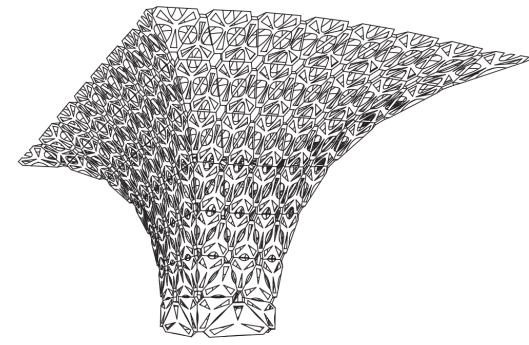
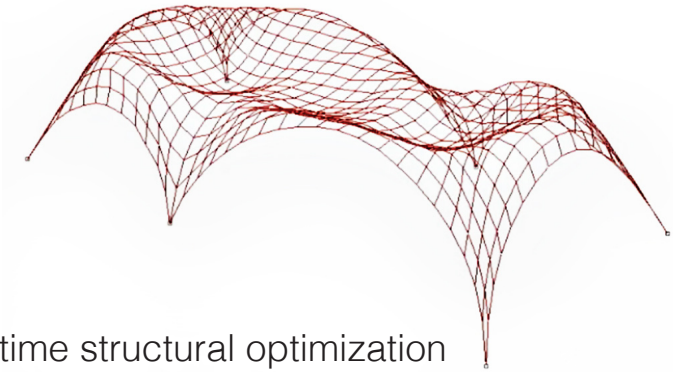


ARK385 - Virtual Tools in a Material Culture

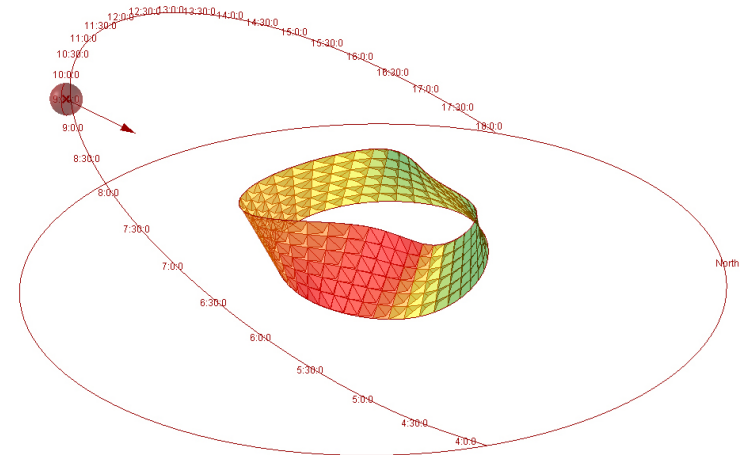
4.5 credit course in
computational design.



Parametric modelling of complex geometries



Integrated real time structural optimization



Integrated real time environmental analysis

Experience from working with Computational design (CD) and BIM at Buro Happold

--Minaret

Fosters and Partners

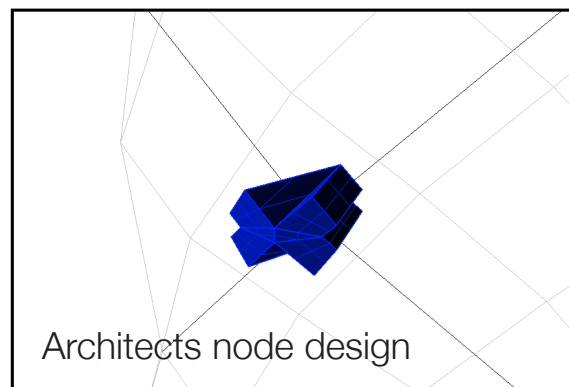
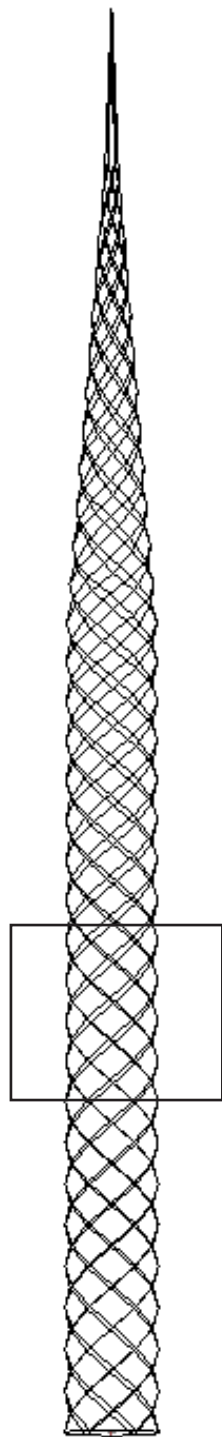
--Glocester gateway service station

Glenn Howells Architects

Minaret

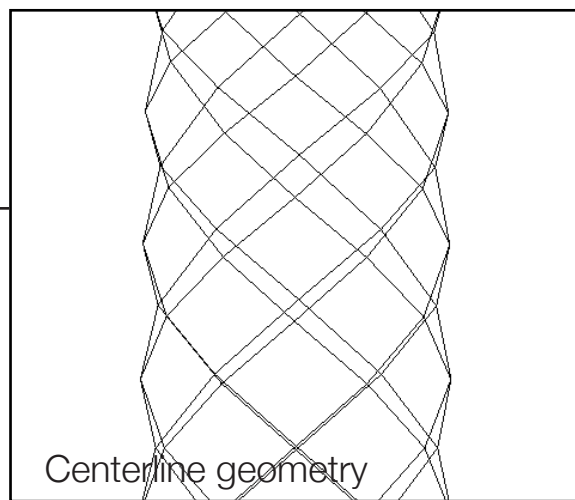
Fosters and Partners





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Autodesk Revit Structure 2011 - [028507-Minareret_Central Modified First.rvt - 3D View: Review]

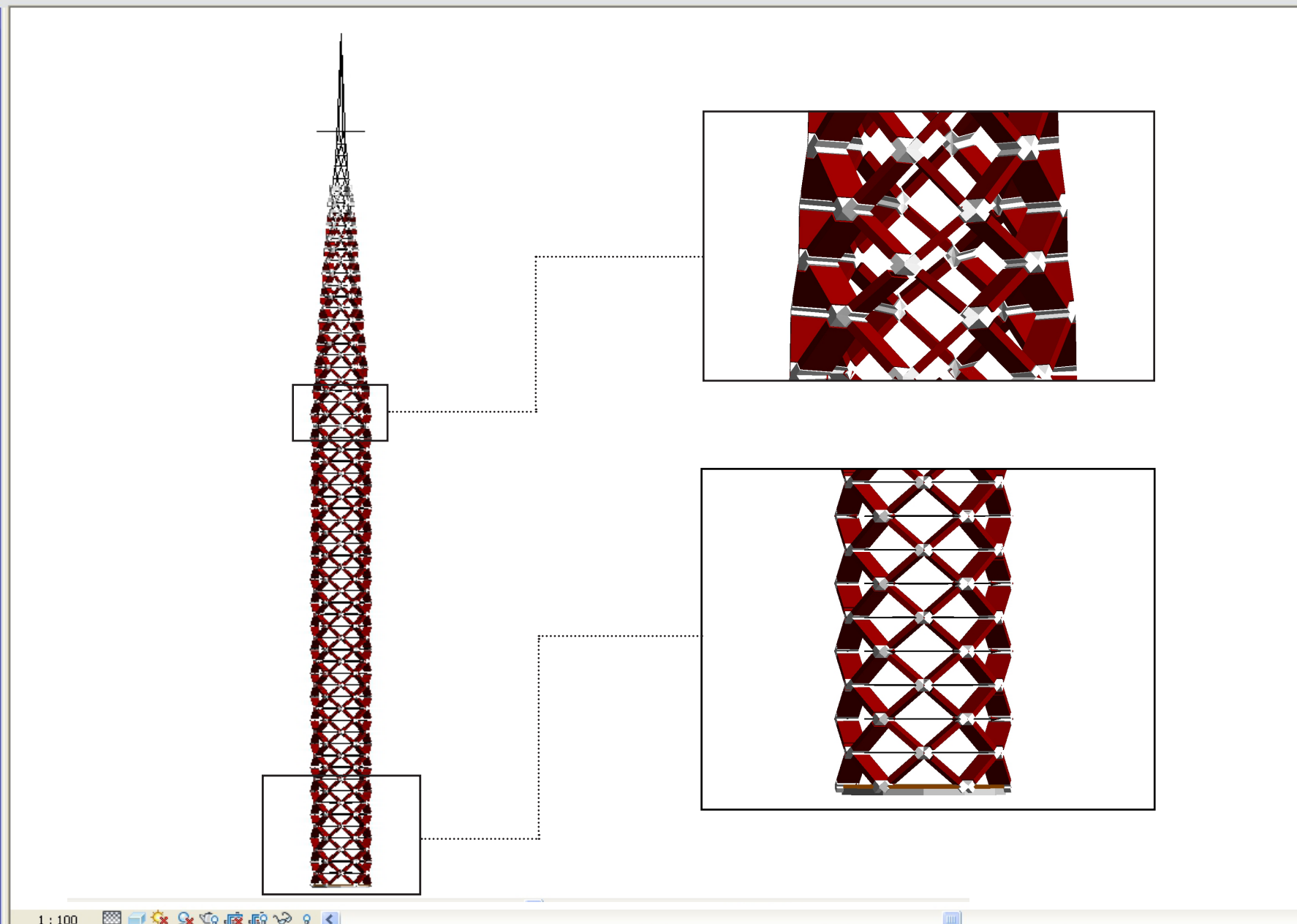
Home Insert Annotate Analyze Architect & Site Collaborate View Manage Add-Ins Modify

Select Modify Beam Wall Column Floor Truss Brace Beam System Isolated Wall Slab Railing Ramp Stairs Component Model Text Model Line Model Group By Face Shaft Wall Vertical Dormer Level Grid Rebar Area Path Cover Set Show Ref Plane Work Plane

028507-Minareret_Central Modified First.rvt - ...

Views (Buro Happold)

- 01. Engineering Review
 - 01. Plans
 - 3D View: 3D SINGLE LINE DIAGRA
 - 3D View: 3D VIEW FRONT ELEVAT
 - 3D View: 3D VIEW LEFT-FRONT
 - 3D View: Review**
 - 02. Plans
 - Structural Plan: Level 0 - Sheet Vie
 - Structural Plan: Level 1
 - Structural Plan: LEVEL 2
 - 03. Elevations
 - Elevation: East
 - Elevation: North
 - Elevation: South
 - Elevation: West
 - 04. Sections
 - Section: Section 3
- 02. Documentation Views
 - 01. 3D
 - 3D View: Cover Sheet
 - 02. Plans
 - Structural Plan: LEVEL 0
 - Structural Plan: LEVEL 1
 - Structural Plan: T1A
 - 03. Elevations
 - Elevation: East - Sheet View
 - Elevation: North - Sheet View
 - Elevation: South - Sheet View
 - Elevation: West - Sheet View
 - 04. Sections
 - Section: Section 4
 - Section: Section 5
- 03. Analytical Views
 - 01. 3D
 - 3D View: Analytical View
 - 02. Plans
 - Structural Plan: Level 0 - Analytica
 - Structural Plan: Level 1 - Analytica
 - 03. Elevations
 - Elevation: East - Analytical View
 - Elevation: North - Analytical View
 - Elevation: South - Analytical View
 - Elevation: West - Analytical View
- 04. Details
 - 01. Concrete
 - 02. Steel



Gloucester gateway service station

Glenn Howells Architects

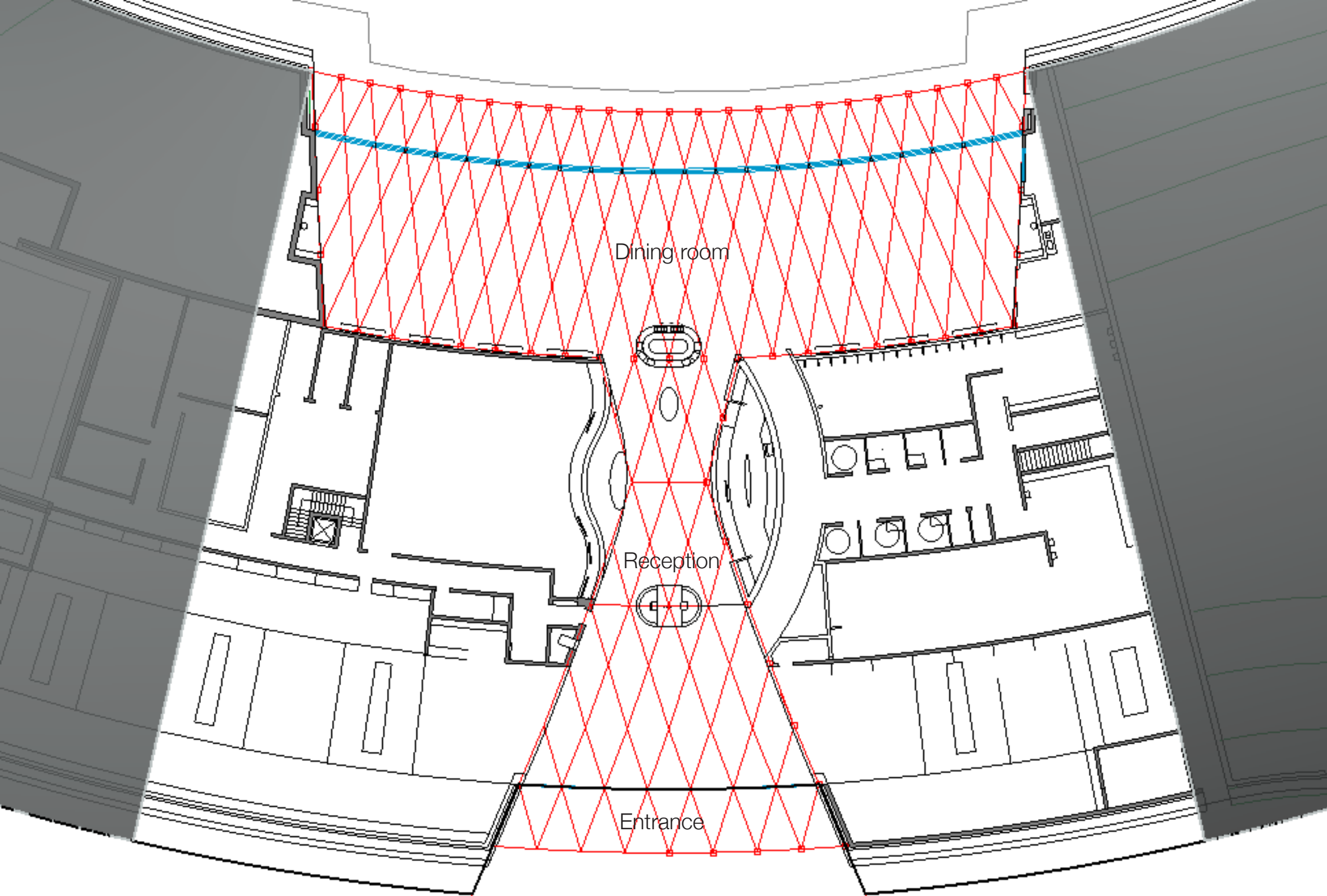
A building woven into the landscape

Exposed timber structure



Architects concept sketch





Dining room

Reception

Entrance

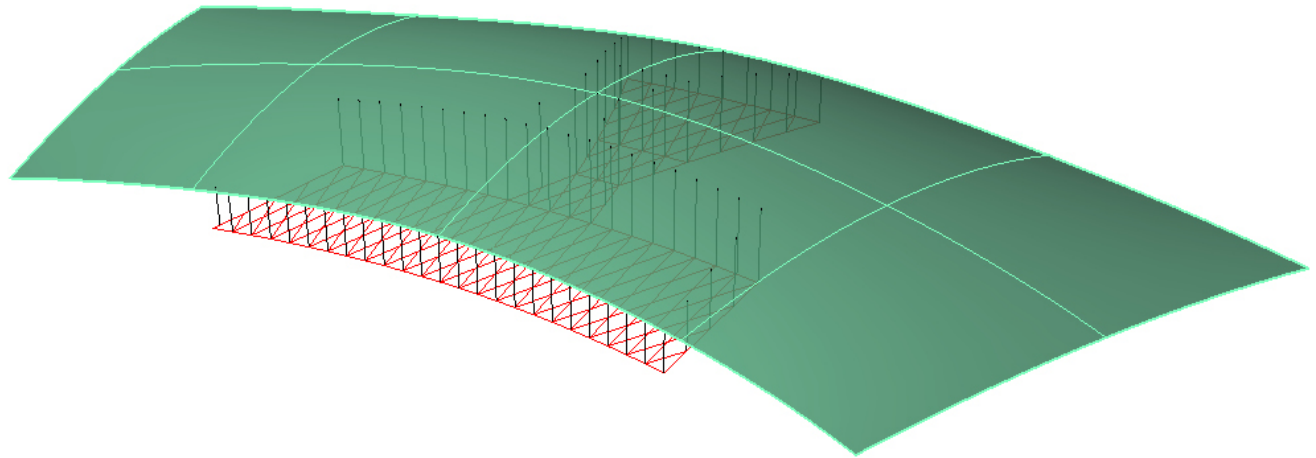
Geometry Inquiry

- How close can the desired form be achieved with:

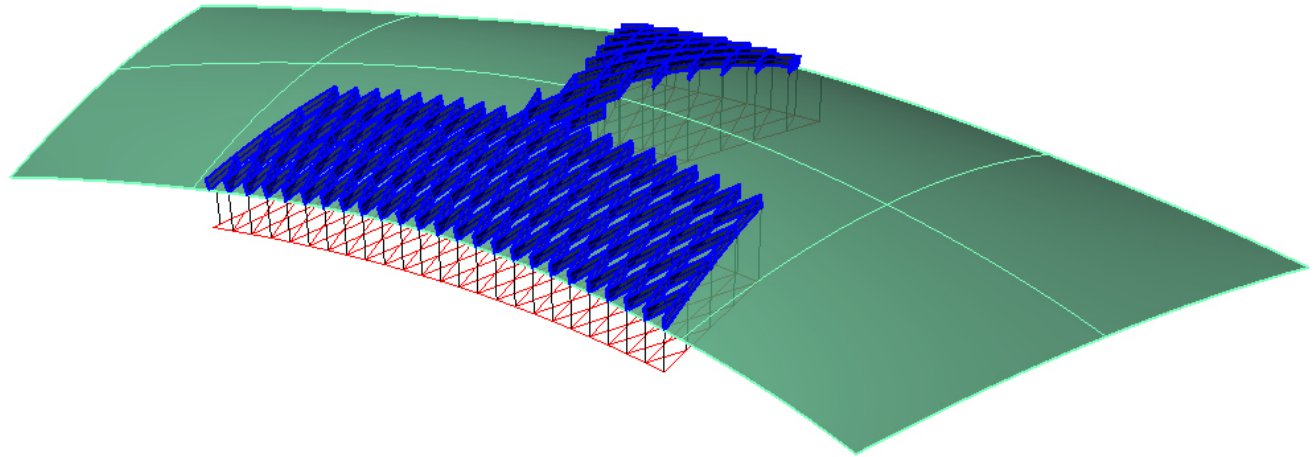
-- Straight beams?

-- Curved beams?

- Can any repetition in the members and connections be achieved?



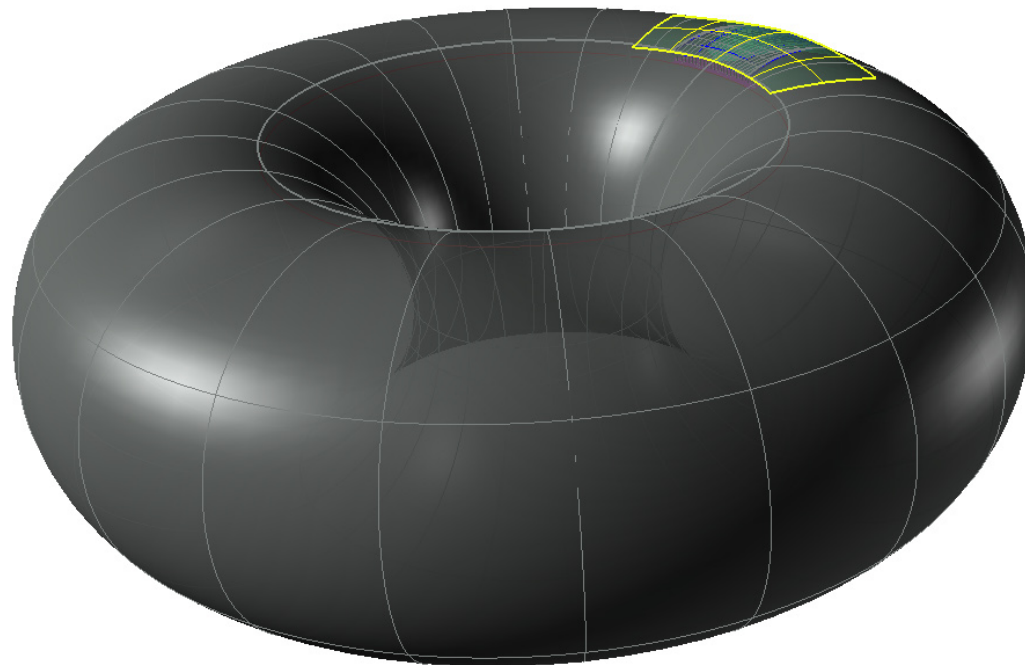
Architects roof surface



Diagrid mapped to the surface

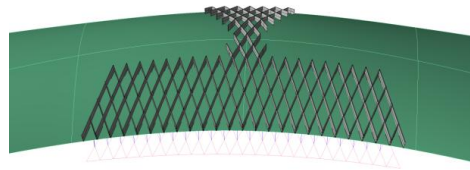


Rationality achieved by mapping the grid on a torus.

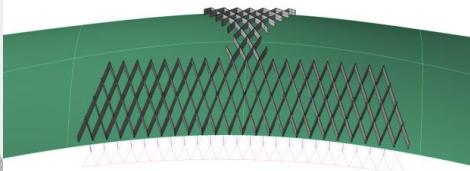


Studies in café zone

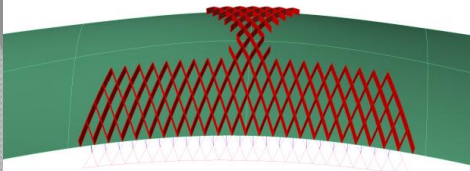
- Fit to GH roof surface
- Fit to torus surface
- Rotated torus section



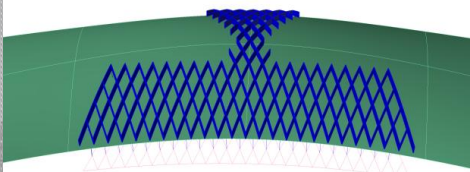
- 01 Straight Beams fitted to GH roof surface



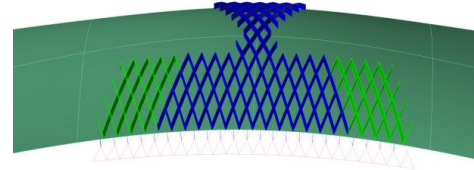
- 02 Straight Beams fitted to the torus surface



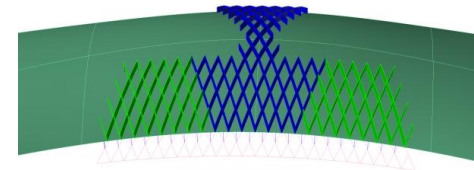
- 03 Curved beams fitted to GH roof surface



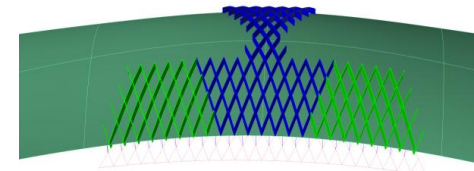
- 04 Curved beams fitted to the torus surface



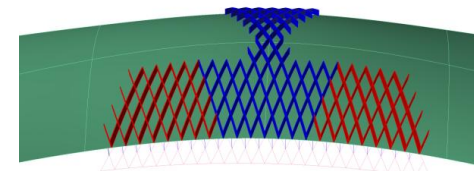
- 05 a) Curved beams fitted to three tori



- 05 b) Curved beams fitted to three tori (change of primary angle)



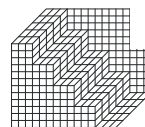
- 05 c) Curved beams fitted to three tori (change of primary angle & additional rotation)



- 06 Curved beams compromise between torus and GH roof surface



SMART

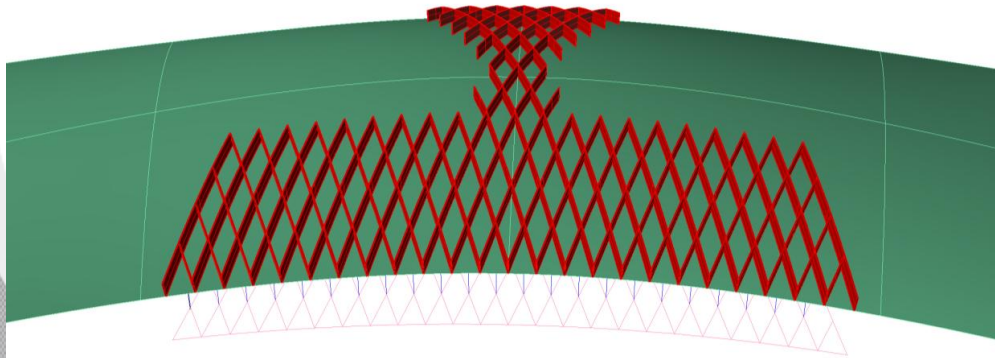


Buro Happold

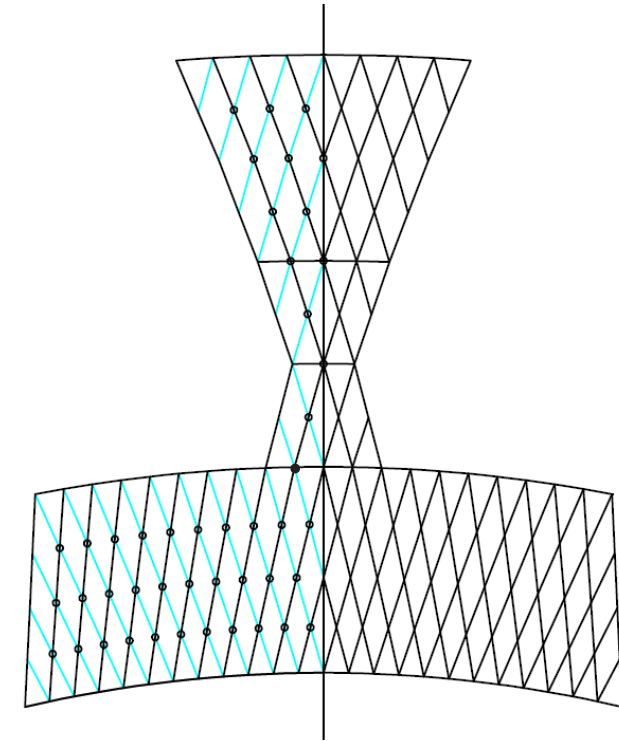
SMART Solutions



Option 03 Curved beams fitted to GH roof surface

The geometry is generated by calculating the average curvature for the GH surface and approximating the primary beams to be circular, all with the same radius. Secondary beams would preferably be approximated with straight elements.



- + All Primary beams in café zone are one section and have the same curvature/radius.
- + Fits the architectural surface well, primary beams deviates in average around 20 mm from the surface. (maximum around 100 mm)
- Curved beams
- Very low level of repetition.
- All secondary beams are unique (half of them mirrored).
- All connections between primary and secondary beams are unique (half of them mirrored)



-  Primary beams
-  Unique secondary beams, connections

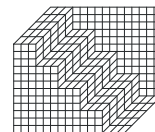
Secondary beams and connections:

Number of beam types: 56
Number of unique beams: 56
Number of connection types: 42
Number of unique connections: 42

(Does only consider the left side of the symmetry line and does not count the nodes on the line.)



SMART

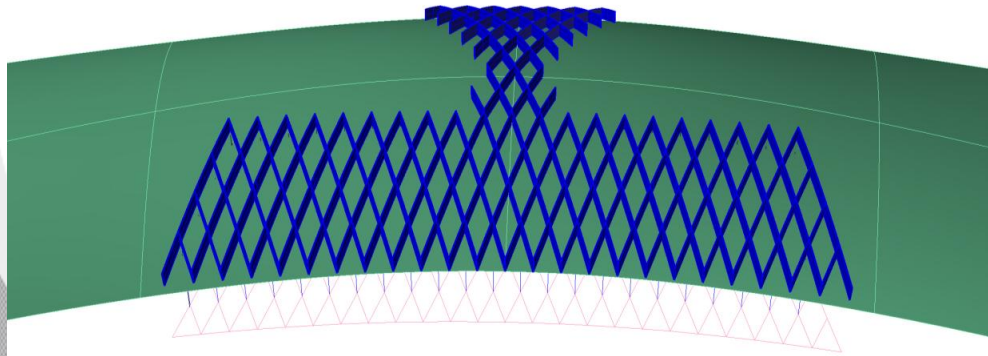


Buro Happold

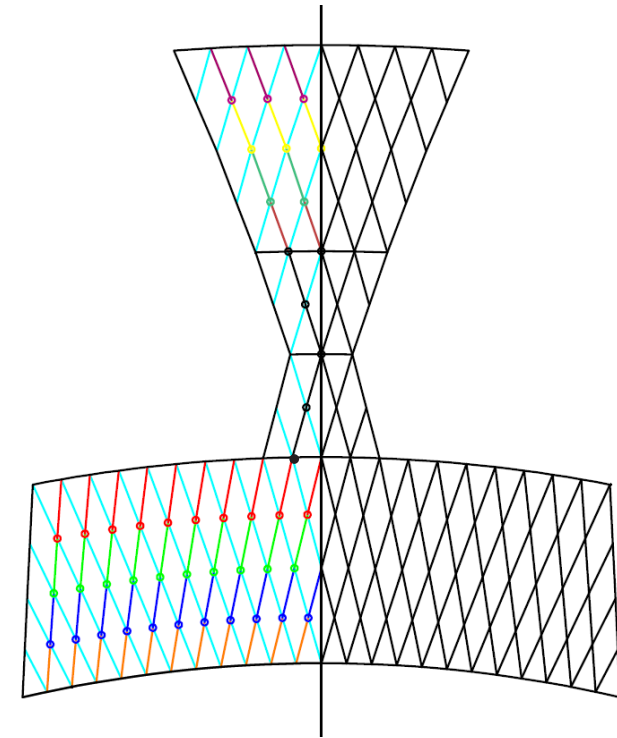
SMART Solutions




Option 04 Curved beams fitted to the torus surface

The geometry is created with the torus as roof surface. Average curvature is calculated as in option 03, but because of the rational geometry a high level of repetition is achieved.



- + All primary beams in the timber zone have the same curvature/radius.
- + High level of repetition in secondary beams, lines of members are identical (half of them mirrored)
- + High level of repetition in connections between primary and secondary beams.
- Does not fit the surface/architectural vision very well towards end walls in café area.



-  Primary beams
-  Unique secondary beams and connections
-  Same colour means same type

Secondary beams and connections:

Number of beam types: 12

Number of unique beams: 4

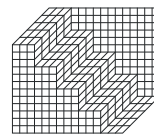
Number of connection types: 10

Number of unique connections: 4

(Does only consider the left side of the symmetry line and does not count the nodes on the line.)



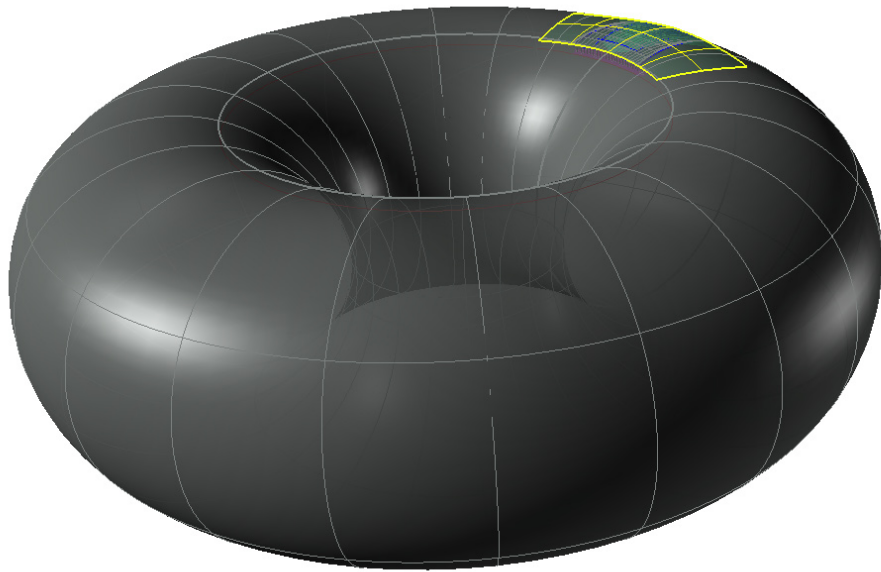
SMART



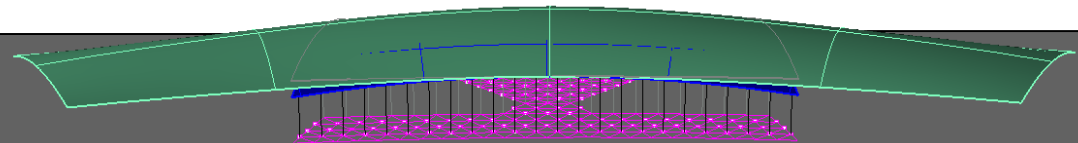
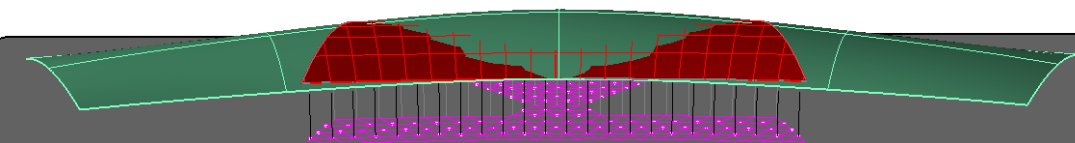
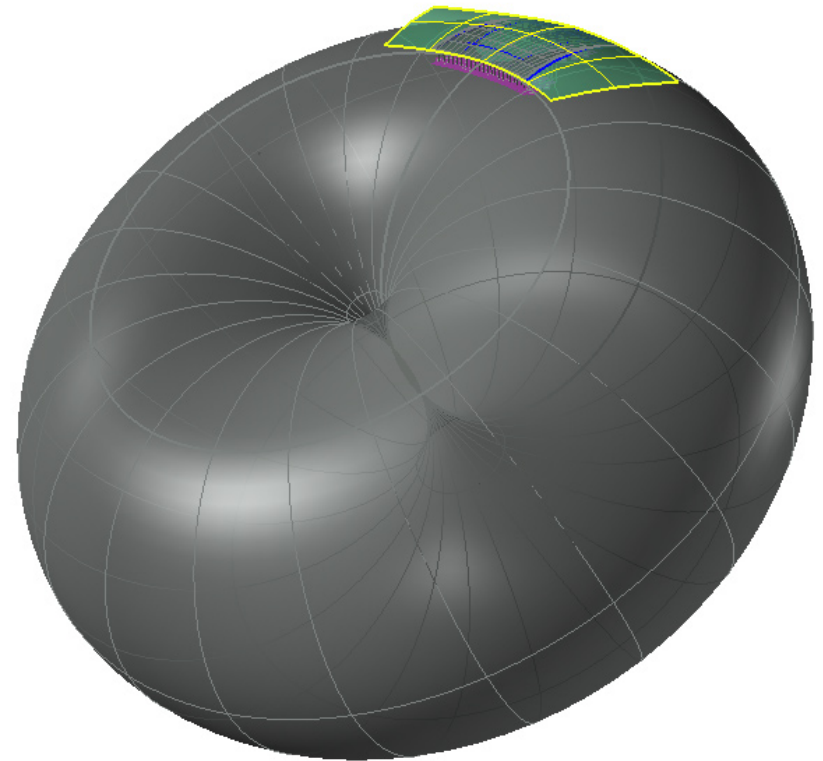
Buro Happold

SMART Solutions

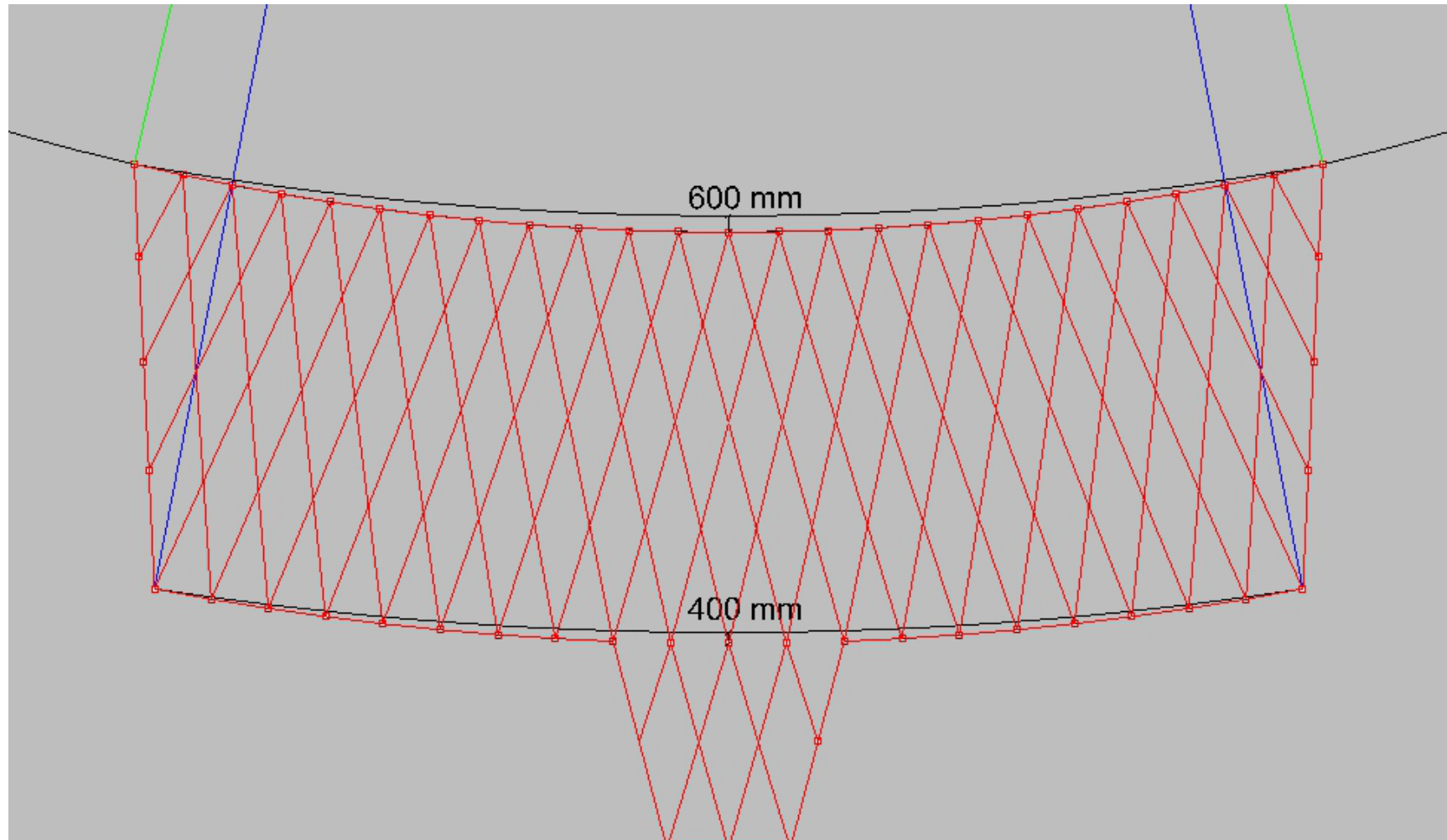
STRAIGHT TOURS



TILTED TOURS



Deviation between plan grid (red) and the projection of the grid mapped on the tilted torus

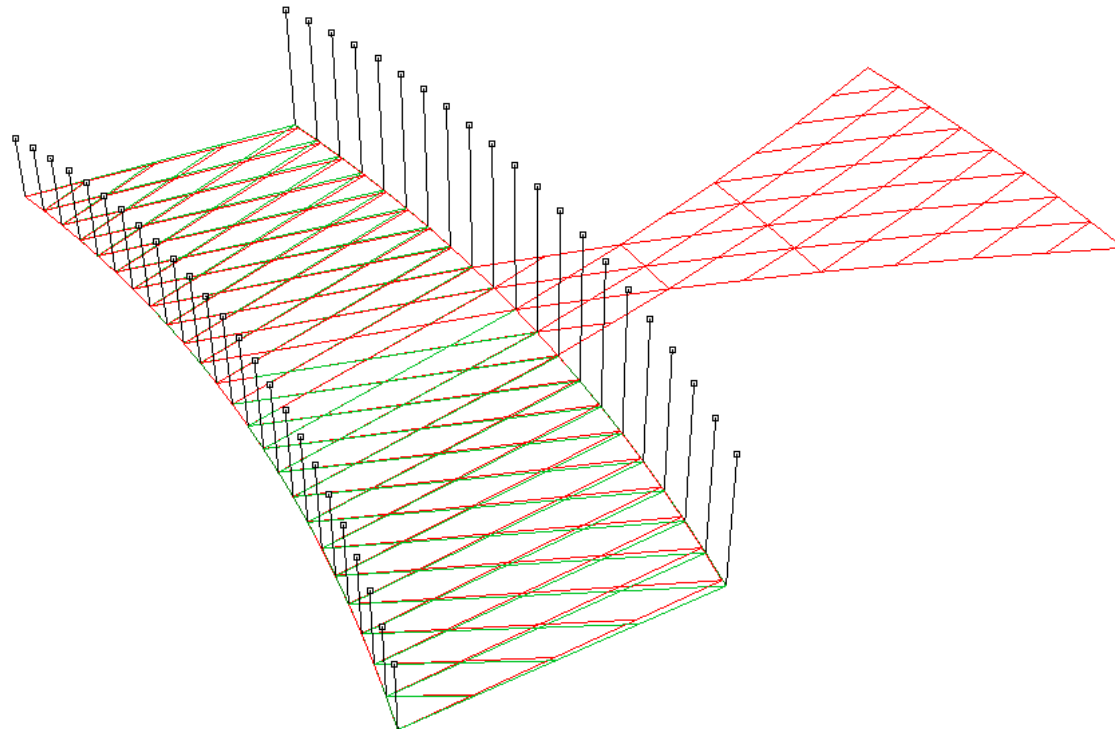


The deviation problem was solved by reversing the algorithm

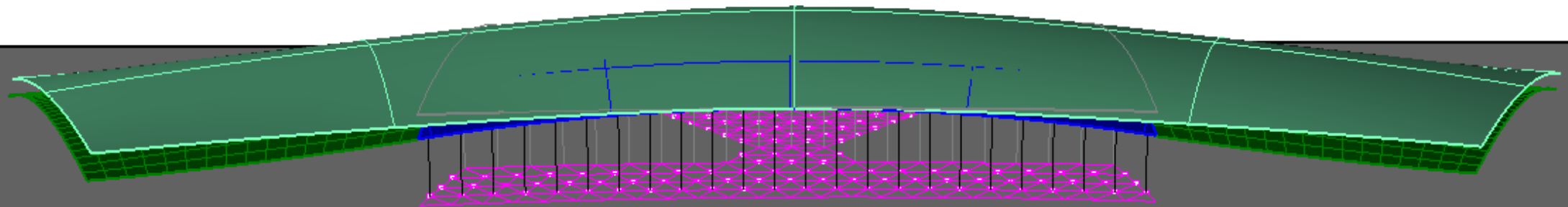
Starting by fitting an ellipse to the initial grid (red)

Generating a tilted circle from that ellipse

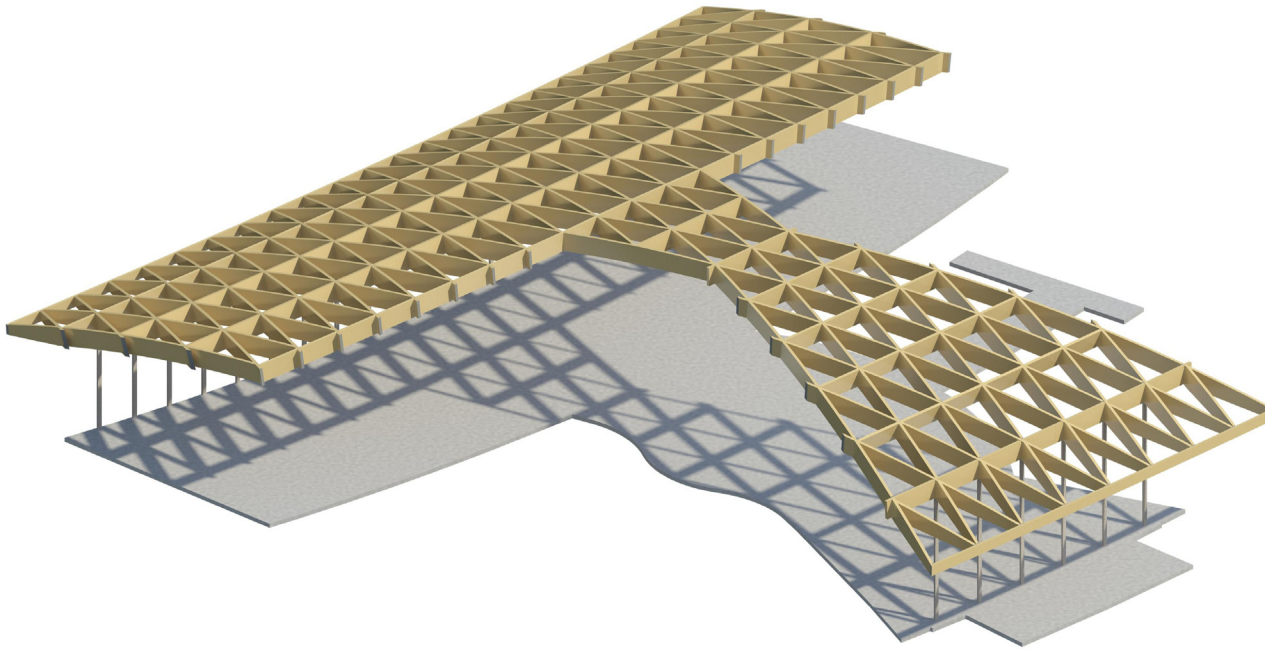
Using that circle to create the torus on which the diagrid structure could be mapped.



Comparison between the architects roof surface and
the surface achieved with the tilted torus



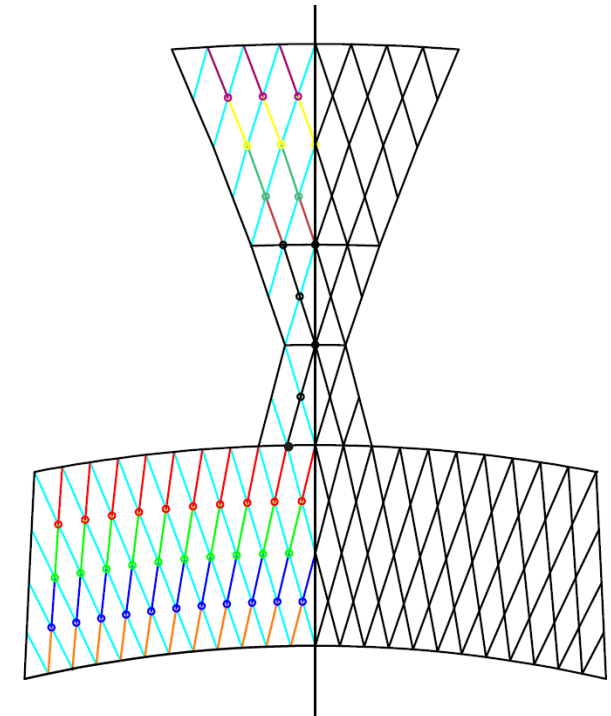
Final geometry imported to Revit






Achieved repetition in secondary beams and connections

Number of beam types: 12

Number of connection types: 10



-  Primary beams
-  Unique secondary beams and connections
-  Same colour means same type



Expectations on **BIM tools, future colleagues** and industry from a computational design perspective.

Expectations on tools

-- Expecting BIM to be a pivot for the design process, including geometry generation, analysis and creation of fabrication/construction manuals.

Expectations on future colleagues

-- To master the tools within their field of specialization leading to a potentially integrated design process.

Expectations on **BIM tools, future colleagues** and industry from a computational design perspective.

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-- Expecting BIM to be a pivot for the design process, including geometry generation, analysis and creation of fabrication/construction manuals.

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-- To utilize these possibilities to conduct innovative and smart sustainable design.

Expectations on **BIM tools, future colleagues** and industry from a computational design perspective.

Expectations on tools

Expectations on future colleagues

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-- Expecting total integration between modelling and analysis, closing the otherwise slow iterative loop between designers and engineers.	-- Good cross-disciplinary understanding and communication providing for an integrated design process.

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-- Expecting new ways of communicating detailed design throughout the construction process (3d drawings?)	-- Expecting future colleagues in the construction industry to adapt new technology to fully utilize the power of BIM.

Expectations on **BIM tools, future colleagues** and industry from a computational design perspective.

Expectations on tools

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-- Expecting new ways of communicating detailed design throughout the construction process (3d drawings?)	-- Expecting future colleagues in the construction industry to adapt new technology to fully utilize the power of BIM.
-- Expecting a well developed SDK/API enabling designers to write their own bespoke tools.	-- Expecting future colleagues to take the overhand over the computer (as our probably most influential design tool) and start using it efficiently (not only as a digital drawing board)