courtesy of TAKENAKA

Success story

Takenaka Corporation automates simulation-based architectural design

Using modeFRONTIER to perfect a 3D model of a complex-shaped building.

Takenaka Corporation offers comprehensive services worldwide across the entire spectrum of space creation from site location and planning to design and construction as well as building maintenance. Recently, structural engineers and computational architects at Takenaka Corporation Technical Research Institute have started to apply optimization driven design approach in their architectural and engineering projects with the aim of exploring and obtaining innovative design solutions in shorter time. They chose modeFRONTIER software to optimize the 3D model of a new complex-shaped office building in Osaka, Japan.

Challenge

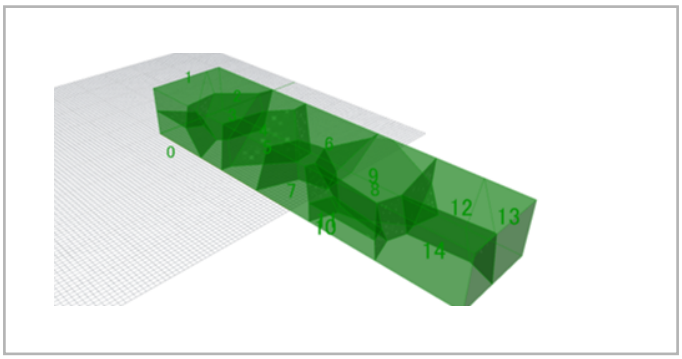
Responding to a request of a client - a steel manufacturer - asking for a new office building featuring their fabrication technologies, Takenaka Corporation **designed a steel pavilion-like office building** which also facilitates and accelerates the communication between employees. Several requirements were considered to perform parametric studies on 3D building models: from maximizing the connections between rooms and expanding office space to designing a stunning atrium. Facing these challenges by manually conducting simulations is quite time consuming, leading to delays in project schedules.

Architects at Takenaka Corporation look at **multi-objective optimization** as an effective methodology to quickly generate creative and innovative designs while meeting client's expectations.

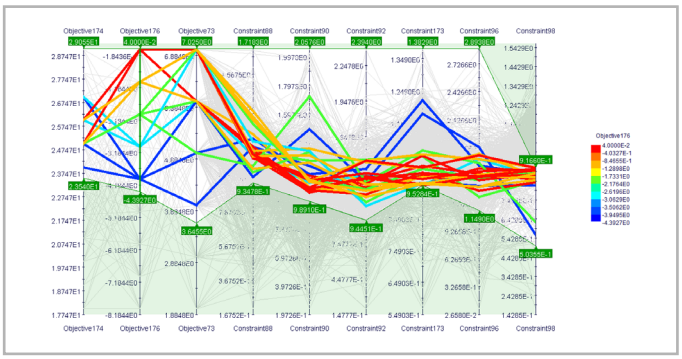
> **We are using modeFRONTIER to quickly generate creative and innovative designs.**

Solution

The shape of the building was generated through the 3D Voronoi component available in Rhino3D/Grasshopper. The 3D geometry was integrated in **modeFRONTIER workflow** to automatically adjust the Voronoi parameters and slab levels, with the aim of optimizing conflicting outputs of the model (area of rooms, floor heights, connection between rooms, angle of surfaces) while also considering required room area and floor height as constraints.
After performing an initial Design of Experiments (DOE) to assess the correlation between slab levels and other parameters, the optimization process was guided by the **pilOPT algorithm available in modeFRONTIER** to maximize the connection between rooms, minimize the sharp angle surfaces of office area and maximize the sharp angle surface of the hall.

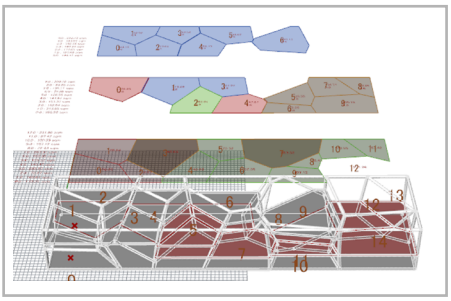


3D Voronoi Shape modeling with Rhino3D/Grasshopper.



Parallel Coordinate Chart allows to identify which parameters are relevant to obtaining better designs.

Benefits



The final design selected for the complex-shaped building.

"With modeFRONTIER, we **run and evaluate 3000 designs in just one day** instead of losing weeks doing it manually. Moreover, the easy to use interface and data analysis & visualization tools enabled our designers to process the results faster and select their favorite designs for further studies.

Finally, we look forward to demonstrating the potential of combining modeFRONTIER workflow with BRAIN, our in-house structural design software that we use in most of our projects" said **Takuma Kawakami, Structural Engineer and Computational Architect** at Takenaka Corporation.

About Takenaka Corporation

With yearly sales of $9 billion, 20 overseas offices, the largest construction R&D laboratory in the world and over 1,000 architects in our design department, Takenaka offers comprehensive services worldwide across the entire spectrum of space creation from site location and planning to design and construction as well as postcompletion services such as building maintenance. **takenaka.co.jp**