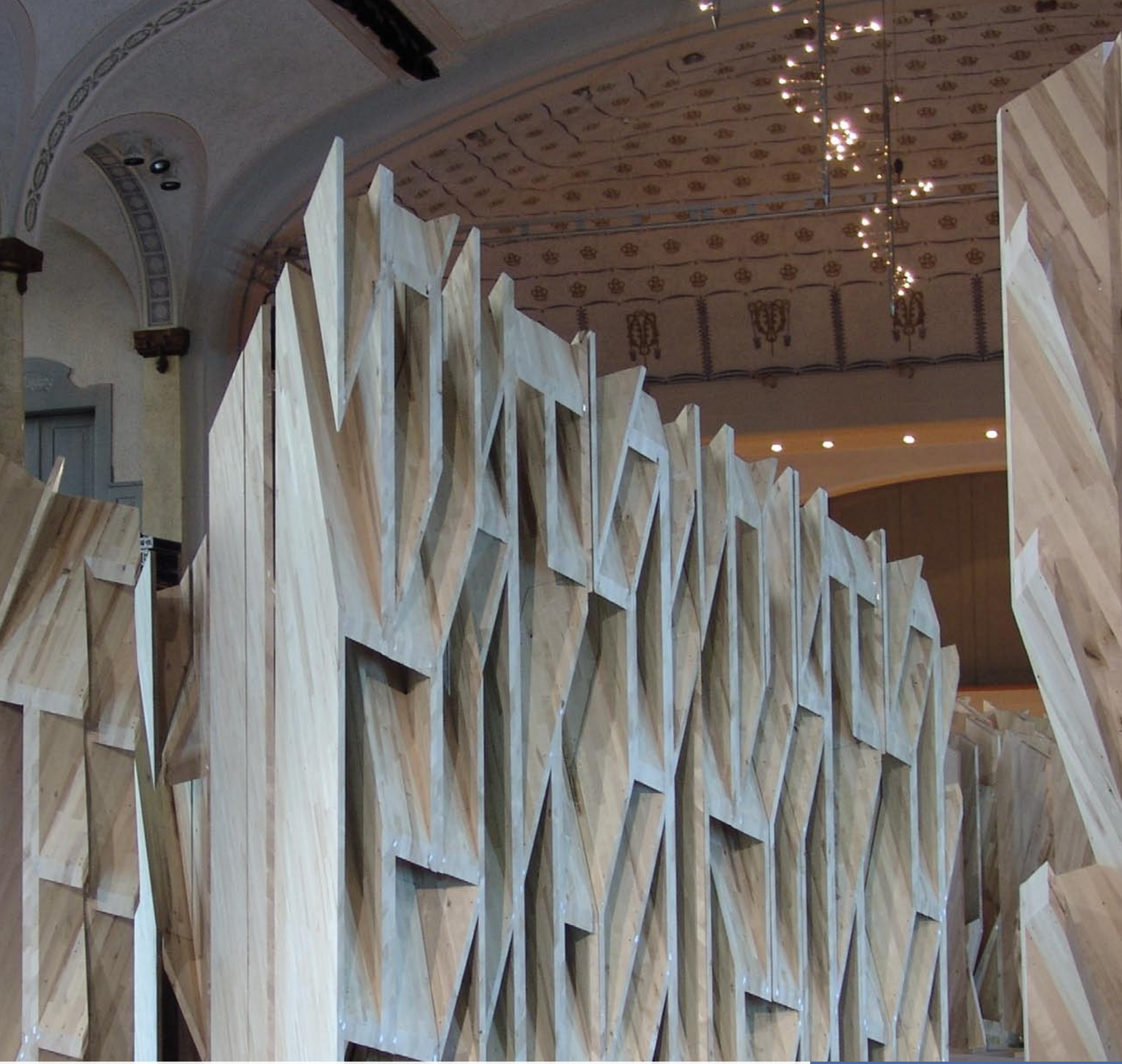
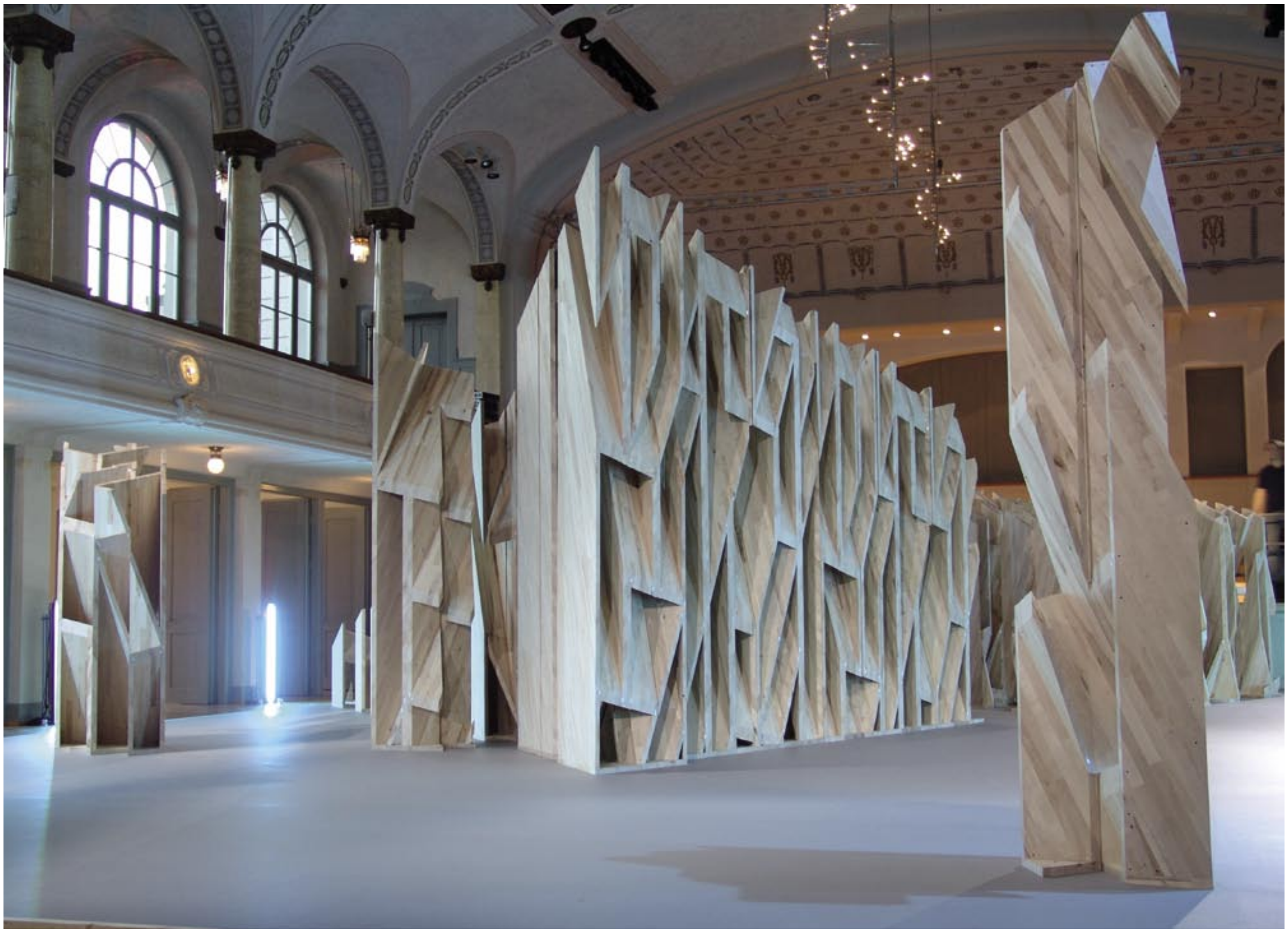


VECTORWORKS CASE STUDY

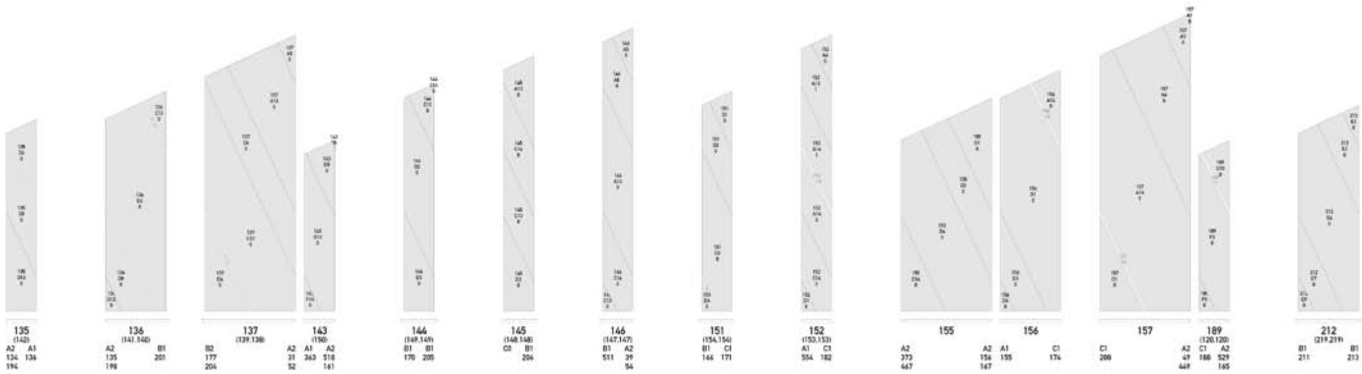
VECTORSCRIPT AND PARAMETRIC MODELING TECHNOLOGY BRING DANIEL LIBESKIND'S FUTUROPOLIS TO LIFE



WITH THE HELP OF VECTORSCRIPT AND THE PARAMETRIC MODELING CAPABILITIES WITHIN VECTORWORKS, THE RESEARCH GROUP CAAD. DESIGNTOPRODUCTION AT THE SWISS FEDERAL INSTITUTE OF TECHNOLOGY (ETH) BRINGS LIBESKIND SCULPTURE TO LIFE IN JUST TWO WEEKS AND SAVES MORE THAN 70% IN CONSTRUCTION COSTS.

Imagine trying to construct a sculpture that weighs seven tons, has 98 towers and consists of 2,164 different birch plates. The wooden sculpture was designed by architect Daniel Libeskind, modeled in VectorWorks by The Swiss Federal Institute of Technology's (ETH) caad.designtoproduction research group and fabricated by Bach Heiden AG for a workshop Libeskind held at the University of St. Gallen (HSG). HSG, a renowned business school, introduces its new students with a freshman week each year. The workshop's purpose was to conceptualize a "city of the future" and visualize student ideas with the help of the intricate towers of the Futuropolis sculpture. The sculpture served as a model for which 850 university students designed and built a futuristic city, under Libeskind's direction.

The design is based on a triangular grid, in which 98 tightly-packed towers form an ascending volume of up to 3.8 meters high. The towers are built from roughly 600



wooden boards that intersect the sculpture at a 25-degree angle and duplicate the pattern of the tower's footprints. Thus, the boards are cut into more than 2,000 wooden polygons by the perpendicular faces of the towers.

Realizing this design within the appointed budget and time frame would not have been possible by means of traditional craftsmanship. So Christoph Schindler, Fabian Scheurer, and Markus Braach, a team of architects and computer scientists with the caad.designtoproduction research group at the CAAD Chair of Prof. Dr. Ludger Hovestadt at ETH, set up a complete "digital production chain" to bring the sculpture to life. They developed an algorithmic form to serve as the basis for manufacturing and constructing the structure. VectorWorks' parametric modeling capabilities and VectorScript technology—a powerful built-in programming language that automates drafting and modeling tasks—made it possible.

CUTTING COSTS WITH VECTORWORKS

Not only did VectorWorks make the project possible, but it cut construction down to just two weeks at a savings of 320,000 Swiss Francs.

ENGINEERING THE VISION

Caad.designtoproduction offers consulting to architects who would like to work with digital production chains to realize complex designs, and VectorWorks is instrumental in the research group's work, as VectorWorks is a widely-used CAD software at the ETH.

"We use VectorWorks because it is easy to handle and available for both Windows and Macintosh platforms, which is especially important in an academic environment," says caad.designtoproduction co-founder and ETH assistant Fabian Scheurer. "Since we run our basic courses at the CAAD Chair on VectorWorks, we've made it a standard in our caad.designtoproduction work, and VectorWorks was indispensable on the Libeskind project."

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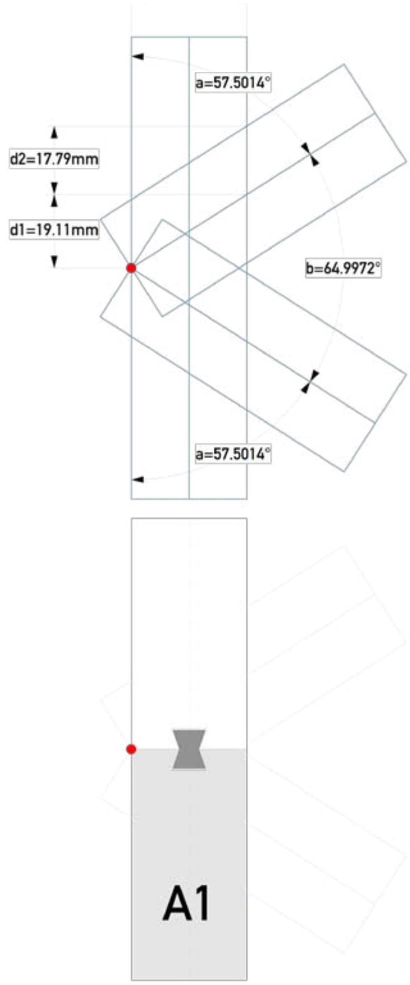
WORKING WITH VECTORSCRIPT

According to Scheurer, VectorScript allowed for tight integration of programming, manual drawing, and editing, which is critical in complex projects like Futuropolis.



"It would not have been possible to fully automate the stencil that defines the structure's geometry," says Scheurer. "But with VectorScript, it was possible to accommodate late-stage design alterations from Studio Libeskind by manually editing the stencil and then automatically recalculating all subsequent changes to the design."

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Scheurer designed a plug-in for the basic board as a 2D line object in the top view that held all the structure's information, from the thickness of the board to the type of connection detail present on every end. The "stencil" could be edited manually using the plug-in. The sculpture's towers were designed in a similar fashion. The remaining design was automated by a collection of scripts and additional plug-ins, yet it also allowed for manual intervention.

"This mixture of automation and manual control makes VectorScript especially powerful," explains Scheurer.

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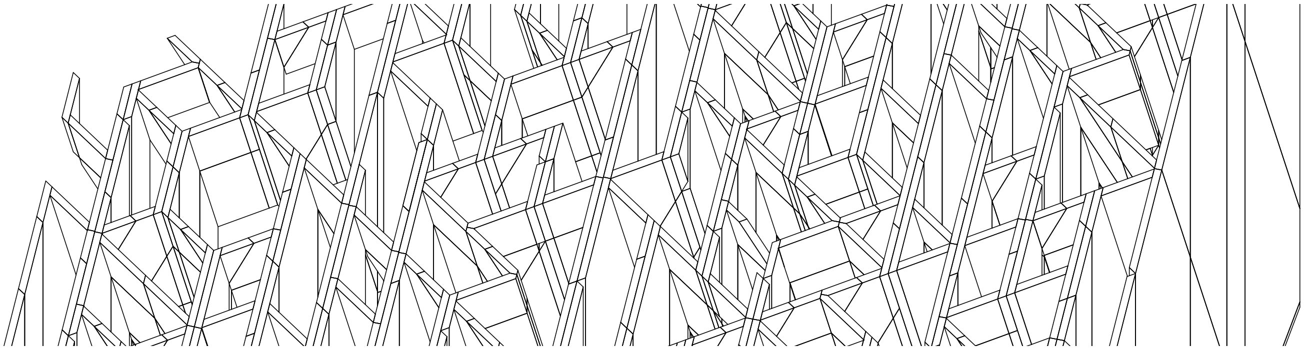
PROGRAMMING PARAMETRIC MODELS

caad.designtoproduction uses VectorWorks chiefly to program parametric models, such as the Futuropolis project.

For Futuropolis, the challenge was to generate the exact geometry of all 2,164 parts, including the bases on which the towers stand. caad.designtoproduction created a parametric 3D model of the sculpture with VectorWorks, which calculated the outline of all parts by closely following the algorithmic designs Libeskind provided. The edges were appropriately designed automatically, then the parts were numbered and arranged on boards.



"VectorWorks allows us to get immediate graphical output of the generated structures for review and presentation," says Scheurer. "The parametric approach with VectorWorks allows us to integrate design changes, even in a late project stage, by automatically reconstructing the whole geometry from the first manual steps within a few minutes. This makes it possible, for example, to change a material's thickness at the very last second—as happened in the Futuropolis project—and regenerate the whole geometry and the resulting G-code for 2,164 parts practically overnight." The third step was to translate this geometry information into the steering code for the CNC-machine. Since the boards had to be turned around in the middle of the production process, two G-code programs per board had to be generated by a script. In addition, the exact widths and lengths for calculating the material costs and preparing the raw boards were automatically exported as data-tables, using VectorWorks. The sculpture consists of 360 square meters of 32-mm-thick boards, altogether almost 11.5 cubic meters of birch wood. Total milling time was approximately 200 hours, and sculpture assembly took approximately 500 man-hours. After a public dedication in October, 2005, at the University of St. Gallen, the sculpture is now on exhibit at the university.

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INVENTIONEERING ARCHITECTURE— A TRAVELING EXHIBIT

Inventioneering Architecture is a traveling exhibit celebrating the innovative work of the following four Swiss architecture schools and showcasing their approach to teaching architecture:

The Swiss Federal Institute of Technology, Zürich (ETH)
Accademia di Architettura, Università della Svizzera Italiana (USI), Mendrisio
Ecole Polytechnique Fédérale de Lausanne (EPFL)
The Institute of Architecture at the University of Geneva

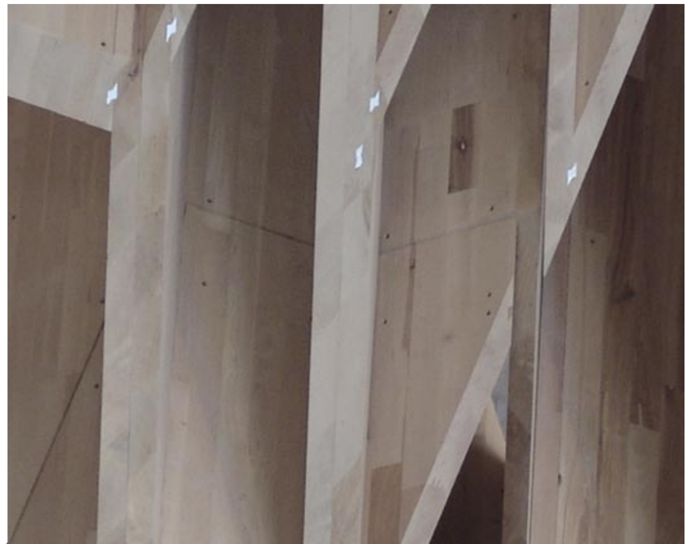
The interactive exhibit's platform is a stage that resembles an abstract cross-section of the Swiss Alps. It was designed to allow visitors to stroll the platform while viewing architectural models and visuals on overhead screens and display panels. A footpath meanders along the surface, passing the exhibits.

To develop this platform, a NURBS surface was translated into the geometry for 1,000 individually-shaped rafters, which formed a doubly-curved surface of 120 square meters, measuring 40 by 3 meters, with varying heights up to 1.5 meters. Since the structure consists of so many individually shaped parts, it was crucial to automate the translation of the platform geometry into the geometry of the single parts and then into the steering code for the computer-controlled mill.

The caad.designtoproduction team was able to accomplish this using the VectorScript technology within VectorWorks. The first script imported the original design (defined as a NURBS surface) in the modeling software Maya, read the coordinates of the platform's cross-sections for every rafter and determined the banking angles. A second script translated this information into the milling paths for all 1000 rafters, including all dowel-hole drillings. A third script arranged and optimized the rafters on the 40-mm-thick MDF-boards and generated the G-code, the programs that control the five-axis CNC-router. 120 1 x 4.2-meter MDF-boards were used to fabricate all rafters in approximately 50 milling hours.

The exhibition opened in October, 2005, in San Francisco, and will travel to Boston, Shanghai, and Dubai, before returning to Zurich, Switzerland, its birthplace.

For more information, contact Nemetschek North America, makers of VectorWorks, at 888-646-4223, or, visit us on the web at www.vectorworks.net



RECOGNIZING GENIUS AT ETH

Nobel and Pritzker Prize Winners The Swiss Federal Institute of Technology, ETH Zurich, was founded in 1855 as the Federal Polytechnic Institute. Today it is an internationally respected research institution of higher learning.

Twenty-one Nobel Prize winners are associated with ETH Zurich, in the fields of physics, chemistry, medicine, and literature—most notably Albert Einstein in 1921. Among ETH's more prestigious faculty are the Pritzker Prize-winning architects Jacques Herzog and Pierre de Meuron. Best known for the Tate Modern in London, Herzog and de Meuron have been receiving critical acclaim for their latest project, the $135 million de Young Museum, which recently opened in San Francisco.

The striking structure is an enigmatic statement of high-tech craftsmanship. Connecting the museum visually to its environment in Golden Gate Park is a copper "skin" that covers its modern, metallic diagonals and is embossed and perforated to simulate sunlight filtering through trees.

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