The Millennium Tower (Figure 1) in Magdeburg, Germany houses an exhibition on the development of mankind. With an emphasis on research and discoveries in the natural sciences, it covers a period of 6000 years going from early history up to today. The exhibition area available for this purpose totals 8,000 m² on ten floors, hosting a maximum of 2300 visitors with an evacuation time of 13 minutes. The space provided inside the tower compares to that of 100 single-family houses.

Figure 1: Millennium Tower, close to completion in April 1999

Responsible for the artistic design is Johannes Peter Staub, Zürich. The translation of his design into a structural design, as well as a general layout, was performed by two Magdeburg-based architects: encoplan and ACM. The basic form of the tower is a skew cone, approximately 60 m high, as shown in Figure 2. Part of its base is a semicircle flaring elliptically into a larger second half.

A spiral stair reaches from the top of the lower central tower with a crown at 21 m height, to a plane at elevation 43 m. The stair’s axis coincides the eccentric vertical axis of the tower. A continuous, 350 m long pedestrian ramp, encircling the tower four times, allows visitors to access all levels from the outside. It also provides several horizontal sections as observation platforms.

The Hildesheim engineering office kgs of Prof. Dr.-Ing. Martin H. Kessel and Dipl.-Ing. Dirk Gnutzmann was put in charge of the structural analysis. The load-bearing structure of the tower is composed of 26 main members, each consisting of a plane rib forming part of the cone shell and one half of the arches forming the three inner domes. At its crown, each half of the arches is rigidly connected to a steel ring. The glued laminated timber girders have maximum dimensions of 32 cm x 200 cm and provide a fire resistance period of 60 min.

1 Ingenieurbüro kgs, Hannoversche Str. 34-36, D-31134 Hildesheim
Figure 2: Cross Section through the Tower and Plan View at Elevation 0.0 m

Figure 3: Lower Dome Arches with Steel Ring on Support Piers
Figure 4: Detailing of Connection of the Arch to the Steel Ring

Figure 5: Connection of one Half of an Arch to the Steel Ring
The special geometry of the skew tower required very detailed planning. The tower comprises a total of 84,000 structural members, a mere 5% of which are duplicates. Thus, three-dimensional design methods had to be used to determine the member’s locations and their dimensions. Geometry development was performed with the three-dimensional CAD system *cadwork*. The three-dimensional truss program *InfoGraph* was used for analysis of internal forces and design calculations (Figure 7).
Figure 7: Three-dimensional Strut and Tie Model (3005 Members, 10 674 Degrees of Freedom)
Figure 8: Minimum/Maximum Moments for Load Case 64 (g,p,w)
Figure 9: Elevation 7.8 Meter, Nailing of Slab Formwork

Shop drawings for the 18 m high tower top, also produced with cadwork, are shown in Figure 11.

Figure 10: Three-dimensional CAD model of the Tower Top
A special highlight during construction was the attachment of the tower top, which was preassembled on the ground and mounted as a complete unit (Figure 12). The total weight of the structural and mechanical installations (including, in particular, a fan with a capacity of 2,200 m³/h to exhaust smoke in case of fire) came to almost 10 tons. So for the complete 55 tons of the tower top, an 800-ton crane, with a 34 m jib length, had to be provided.

Finally, the translucent membrane was fitted, which covers the whole structure. Though admitting light into the inside of the tower, it obstructs any view to the outside.

**Dimensions:**

- Height: approx. 60 m
- Length x Width: 70 m x 60 m
- Volume: 50 000 m³

**Materials:**

- Solid Wood 1200 m³
- Glued Laminated Timber 3300 m³
- Steel Members: 146 t
**Figure 13:** Internal View of Lower Dome

a. Tower Elevation 21.0 m, with Central Stair Case  
b. Tower Elevation 33.0 m
c. Elevation 43.0 m

**Figure 14:** Internal Views  
**Figure 15:** Completed Millennium Tower, with Translucent Membrane and Pedestrian Ramp

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