

Vision to Production

The digital optimization of the ceiling of the Central Plaza in the Mall of the Netherlands

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When you walk into the Central Plaza of the Westfield Mall of the Netherlands, you are immediately drawn to the ceiling. It is not a ceiling in the traditional sense, but a 635 m² sculptural wave of wood that flows through the space, comprised of over 700 individual blades around the elliptical skylight. It is an impressive piece of architectural vision. However, turning this fluid concept into a physical, buildable reality presented an engineering challenge. The architect, MVSA, provided a 3D model in Rhino that captured the ambitious, veil-like form. The client, Julia+ Passion for People & Interiors, commissioned Vibes Building Engineers to translate this vision into a technical model for fabrication and execution. This is the story of that translation, a process of digital optimization, computational problem-solving, and intense collaboration to iron out the digital kinks and deliver a perfectly smooth, flowing structure.

The digital workflow: optimization with Dynamo and Revit

The initial goal was to make the design buildable and rationalize the geometry for CNC production. During the engineering phase, it became clear that the design also needed to be enhanced in its intended aesthetic of seamless fluidity. This required a deconstruction of the architect's model and rebuilding it in a more controlled, parametric environment.

The architect's Rhino model (see Figure 1) was the starting point, defining the 'what'. The task was to define the 'how'. Upon analysis of the complex, double-curved surfaces of the model, it was found that the faces were not perfectly continuous. This resulted in small but perceptible kinks in what were meant to be seamless, flowing lines. If built as-is, this would compromise the core aesthetic.



Figure 1: The architect's initial conceptual render of the ceiling

The design was transitioned from Rhino into Revit with Dynamo. This new setup provided control over the geometry and data, as well as better integration with other production companies, such as the traditional ceiling company, the skylight manufacturer, and the sprinkler installer. The workflow then became a four-step process of digital refinement:

1. Deconstruction and rationalization: Instead of trying to fix the existing surfaces, the design's underlying logic was analyzed. It was found that by re-drawing the main guiding curves in the opposite direction of the original model, a new, perfectly smooth, and mathematically continuous surface could be generated.

2. Re-projection: With this optimized base surface, the architect's original 2D plan-view curves were then projected onto it. This crucial step preserved the exact footprint and 'rhythm' of the blades as intended but ensured that their 3D form was now perfectly fluid.

3. Segmentation: Over 700 blades, each with a unique 3D curve, were far too large to produce in one piece. A Dynamo script (see Figure 2) was used to project a grid of "cut lines" onto the 3D blade geometries. This sliced each blade into manageable segments, resulting in over 2,800 unique, numbered pieces.



4. Data export: Finally, the unrolled, 2D flat geometry of each individual segment was exported, ready to be fed into nesting software for production.



Figure 2: The Dynamo script used to translate the geometry to Revit

No additional optimizations were used, like topology optimization for the blades, as the form was driven by aesthetics, rather than structural efficiency. The structural engineering itself was handled by Aveco de Bondt. They calculated the hidden, load-bearing support structure above the blades, using traditional methods. A full calculation of each unique element for the over 700 blades was not necessary. Instead, Aveco de Bondt performed structural calculations on composite-wise selected blades. This approach was justified by the design's gradual changing shape of the blades, where adjacent blades have only minor geometrical differences.

Material, production, and an honest challenge

The choice of material was critical. Given the fact that this is a high-traffic public building, fire safety was paramount. The blades are made from 30-minute fire-resistant MDF, finished with a durable melamine layer and edge banding.

This material choice, combined with the complex geometry, presented a significant production challenge. The over 2,800+ unique, non-repeating organic shapes were optimized onto the large MDF plates using nesting software to minimize material loss (see Figure 3). However, minimized did not mean zero. The irregular shapes inevitably created substantial waste. This created a conflict with the project's sustainability goals.



Figure 3: Result of one segment for CNC milling after nesting optimization

The combination of fire-resistant MDF and a melamine coating makes the material extremely difficult to recycle. This was noted as a key lesson learned to be discussed with architects on future projects, highlighting the tension that can exist between ambitious design, material specifications, and circularity.

The challenges went beyond digital coordination and material waste; the physical details had to be engineered for production and assembly as well. A critical detail was the coupling between segments. To achieve a seamless finish, a custom connection was designed using two pins, each with two conical recesses. These are pulled by conical-pointed screws set into threaded bushes. The key was a subtle geometrical trick: the distance between the recesses on the pin is slightly smaller than the distance between the holes in the segments. As the conical screws are tightened, they automatically pull the two segments together, creating a perfectly tight and clean joint.

A symphony of collaboration

A project of this scale is always a collaborative effort, but this collaboration was defined by a unique shift in dynamics. The project was kicked off in June 2019, just six months 'B.C.' (Before Covid). The initial design and mock-up discussions with the client, the architect, and the structural engineers were held in person. By the time the project reached the critical final coordination phase, the world had changed. This new dynamic meant all final alignment and integration of the complex work of fabricators, the steel support structure, the sprinkler system, etc., had to be managed entirely through online meetings. The team adapted and succeeded, but it confirmed that for solving complex, multi-disciplinary challenges, nothing beats being in the same room.

Lessons learned: the mirrored blade

In any complex digital-to-fabrication project, the process is as important as the result. The key takeaway? Test every single step. In the building sector, the first or second prototype is the product. At one point, a project script decided to mirror a batch of segments on its own. The numbering system, designed for the assembly team to identify which segment went where, was placed to be visible from one side. This caused the numbers on the first 30 blades produced to be on the wrong side. It was a small digital error that had an immediate physical consequence. Another lesson was to get involved in the technical design process before the architect's vision is finalized. Feedback can be provided, which makes the entire process from design to fabrication more efficient, sustainable, and successful.

In the end, this project was a fantastic puzzle. It pushed the team's computational design skills and reinforced the power of BIM as a collaboration tool. The team was able to take a highly ambitious architectural concept, optimize its flaws, and help create the stunning centerpiece that now defines the Mall of the Netherlands (see Figure 4).



Figure 4: The finished ceiling