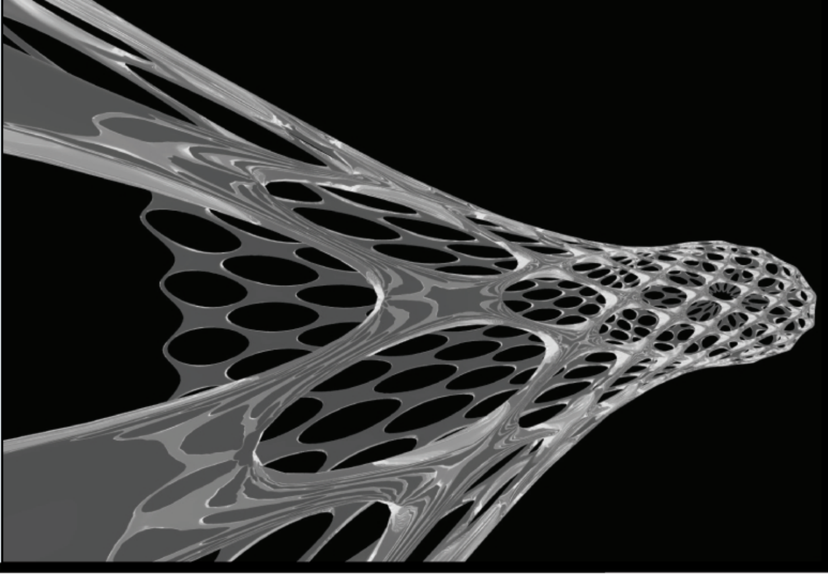

Digital Architectonics
University of Bath

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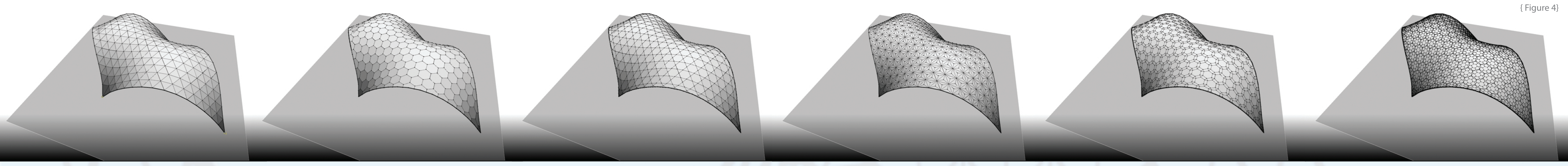


[Figure 4]

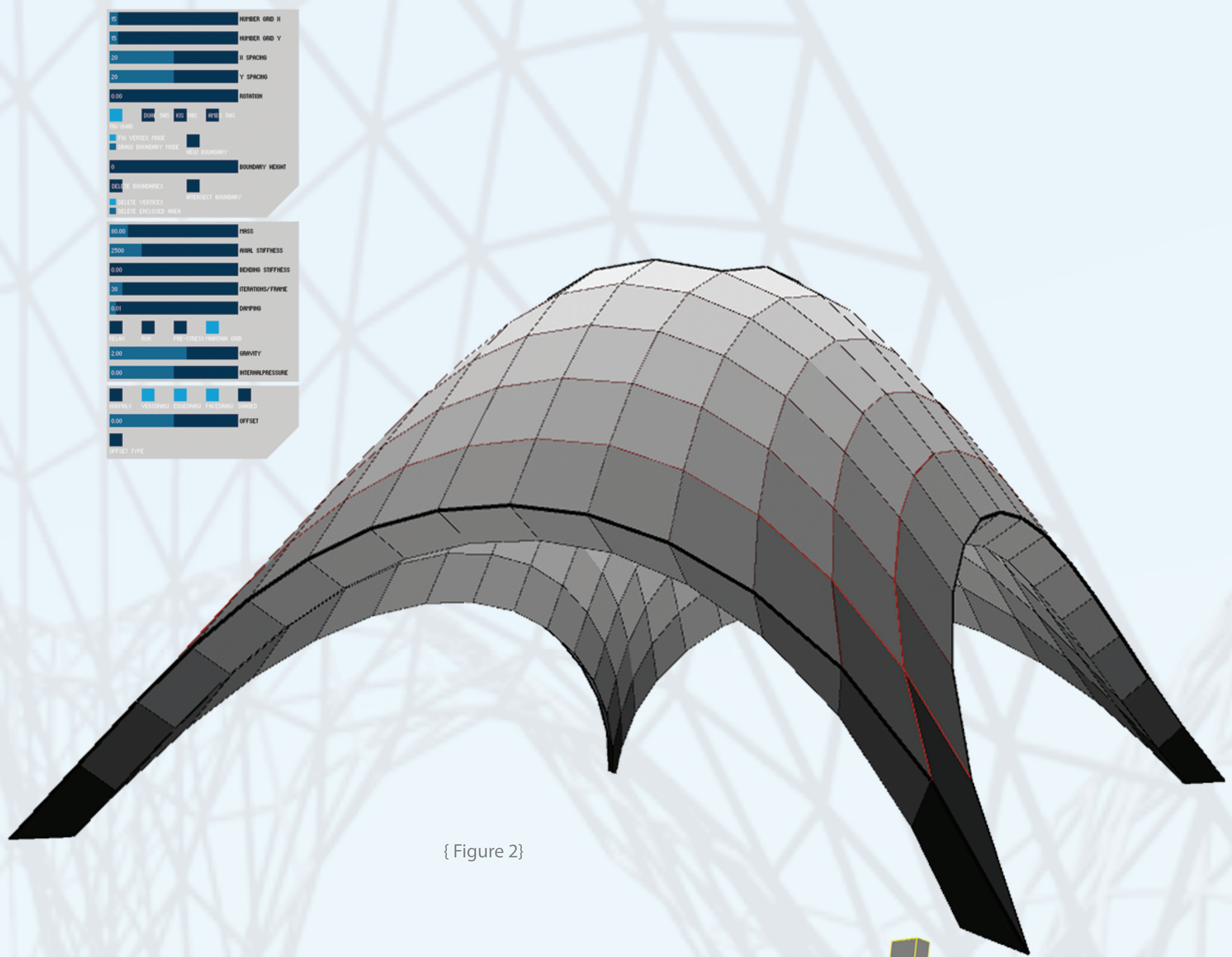
Interactive form-finding

A continuation and digitisation of the classic “hanging chain” models for form-finding experiments. Using simulated gravity and internal/external pressures the virtual surface finds the most efficient shape to avoid bending stresses, see figure 1.

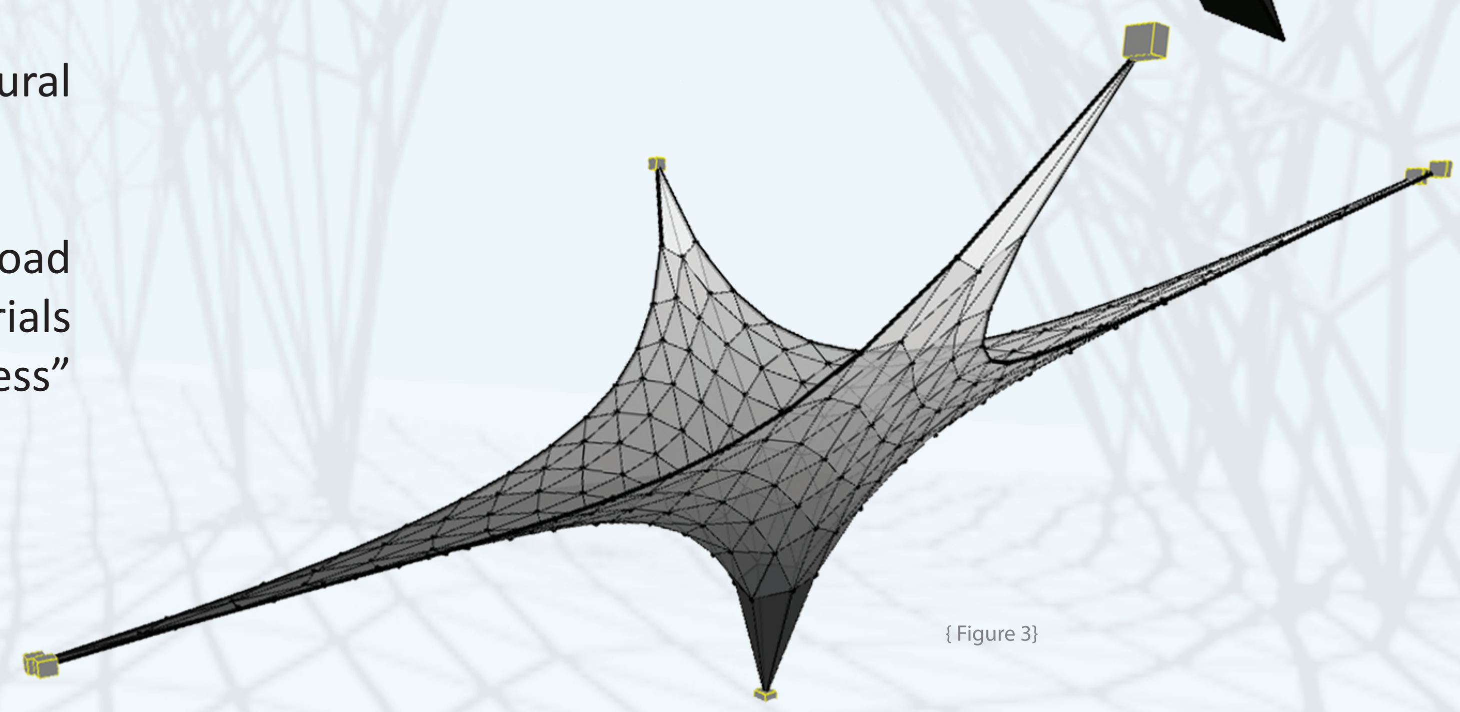
These digital models can be quicker, cheaper, more adaptable and far easier to extract geometrical data from in comparison to hand-made models.

Some features of the software:
- Vertices can be fixed in space individually or, using interactive drawing tool, fixed and equally spaced onto spatial polylines.
- Mesh relaxation algorithm.
- Real-time strain visualisation.
- The surface can be offset to create a solid object, see figure 2.
- Vertices can be deleted during physical simulation.
- Pre-stress and axial stiffness can be adjusted for the members, see figure 3.
- Bending stiffness at the connections can be simulated.
- Mesh operations can create complex meshes from simple triangular or quad bases, see figure 4.
- Full geometry including support and loading information can be exported in a variety of formats for structural analysis, integration in architectural model or fabrication.

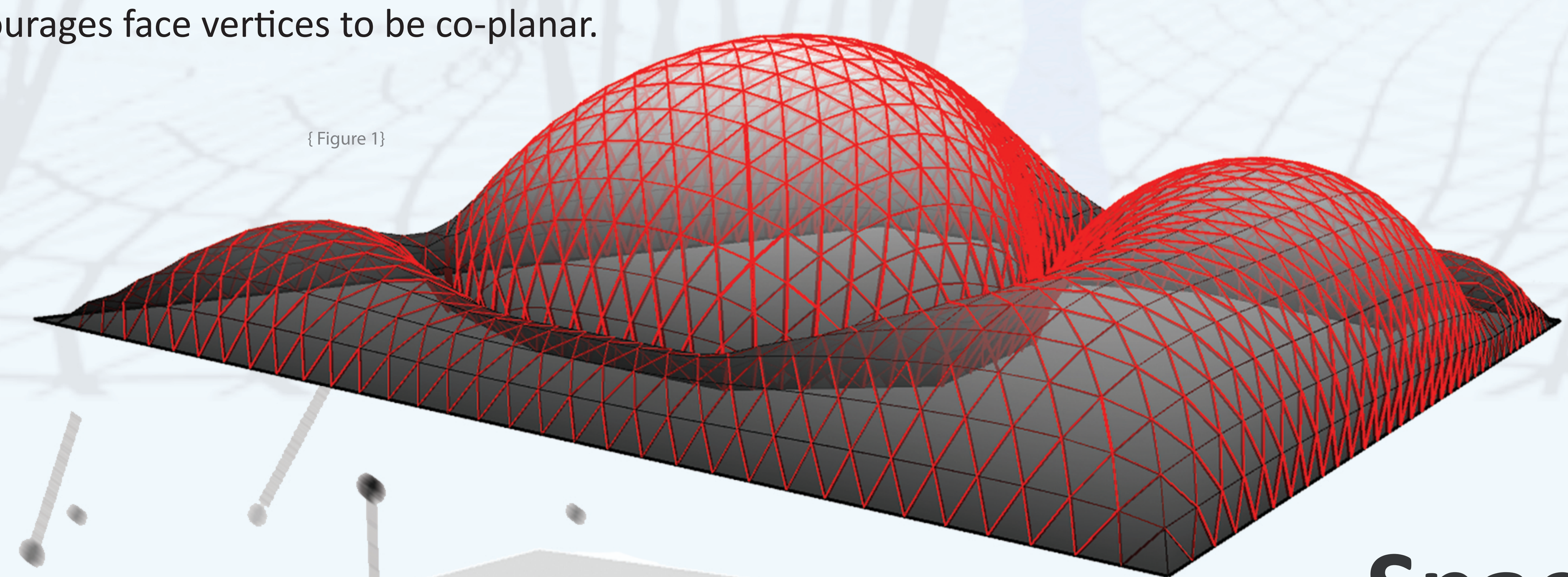
The software was used to design and aid the fabrication of a scale model, which performed well under load testing. Further development in this area could be “pseudo-physical materials”. These are digital materials that can simulate not only physical properties but also behavior not seen in real materials, such as a “stiffness” that encourages face vertices to be co-planar.



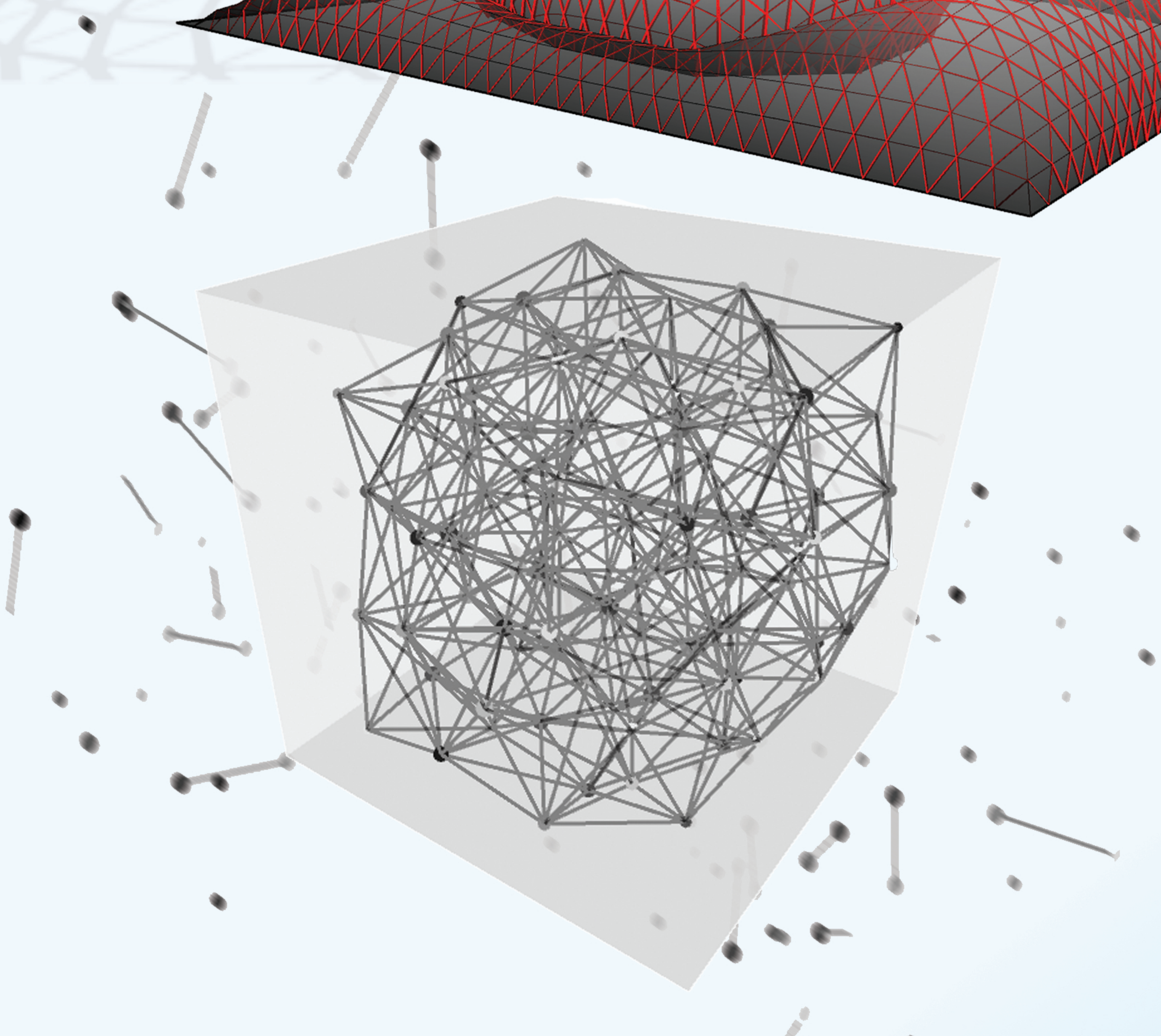
[Figure 2]



[Figure 3]



[Figure 1]



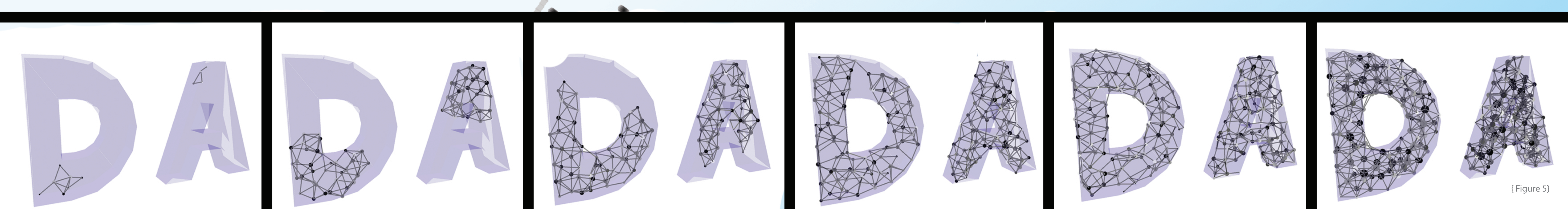
Space-filling particle simulation

This works by producing particles within an imported mesh and, if a particle’s trajectory takes it through a face, bouncing the particle back into the space. Mesh boundaries can be highly complex concave meshes and may include internal spaces that must be avoided by the particles, see figure 5.

The particles will run an adapted form of Delaunay tetrahedralisation to to connect to other particles and create a statically determinant, irregular three-dimensional space frame that respects the boundary conditions. This structure is analysed within the software and various optimisation loops will be tested.

The software will be applied to a live project in partnership with Ramboll Computational Design group and BIG architects - Tallinn city hall.

The simulation and optimisation could be used at a variety of scales - from large civil engineering projects, to furniture design, to ultra lightweight internal structures for parts in the aerospace and automotive industry, right down to the creation of finite-element meshes in digital models.



[Figure 5]