TEKLA® Structures

TEKLA STRUCTURES IN PRACTICE:

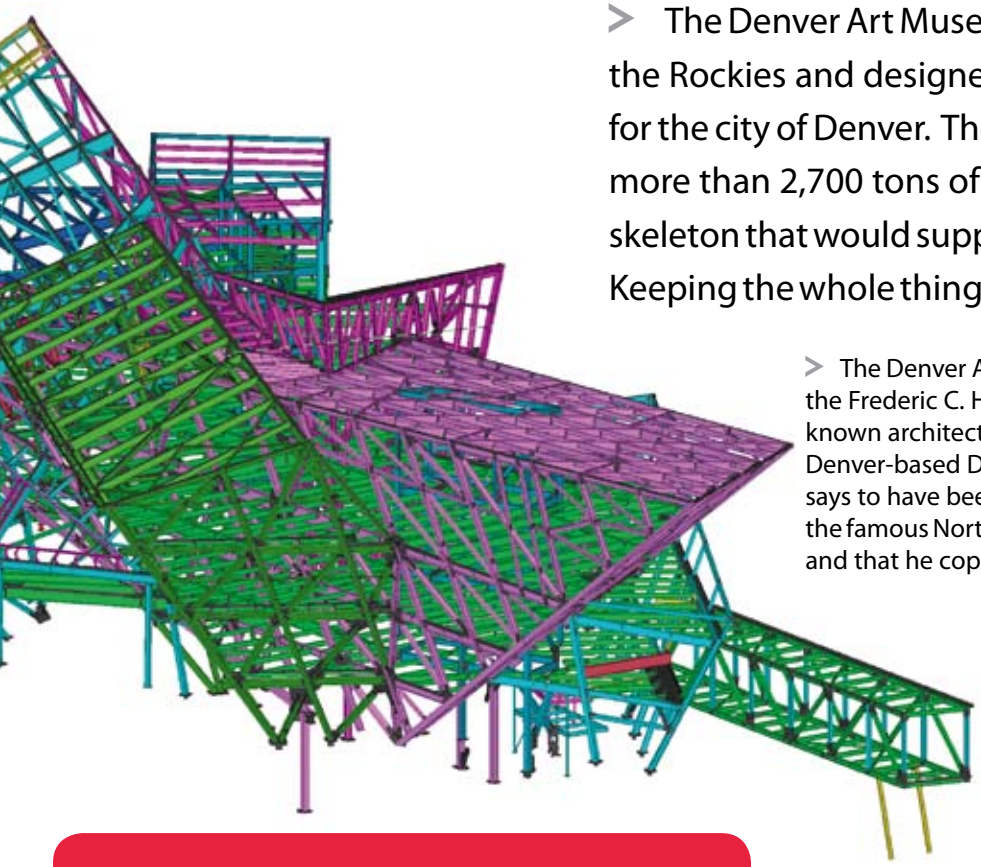
DENVER ART MUSEUM EXPANSION

TEKLA Structures

DENVER'S DASHING NEW LANDMARK

2,700 TONS OF STEEL IN AN AWESOME ANGLE

> The Denver Art Museum expansion was inspired by the Rockies and designed to be a signature landmark for the city of Denver. The plans called for transforming more than 2,700 tons of steel into a complicated skeleton that would support and create oblique angles. Keeping the whole thing together was Tekla Structures.



> The Denver Art Museum (DAM) expansion, also called the Frederic C. Hamilton Building, was designed by well-known architect Daniel Libeskind in collaboration with Denver-based Davis Partnership Architects. Libeskind says to have been inspired by the light and geology of the famous North American mountain range, the Rockies, and that he copied the shapes for the building through an airplane window while flying over the mountains. The building project intends to put Denver on the architectural map of the world. Construction of the expansion took three years, with up to 200 people working on different parts of the building each day. Installation of more than 9,000 façade panels of titanium started in 2004. The building was opened to the public on October 7, 2006.

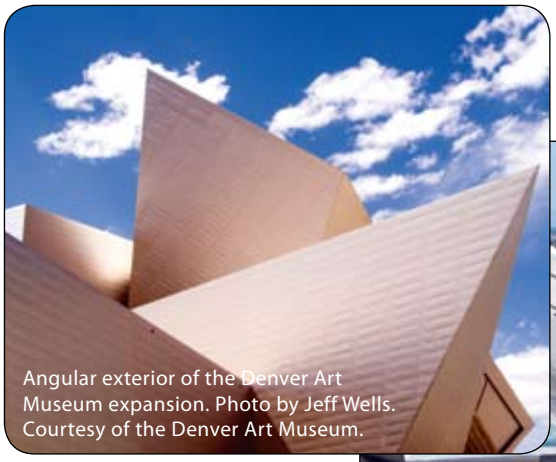
DAM IN FACTS AND FIGURES

- 15 sequences with 3,500 shop drawings
- 2,750 tons of steel
- 230,000 square feet of titanium panels
- 7,400 cubic yards of concrete
- 110 feet in height
- 100-foot bridge to connect with old building
- Project cost $110 million

THE STEEL PHASE WAS COMPLETED 3 MONTHS AHEAD OF SCHEDULE DUE TO 3D MODELING CAPABILITIES

TOUR-DE-FORCE OF STEEL CONSTRUCTION

> The plans called for transforming more than 2,700 tons of steel and about 50,000 bolts – three times the amount in a conventional building of the same size – into a complicated skeleton that would support and create oblique angles. Building the steel frame took approximately 13 months. Construction workers began



Angular exterior of the Denver Art Museum expansion. Photo by Jeff Wells. Courtesy of the Denver Art Museum.

> "IT WAS TRULY AMAZING TO ME HOW ALL THE PIECES FIT INTO PLACE." – CURTIS MAYES, L.P.R. CONSTRUCTION

The Denver Art Museum's Frederic C. Hamilton Building Photo by Jeff Wells. Courtesy of the Denver Art Museum.

to assemble the building's angular skeleton in July 2003 – a true challenge with the complex structures and slopes, where steel erectors faced the difficulty of climbing around the beams on site. Each beam plays a role in holding up the building, and if one beam moved or bent the wrong way, it would create problems throughout the structure.

General contractor M.A. Mortenson Construction decided to use the latest technology to pinpoint the exact location of each beam. This technology was provided by Tekla Structures (Xsteel v8), the modeling software that kept the whole thing together. The program created a 3D model of the building, which detailed everything down to the size of each of the thousands of bolts used to secure beams. Modeling also introduced a fourth dimension to the project: time. Tekla Structures took the whole four-year building schedule – drawn up beforehand – and integrated it into the model to create a movie that showed every step of construction. The movie enabled everyone working on the project to visualize the work before they did it.

ALL IN ONE MODEL

> Tekla Structures solution allowed all team members – M.A. Mortenson Construction (general contractor), Dowco Consultants (detailer), Structural Consultants Inc. (connection designer), ARUP (structural engineer), L.P.R. (erector), and Zimmerman Metals Inc. (steel fabricator) – to stay in the building information loop. "The Tekla Viewers were a tremendous asset because of their ability to provide quick and accurate centers of gravities and weighs of assemblies," says Curtis Mayes, P.E. with L.P.R. Construction. "The ability to export 3D DXF files of the model for use in erection planning and design is an outstanding feature."

Concludes Sales Manager Mark Magruder of Tekla Inc: "According to all the reports I've heard, the degree of collaboration utilizing Tekla Structures is what made the project successful and profitable. The steel was topped out about three months ahead of schedule even though it got underway later than expected." One thing that helped with the schedule acceleration was being able to export all or portions of the detailing model from the viewer model to the CAD software and create shoring, then import data back to the viewer model and pass on to detailing. Another time-saver, according to Magruder, was the ability to import reference models of cranes into the viewer model, enabling accurate staging and positioning plans to be completed in the erector's office rather than in the field.

FROM ACCURATE DETAILING TO SMOOTH ERECTION

> With Tekla, Dowco was able to accurately detail this incredibly complex steel structure. Portraying multifaceted 3D information in a two-dimensional format for shop use enabled Zimmerman Metals and L.P.R to perform well. "A huge key to the successful preplanning and execution of this project was the flawless list of specially generated XYZ coordinates," explains Curtis Mayes. "It allowed unparalleled alignment control. It was truly amazing to me how all the pieces fit into place."

The DAM expansion was a very geometrically complex structure. It's often difficult to create the intricate angles that occur at building connections. The level of accuracy provided with Tekla Structures modeling has the capability to determine down to the last millimeter the fit-up of a given bolt or welded configuration. This meant that the accuracy of the steel framing resulted in a very smooth erection process. "The software not only helped during the design and steel detailing phases," continues J.R. Barker of Structural Consultants Inc, "but it was also used by the steel erector to plan daily erection activities."

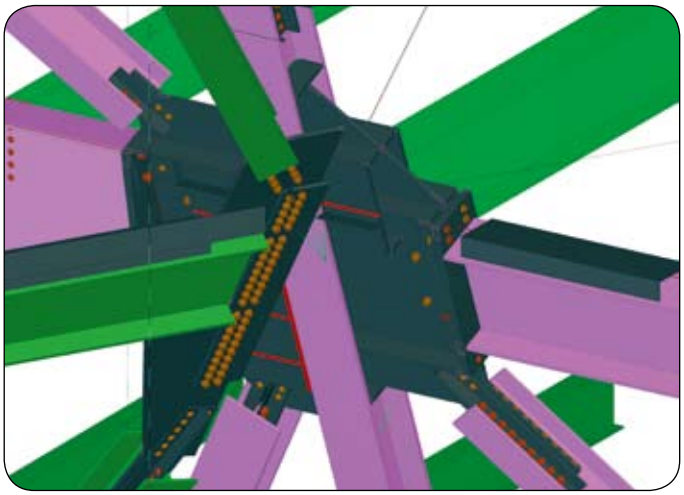
TEKLA STRUCTURES – INTELLIGENT 3D MODELING

TEKLA CORPORATION

> Tekla is a leading international software company whose innovative software solutions make customers' core businesses more effective. Tekla's software products and related services are used mostly in building and construction, but also in energy sales and distribution, defense, and by municipalities. Tekla Group's net sales in 2005 were 38 million euros. International operations account for 75% of net sales. Tekla was founded in 1966 and celebrates its 40th year in business in 2006.

TEKLA STRUCTURES

> Tekla Structures software is the building information modeling (BIM) solution that can take any building project all the way from sales and conceptual design to detailing, fabrication, erection and beyond. Its innovative tools provide new possibilities to create an intelligent model of any size or complexity and to coordinate different materials with ease and precision. Tekla 3D models contain all the information required for the different construction phases of a project. Tekla Structures encompasses specialized configurations for structural engineers, steel detailers and fabricators, precast concrete detailers and manufacturers, as well as contractors. The software is used by industry leaders in more than 80 countries.



Find your local TEKLA contact at

www.tekla.com

Rendering of the north view of the Denver Art Museum's new Frederic C. Hamilton Building, designed by Daniel Libeskind. Image by Miller Hare. Courtesy of the Denver Art Museum.

CONTACT INFORMATION
Tekla Corporation (HQ)
Metsänppojankuja 1, P.O. Box 1
FI-02131 Espoo, FINLAND
Tel. +358 30 661 10
Fax +358 30 661 1500