AUTODESK UNIVERSITY

Digital Fabrication Journey

From Rhino, to Revit, to CADWork and back!

Tareq Qassrawi

Senior Manger | Digital Delivery

Radu-Ionut Boeriu

Architect BIM & Design System Manager (Technical)

Bettina Baggenstos

VDC | BIM | Sustainability

Tareq Qassrawi
Sr. Manger | Digital Delivery

Tareq currently working as Sr. Digital Delivery Manger at The Red Sea Development Company In KSA, with 10+ years of extensive experience supporting and leading the implementation of digital delivery processes across The Red Sea's projects, developing content, effectively leveraging emerging technologies and building company-wide support behind strategic improvement initiatives. This process includes CDE evaluation, BIM implementation (Processes & Softwares), and data management.

Prior to joining The Red Sea, Tareq worked with different consultants in the AEC field known for championing and instituting best practice standards saving tens of thousands hours in unnecessary or poorly timed investments in hardware, software, staff, and training.

Tareq graduated with a Bachelor's degree in Structural Engineering and so closed to obtain the MSc. degree in the same field.

Radu-Ionut Boeriu

Associate Partner / Architect BIM & Design System Manager

Radu Ionut Boeriu studied Architecture at the University of Architecture and Urbanism *"Ion Mincu"* in Bucharest graduating with distinction in 2009. While still in University, Radu started working for Epstein Architecture & Engineering, a global company with the headquarter in Chicago, but with several office around the world. He joined Foster + Partners in 2015 and brought with him a wealth experience including commercial, transportation, high-rise buildings, medical and industrial projects. He was made a BIM & Design System Manager (Technical) in 2017 and has been taking new challenges and engaged into a companywide BIM Strategy designed to put Foster + Partners in a global forefront position when it comes to BIM adoption, leading the effort around Standards, Methods and Procedures by working on a wide spectrum of studio's and internal research projects.

Bettina Baggenstos

VDC | BIM | Sustainability
at Blumer Lehmann AG

Bettina is originally from Switzerland where she did her studies of Architecture at ETH Zurich. In her Masters at BFH she specialized in timber construction and worked part-time at Renggli International, a timber construction company.

After graduating Bettina took her job at Blumer Lehmann where she is working on several internal projects to further digitize the internal as well as external collaboration processes.

Passionate for sustainability, Bettina also established a system for quantifying the ecological impact of different options in the planning stage to assist a well-informed decision making for the clients.

As BIM manager in the Red Sea projects and other national and international projects, Bettina works closely with the clients and project managers to make sure the information can be exchanged as desired.

Agenda

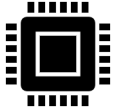
- Topic 1: **Planning staging and implementation**
- Topic 2: **Design process**
- Topic 3: **Fabrication and the assembly process**
- Summary
- Q&A


The Red Sea
Development
Company

Key Learning Objectives

After this class you will be able to...

Learn about deploying BIM 360 as an asset owner to work collaboratively and efficiently with all appointed consultants/contractors



Learn about digitally collaborating with consultants and contractors on achieving your goals for off-site manufacturing

Discover the best practice for the Interoperability between Revit, Rhino, and cad work.

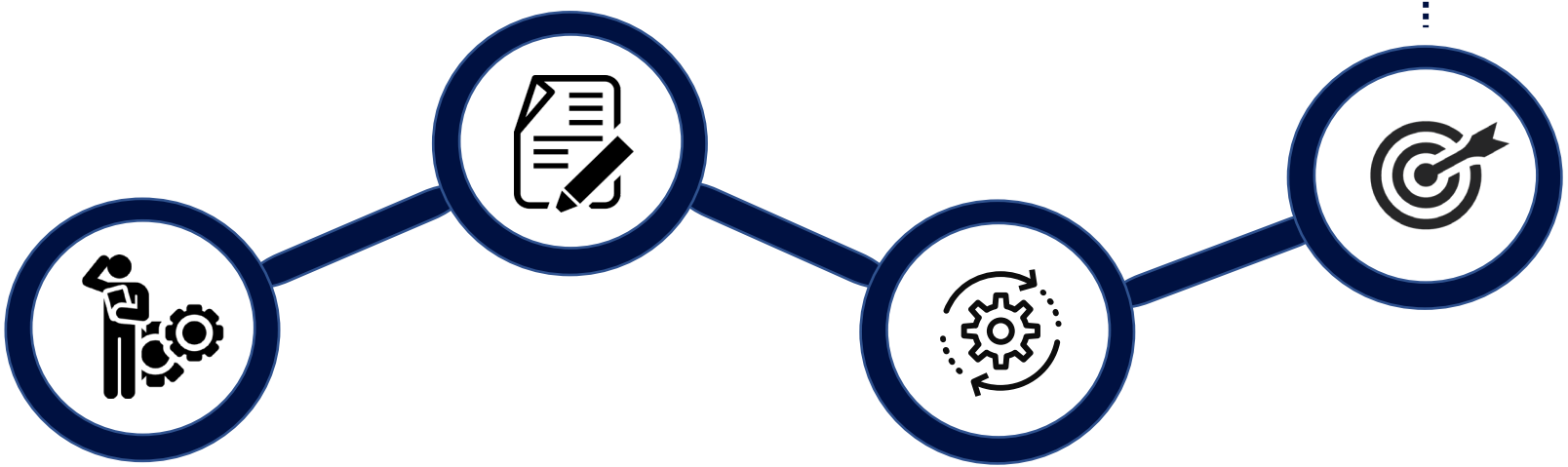
Discover the critical QA/QC steps required to optimize the Interoperability.

Interoperability

The ability of diverse systems (and organizations) to work together seamlessly without Data loss and without a special effort. Interoperability may refer to systems, processes, file formats, etc. Interoperability is not synonymous with openness.

https://bimdictionary.com/en/interoperability/1

Solution Approach - 4 Steps



2 Plan
to implement the processes

4 Execute
the requirements in the CapEx phase

1 Understand
The project circumstances

3 Implement
centralized source of information

Step 1 - Understand

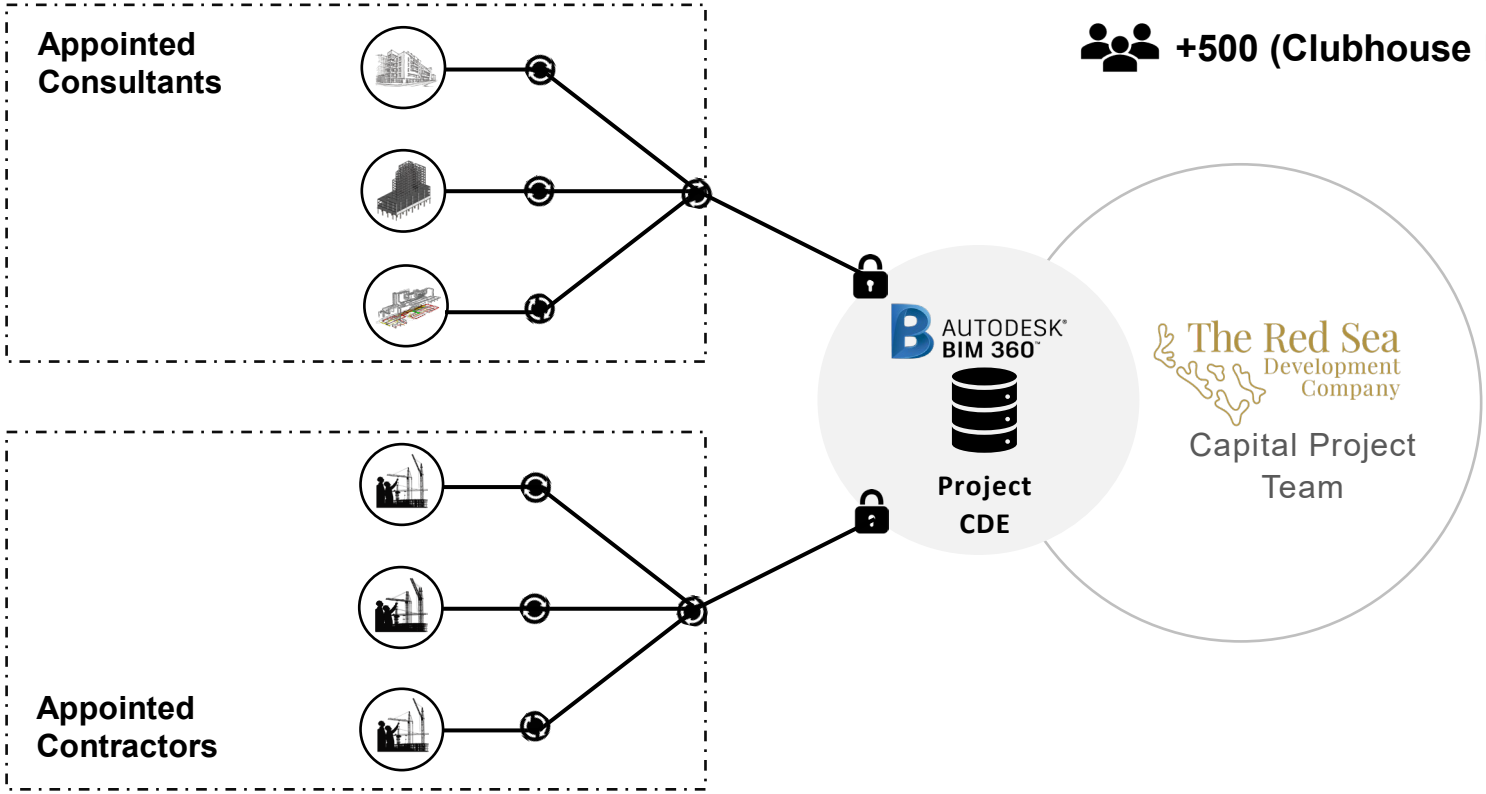
1 **U**nderstand

The project circumstances

1 Procurement Strategy

+3400 (Total Active users)

+500 (Clubhouse Project)



1 Consultants Offices

The Red Sea Development Company

1 Project location

16
Hotels

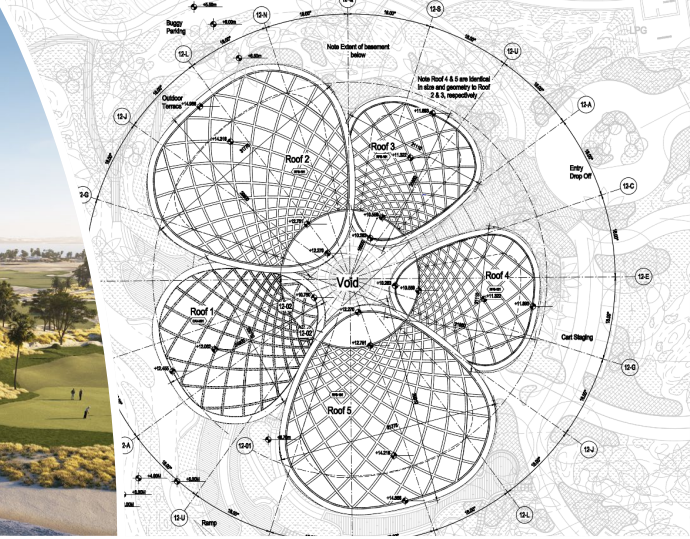
3,000
Keys

~300,000
Visitors

Shura Island

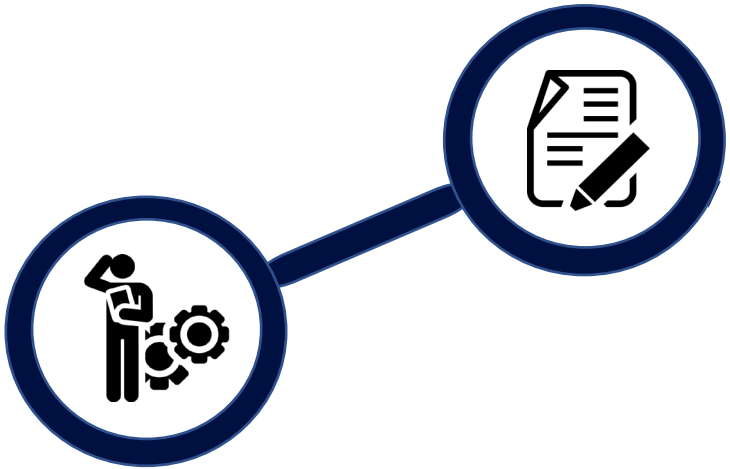
1 Project Brief

The clubhouse is the architecture landmark for the golf course, and it’s located on a prominent location where it’s visible from numerous hotels, the design is sympathetic to the environment and organic in form.



Step 2 - Plan

2 **Plan**
to implement the processes



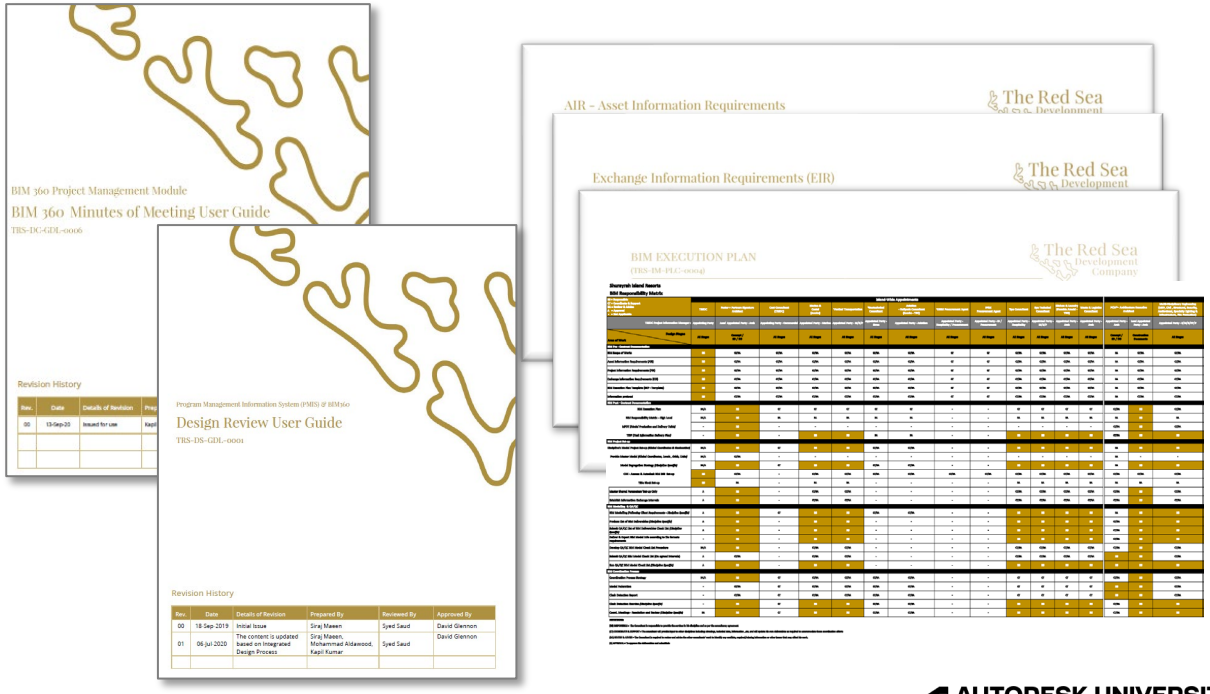
1 **Understand**
The project circumstances

2 Communication Protocols

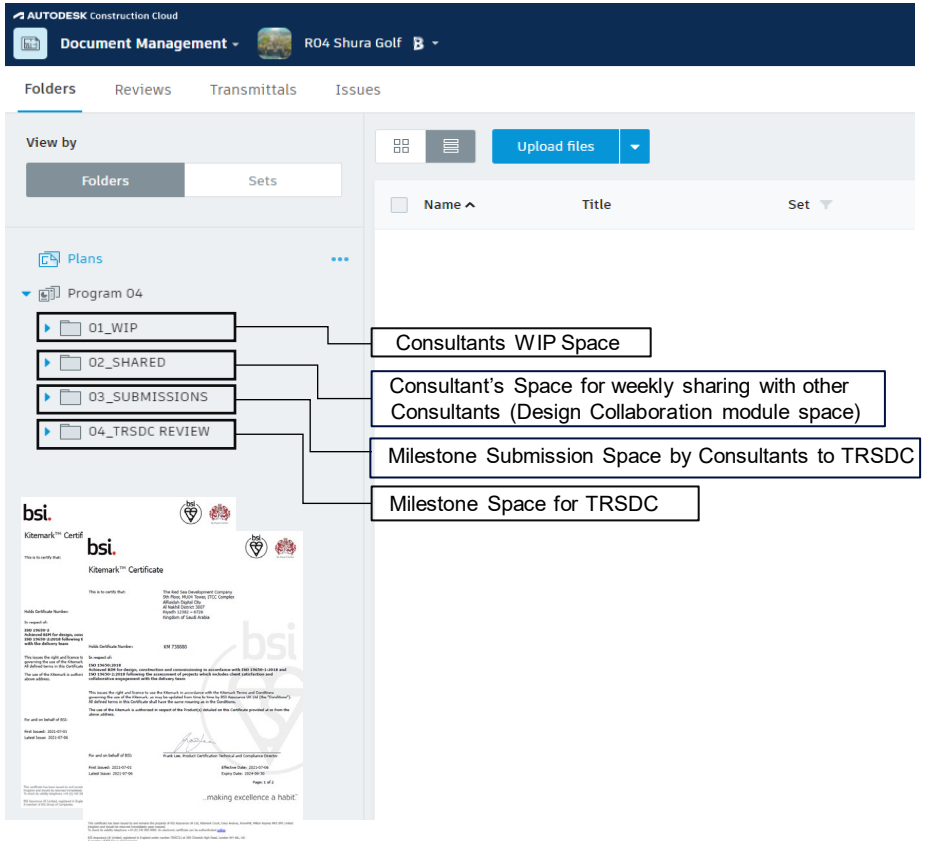
The Red Sea Development Company

BIM Requirements

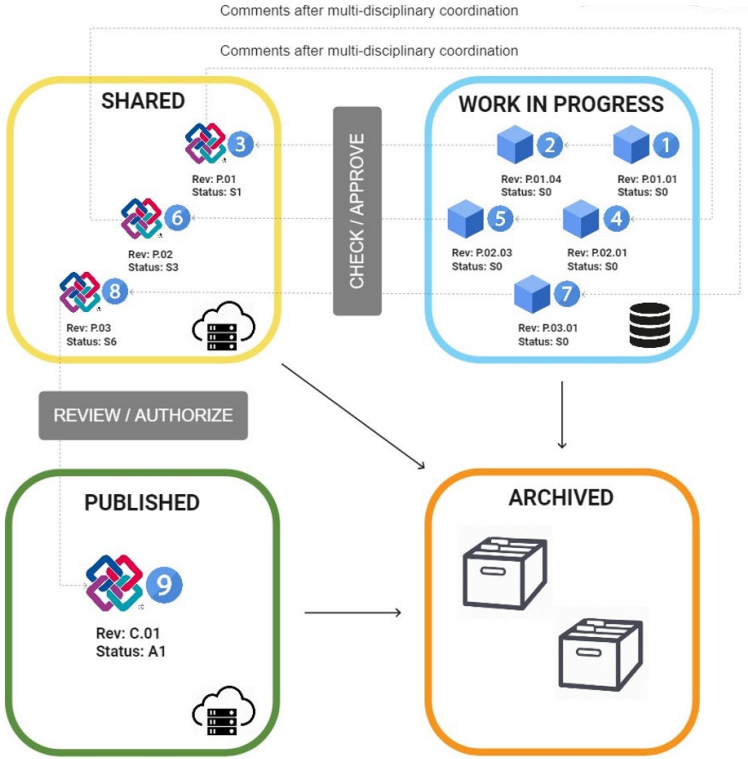
Digital Delivery Team, BIM Managers, GIS and Information Managers, have accomplished ISO-19650 certification.



2 BIM 360 Setup



ISO-19650 Compliance



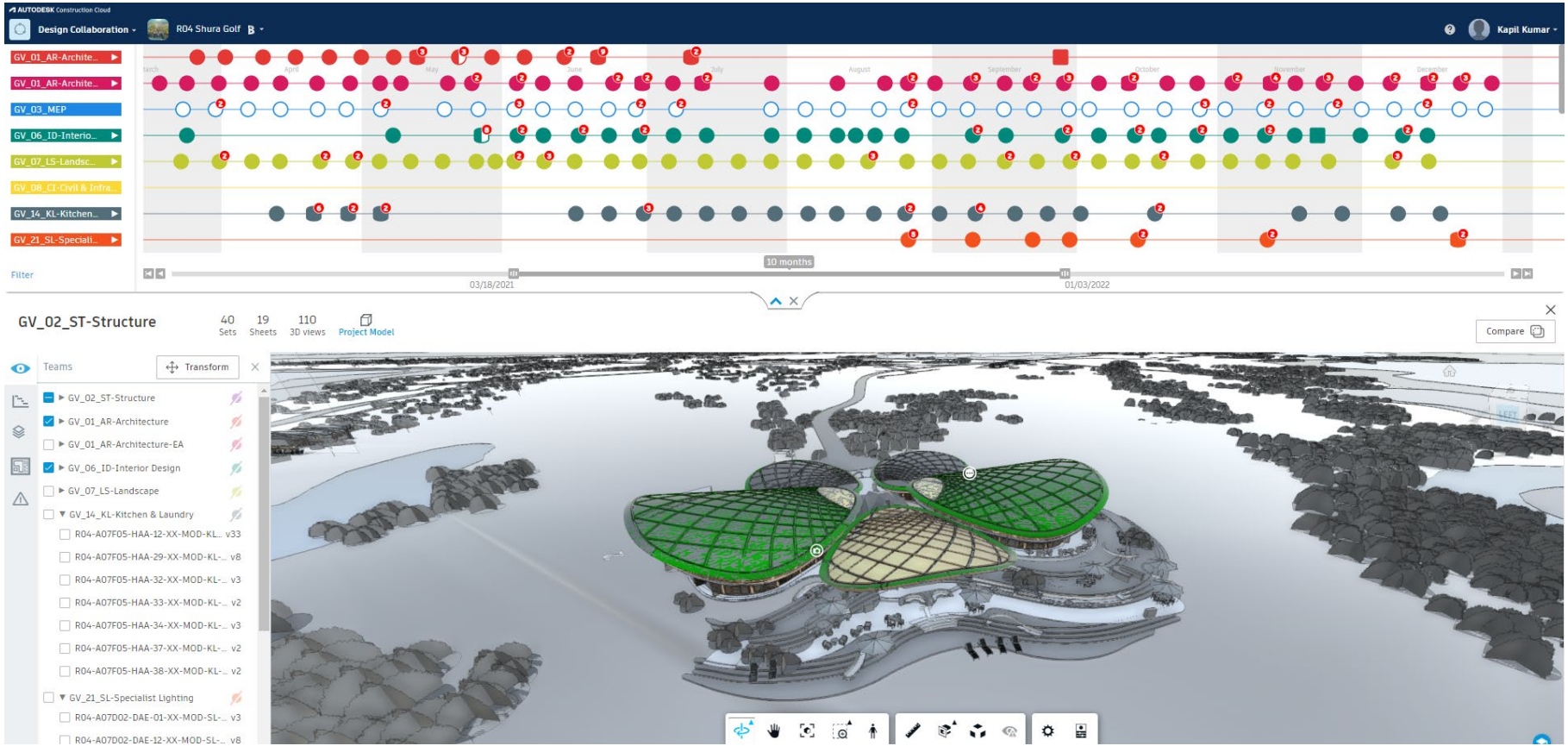
Step 3 - Implement

2 **Plan**
to implement the processes

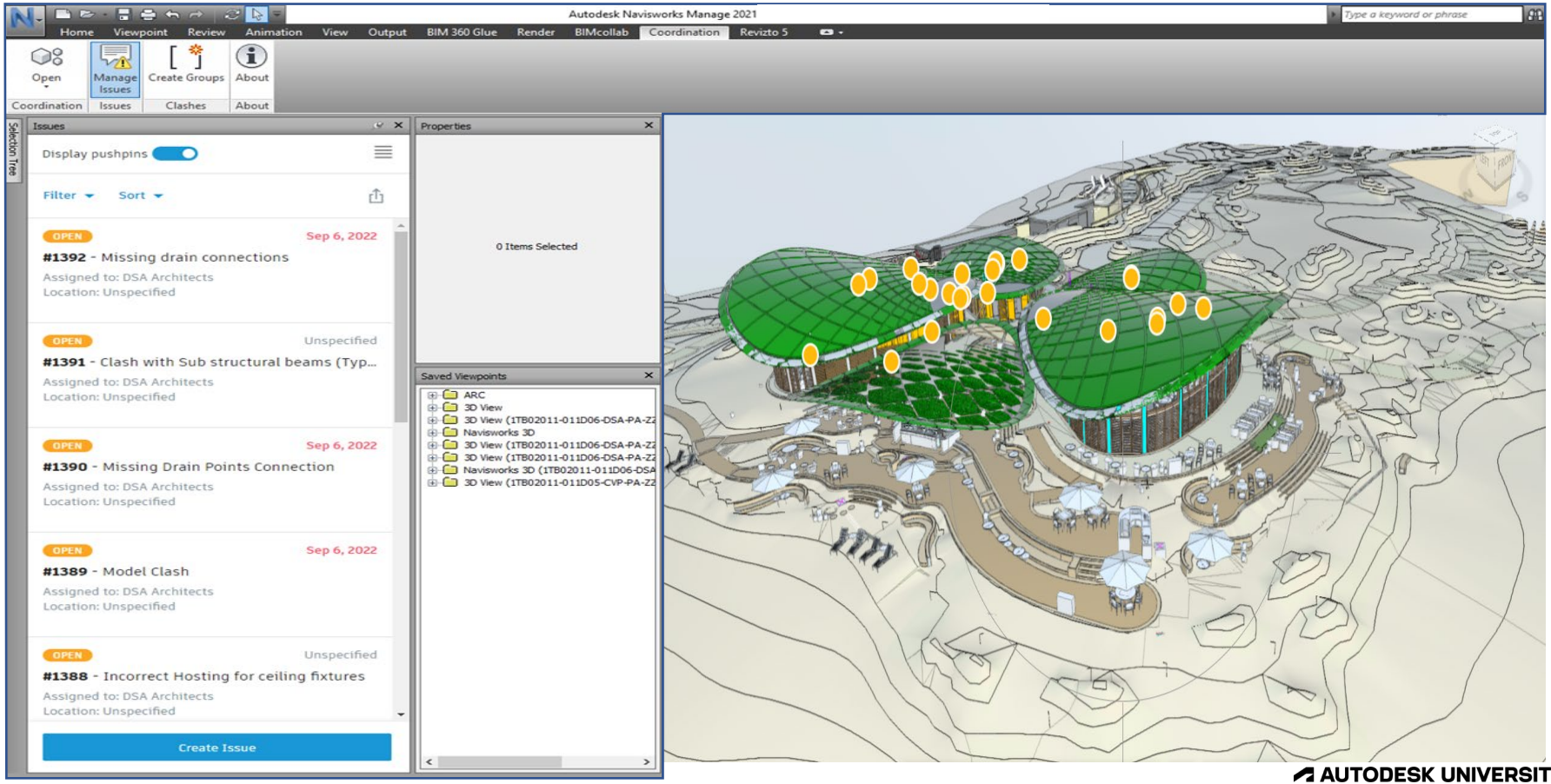
1 **Understand**
The project circumstances

3 **Implement**
centralized source of information

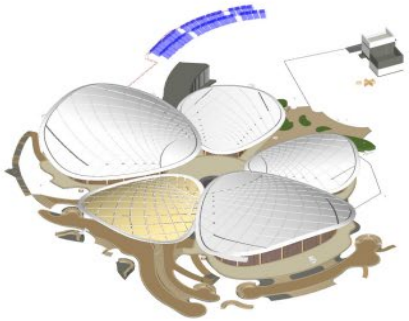
3 BIM 360 Design Collaboration



3 BIM360's Issues interface with Navisworks

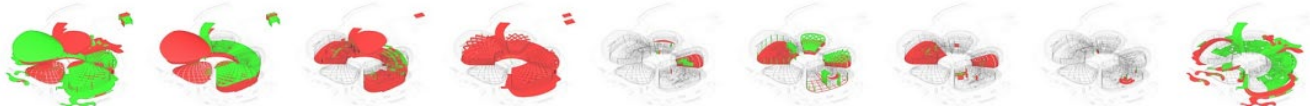


3 Coordination Progress

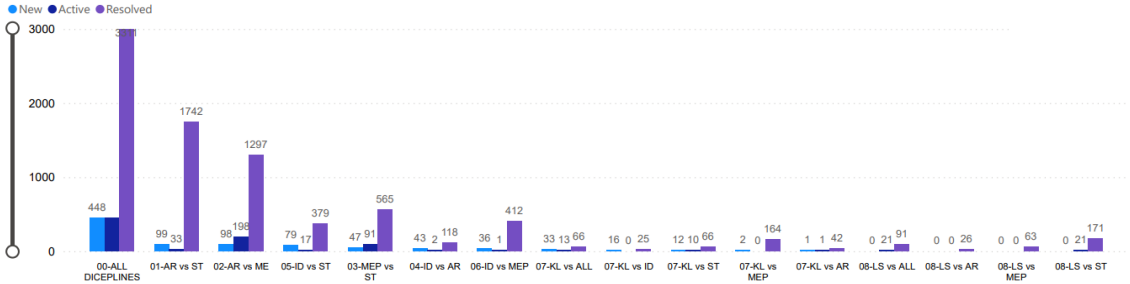


DATE	TOTAL CLASHES
00-2021/05/06	1592
01-2021/05/20	1654
02-2021/06/03	2259
03-2021/06/10	2020
04-2021/06/24	1646
05-2021/07/01	1105
06-2021/07/06	793
07-2021/07/15	894
08-2021/07/22	868
09-2021/07/29	820
10-2021/08/05	834
11-2021/08/16	703
12-2021/08/19	895

20000-Clubhouse



TOTAL CLASH NUMBER



3 BIM 360 utilization Statistics

4T

Data Shared

Total size of all deliverables from all consultants

200+

Shared Packages

Between all consultants utilizing the design collaboration module

10

Team space

For each discipline in the collaboration module

1900

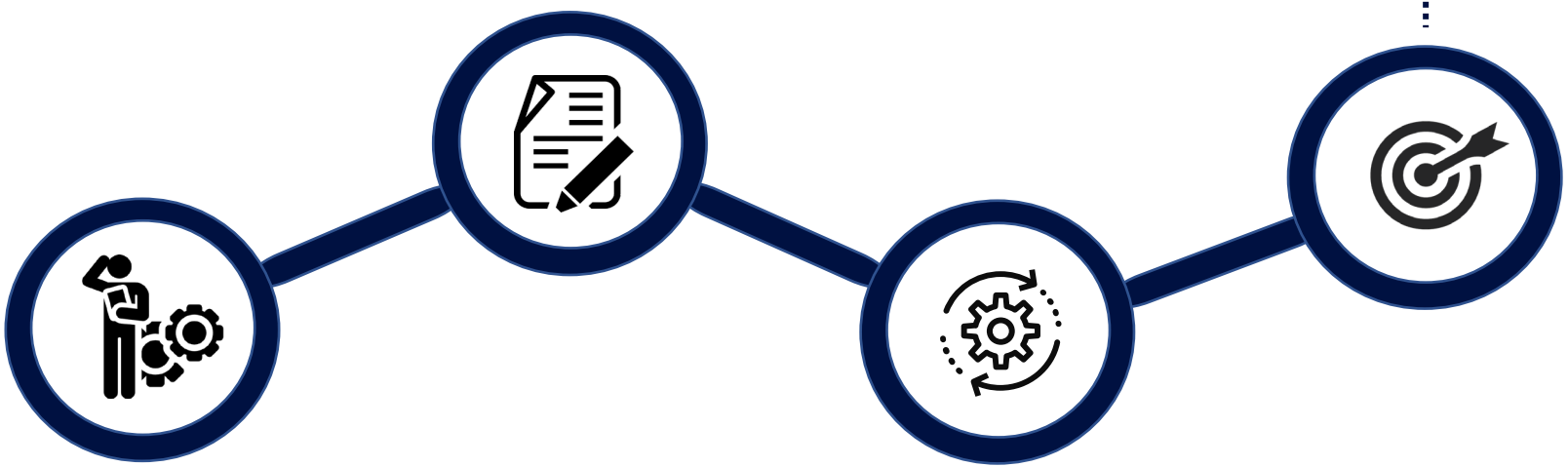
Coordination Issues

Assigned to the appointed consultants /contractors

Step 4 - Execute

2 **Plan**
to implement the processes

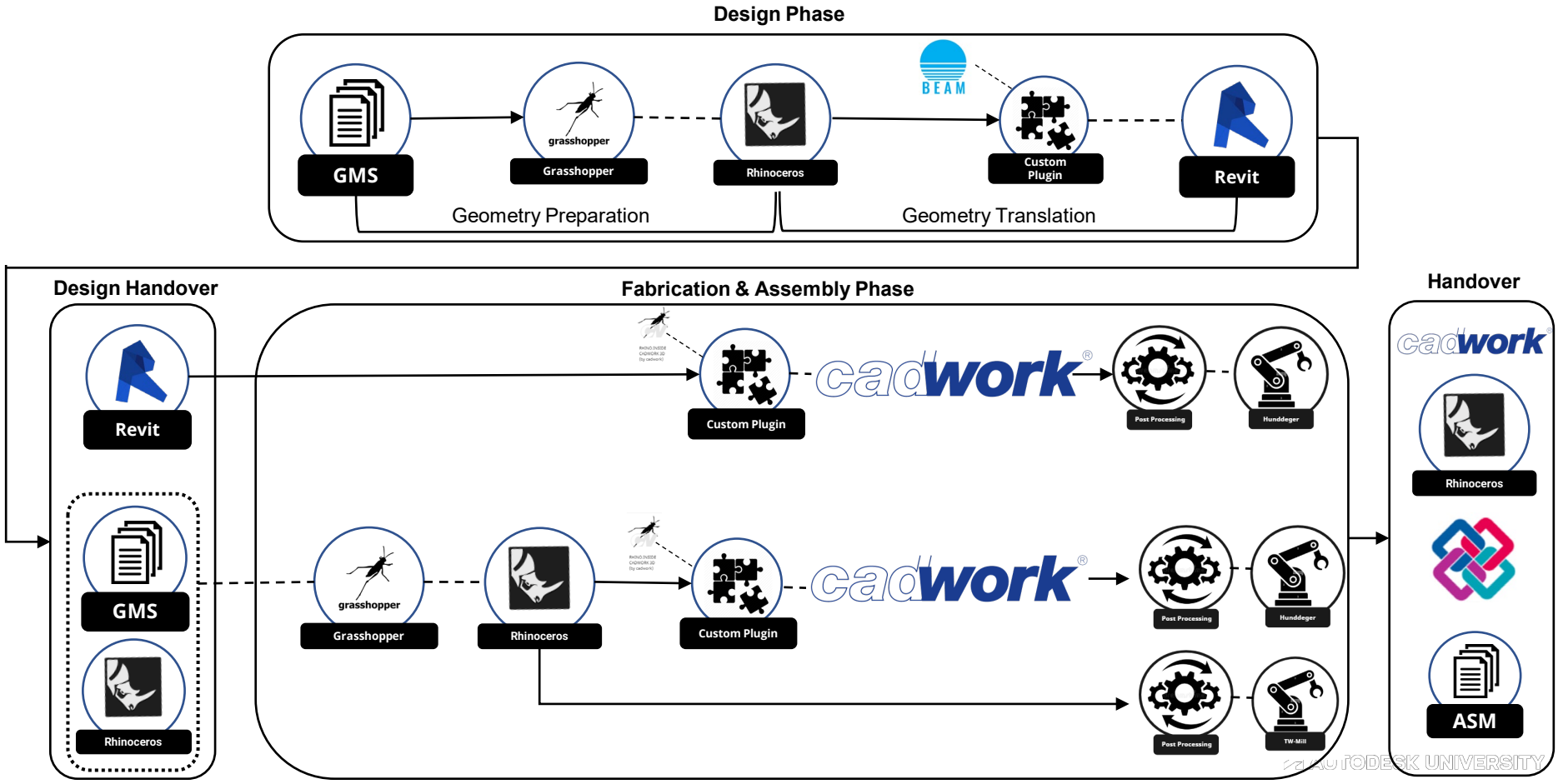
4 **Execute**
the requirements in the CapEx phase



1 **Understand**
The project circumstances

3 **Implement**
centralized source of information

4 Execution workflow



Execute

Used Software

- Autodesk Revit 2019
  - BEAM – Plugin
  - https://www.mksdtech.com/?gclid=CjwKCAjw3qGYBhBSEiwAcnTRLltC3hrn20x3TbiwW43aDFYk9Ktj5lOhl8oGH_L0_0me8RFu5mOythoCZ0UQAvD_BwE
- Autodesk Navisworks Manage 2019
  - Navisworks® Coordination Issues Add-In
  - https://apps.autodesk.com/NAVIS/en/Detail/Index?id=5155805354033590972&appLang=en&os=Win64
- Rhino 7
- Cadwork 29
  - RHINO.INSIDE CADWORK 3D (by cadwork)-Plugin
  - https://www.food4rhino.com/en/app/rhinoinside-cadwork-3d

Design - Sketching

Roof Evolution

The Concept Vision

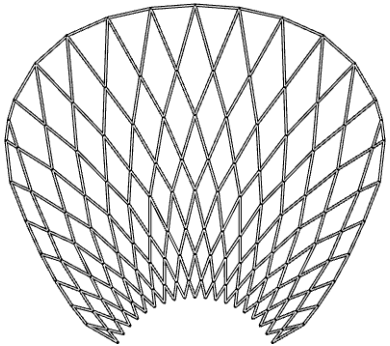
The Clubhouse is located in the middle of the island, which makes it one of the most perceptible building on Shura Island. The vision around the Clubhouse is in line with the overall Coral Bloom vision, which is tailored around creating a truly barefoot experience.

Being the in heart of the Golf Course the Clubhouse is welcoming guest from every direction with is glass translucent façade over which the double curvature roof floats.

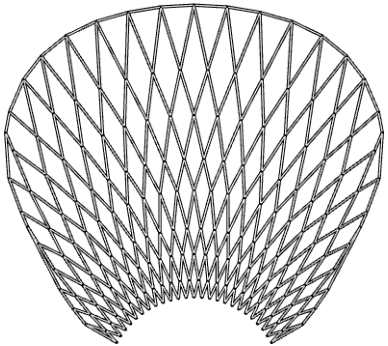
Structural Rationalization

- The initial design was not structurally possible. Several design iteration were studied to achieve the desired shape, but ultimately the shape had to go through several structural rationalization exercises.

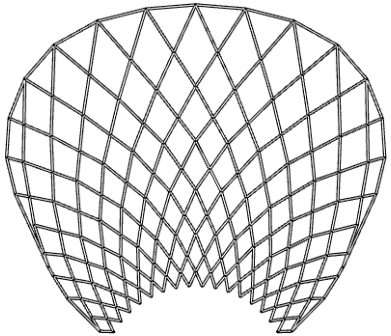
- The structural rationalization focused on two aspects:
  - The Surface – reduce the number of nodes whilst still maintaining the overall shape
  - The Edge – maintain the edge as per the design intent



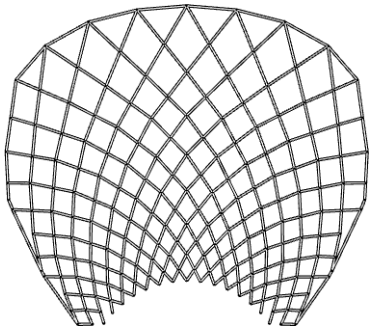
Circumferential:18, Radial: 4



Circumferential:24, Radial: 4



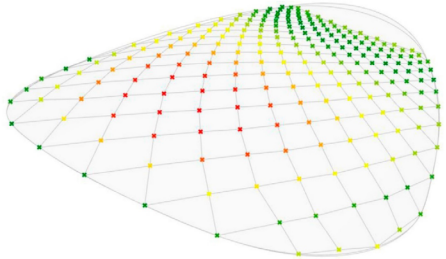
Circumferential:16, Radial: 6



Circumferential:16, Radial: 8

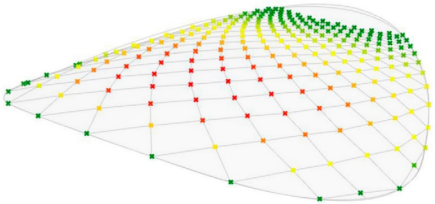
Structural Rationalisation

Edge Approximation



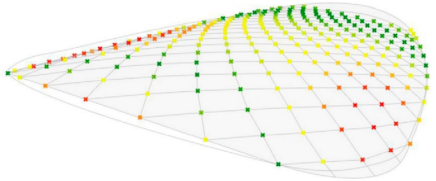
Petal 1

Bounds of surface deviation on diagrid nodes = 0.001624 To 0.390368 m



Petal 2

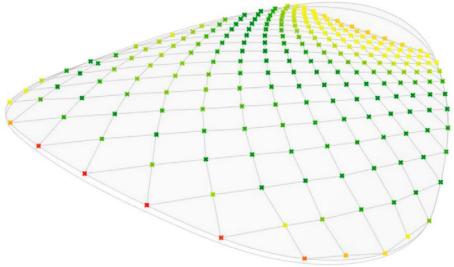
Bounds of surface deviation on diagrid nodes = 0.000424 To 0.58127m



Petal 3

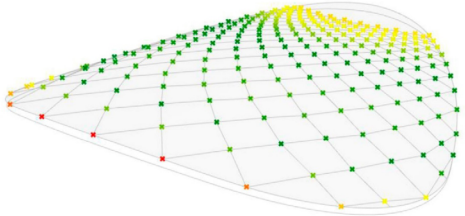
Bounds of surface deviation on diagrid nodes = 0.000228 To 0.514529 m

Surface Approximation



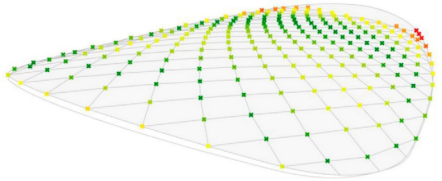
Petal 1

Bounds of surface deviation on diagrid nodes = 0.000823 To 0.395547 m



Petal 2

Bounds of surface deviation on diagrid nodes = 0.002169 To 0.550434 m

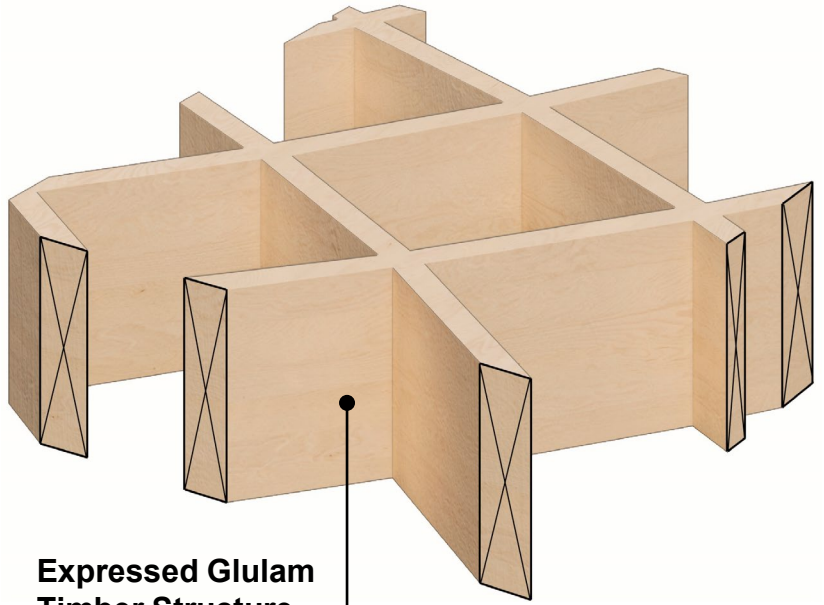


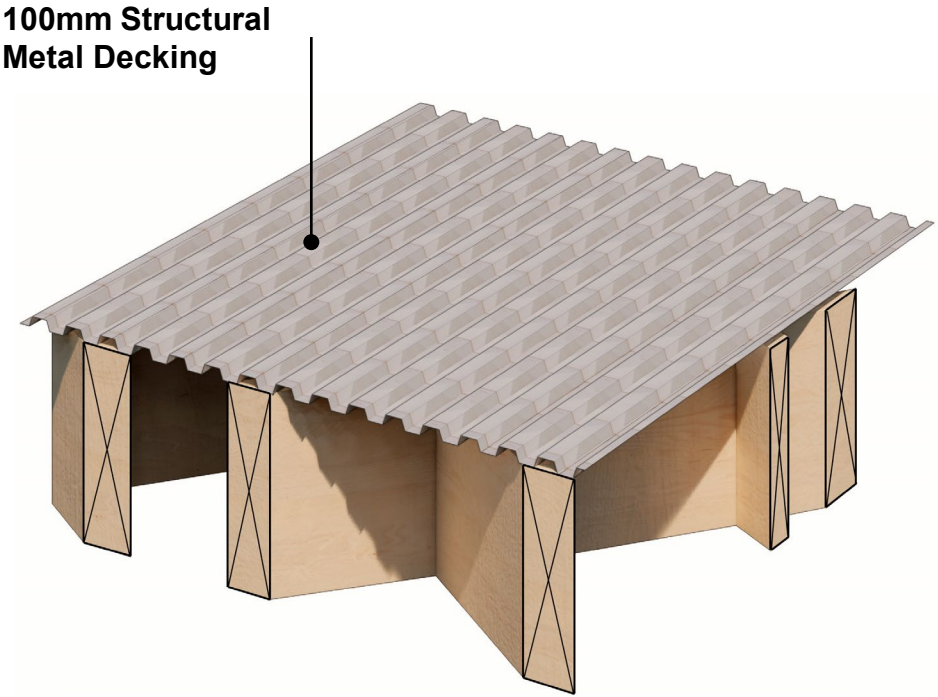
Petal 3

Bounds of surface deviation on diagrid nodes = 0.000531 To 0.49223 m

Roof Construction

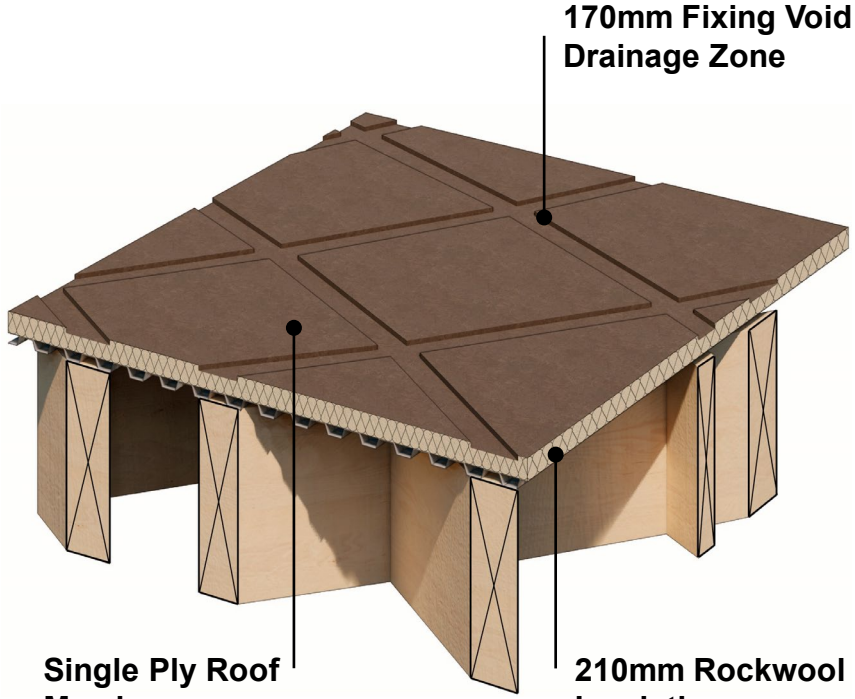
Build-up #1

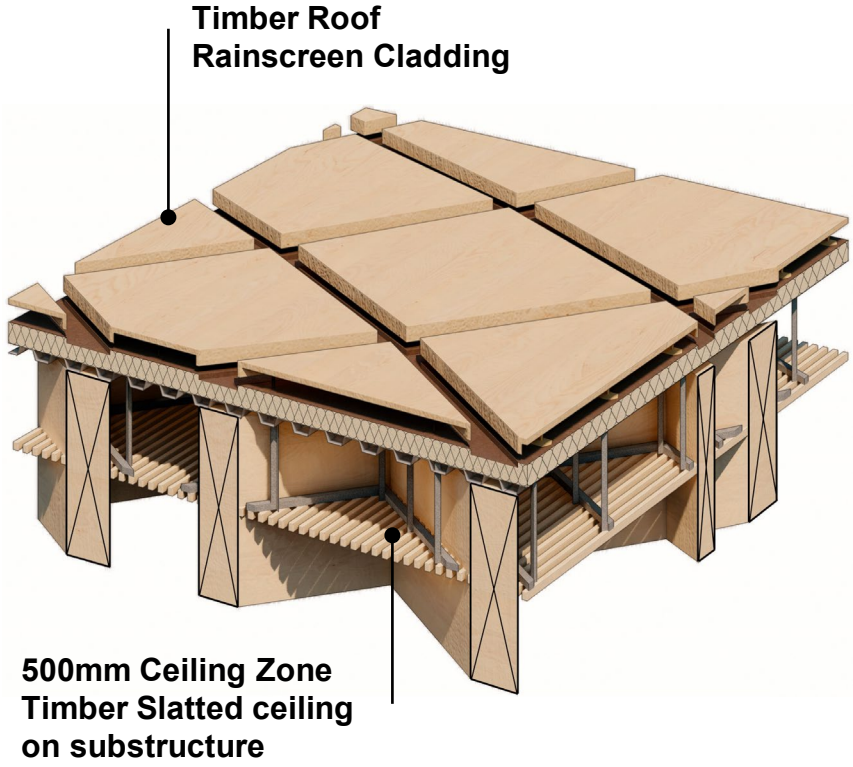


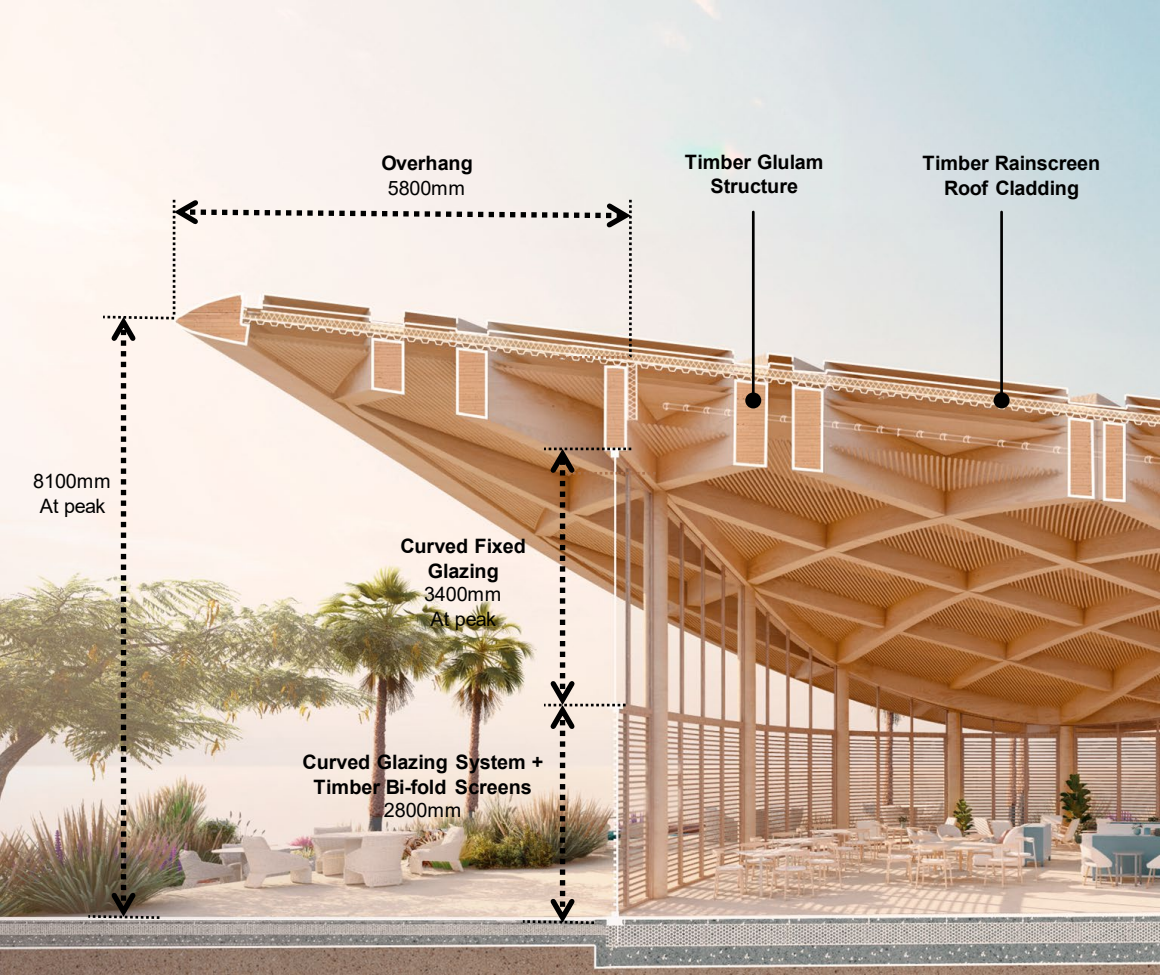


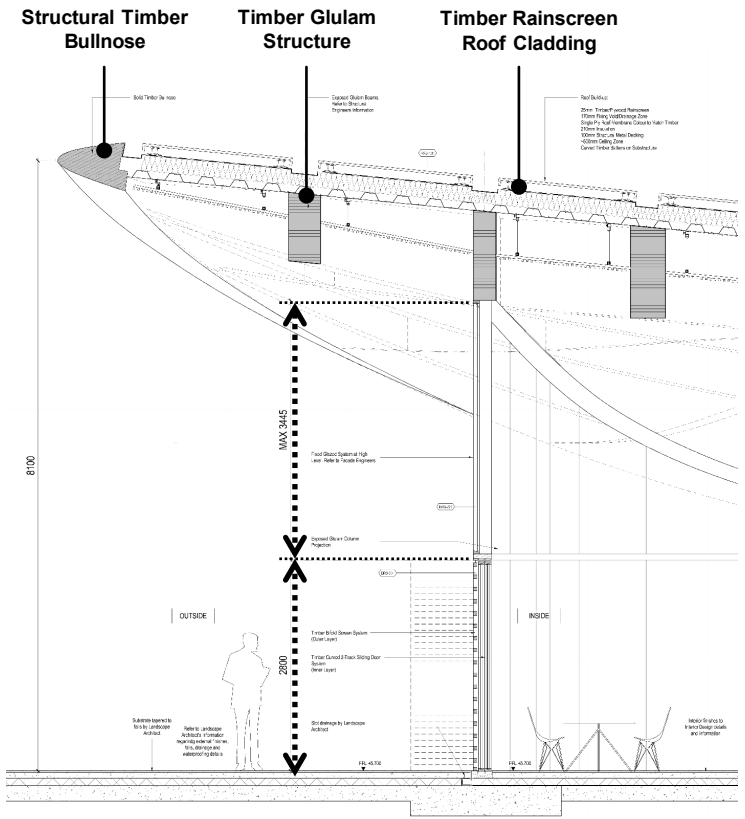
Roof Construction

Build-up #2



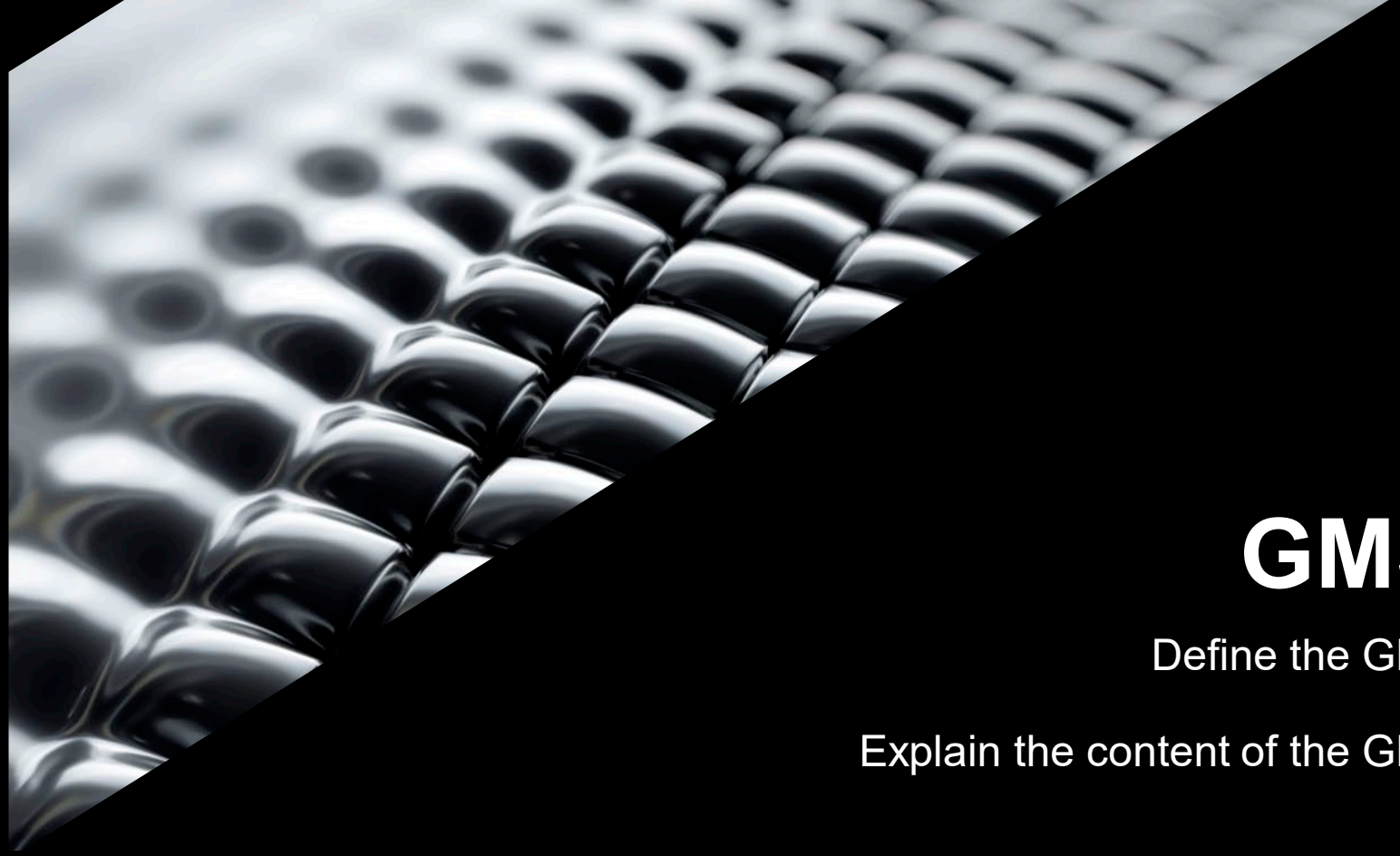



Overhang
5800mm
Timber Glulam Structure
Timber Rainscreen Roof Cladding
8100mm
At peak
Curved Fixed Glazing
3400mm
At peak
Curved Glazing System + Timber Bi-fold Screens
2800mm


Structural Timber Bullnose
Timber Glulam Structure
Timber Rainscreen Roof Cladding
8100
MAX 3445
2800
OUTSIDE
INSIDE

Foster + Partners

AUTODESK UNIVERSITY



GMS

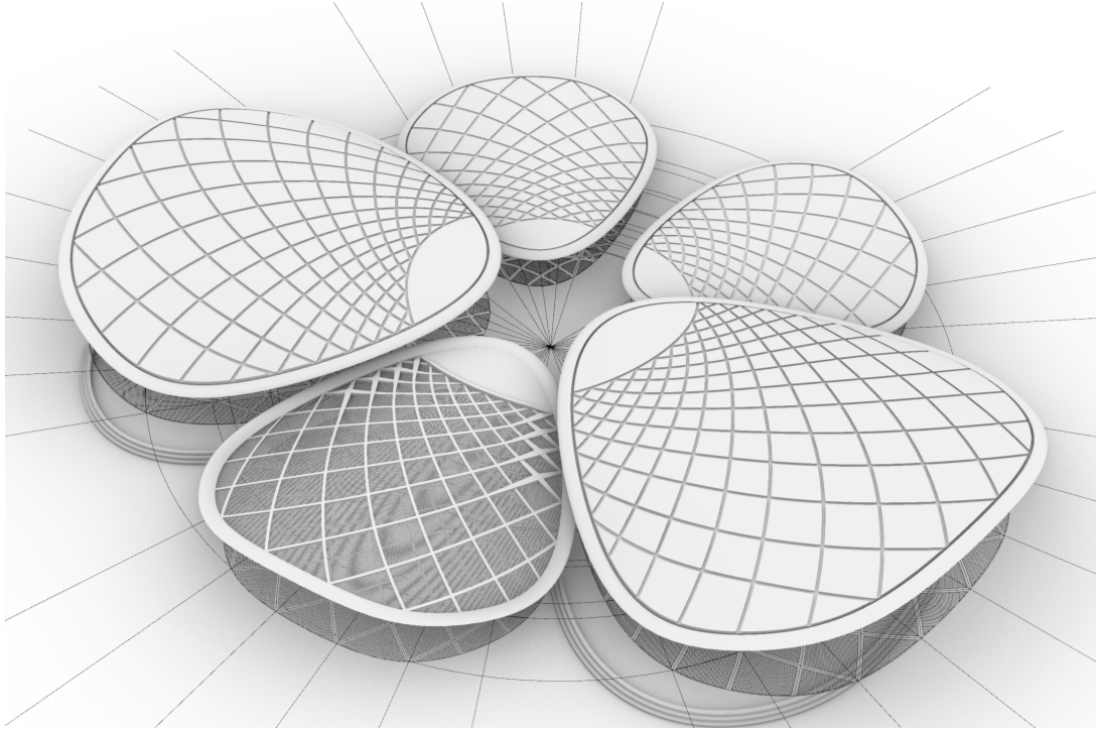
Define the GMS

Explain the content of the GMS

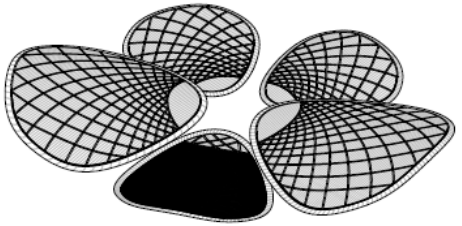
Define the GMS

Geometry Method Statements are used to describe the forms of complex, non-rectangular or circular buildings. The geometry method statement is a way of communicating the design intent so that the geometry of relevant building elements can be described using the simplest possible series of steps, even for complex forms. This allows the local collaborating architect, contractors, fabricators or surveyors to produce the same geometry independent of what software is used. In a sense it is the design DNA. It takes the form of a method statement annotated with text and illustrated with diagrams and/or data tables, formulas or co-ordinates which clarify the design drawings.

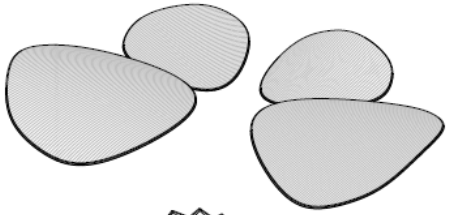
Parts



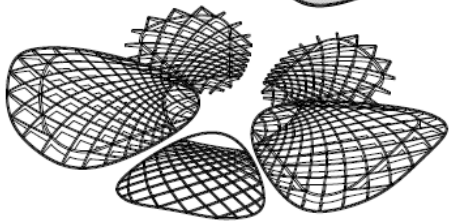
Upper Layer & Nosing



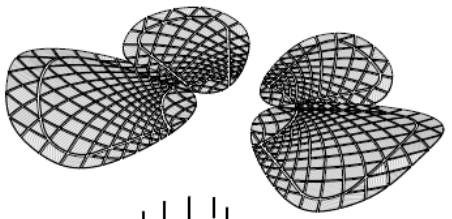
Deck & Insulation



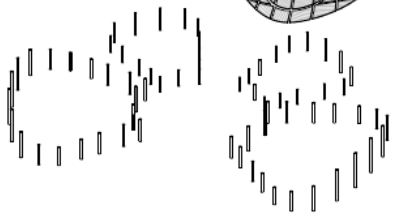
Structure



Soffit & Ceiling



Columns



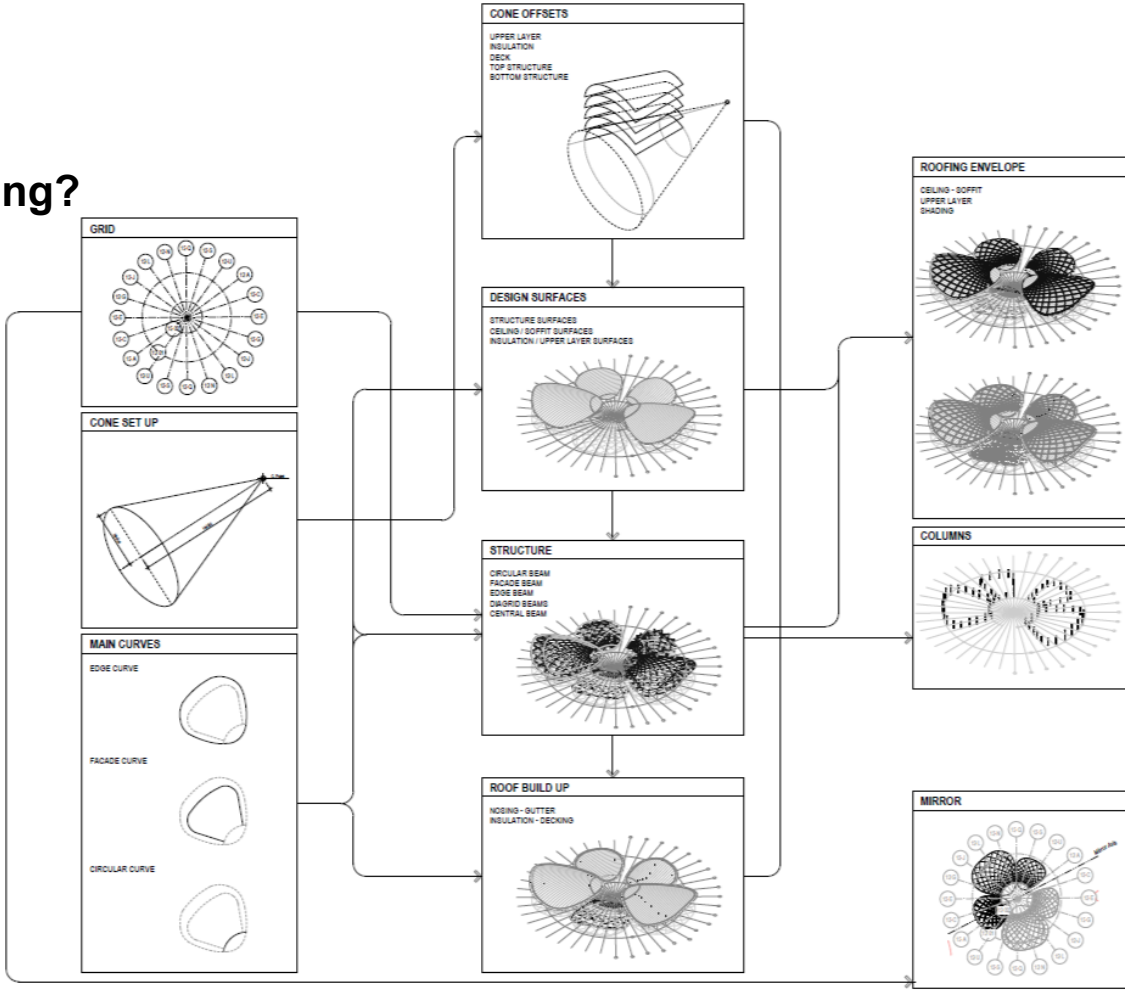
Why are we doing this?

Think about how this is going to be build. Understand the lowest denominator

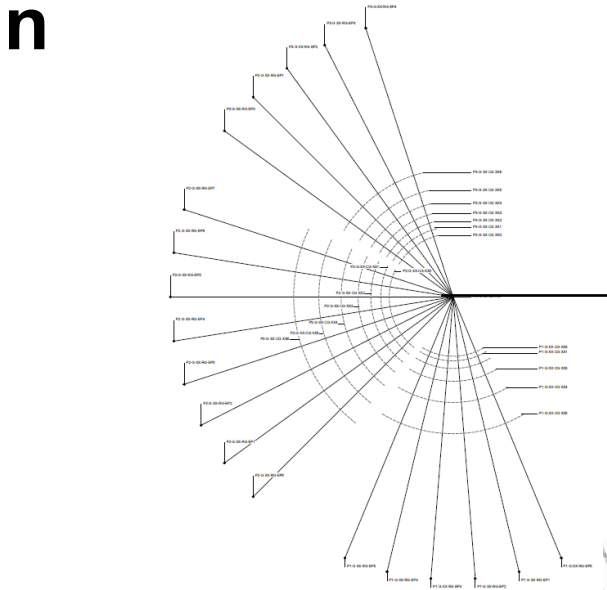
Dependencies

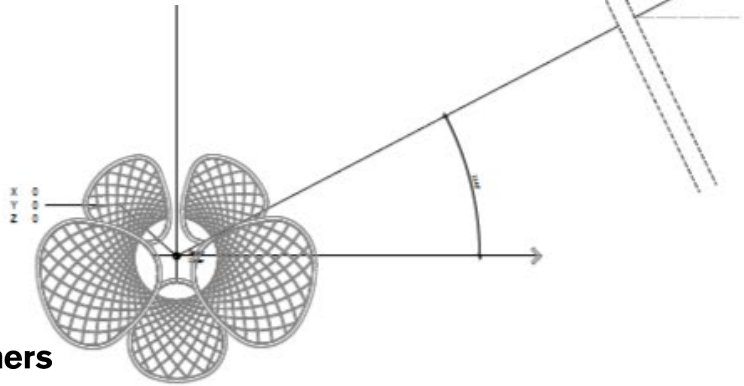
What happens if I change something?

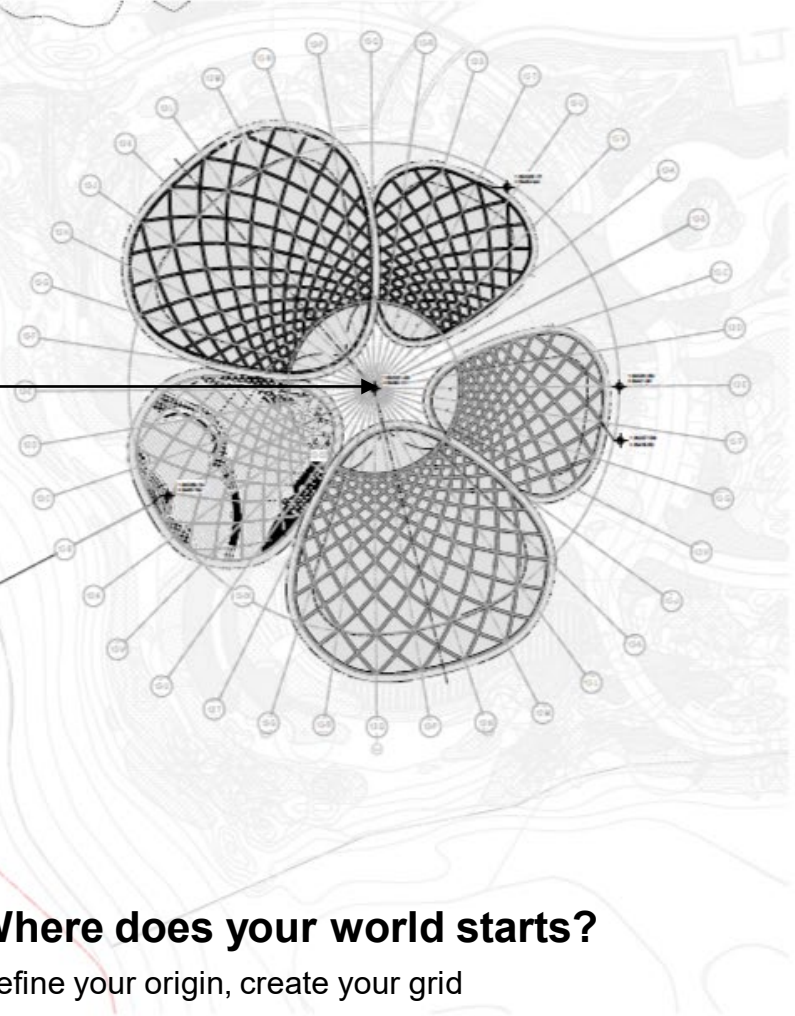
The diagram of geometry dependencies describes the relationships between the different chapters of the GMS. For example, if the geometry of a particular chapters changed, this diagram allows one to determine where this change will affect components in other chapters. The diagram also includes the identification of check points where a validation procedure should occur to ensure that the correct geometry has been determined before moving onto another chapter



Origin





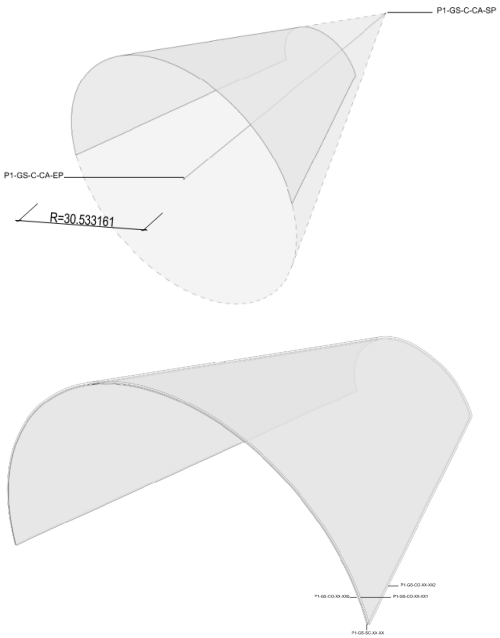


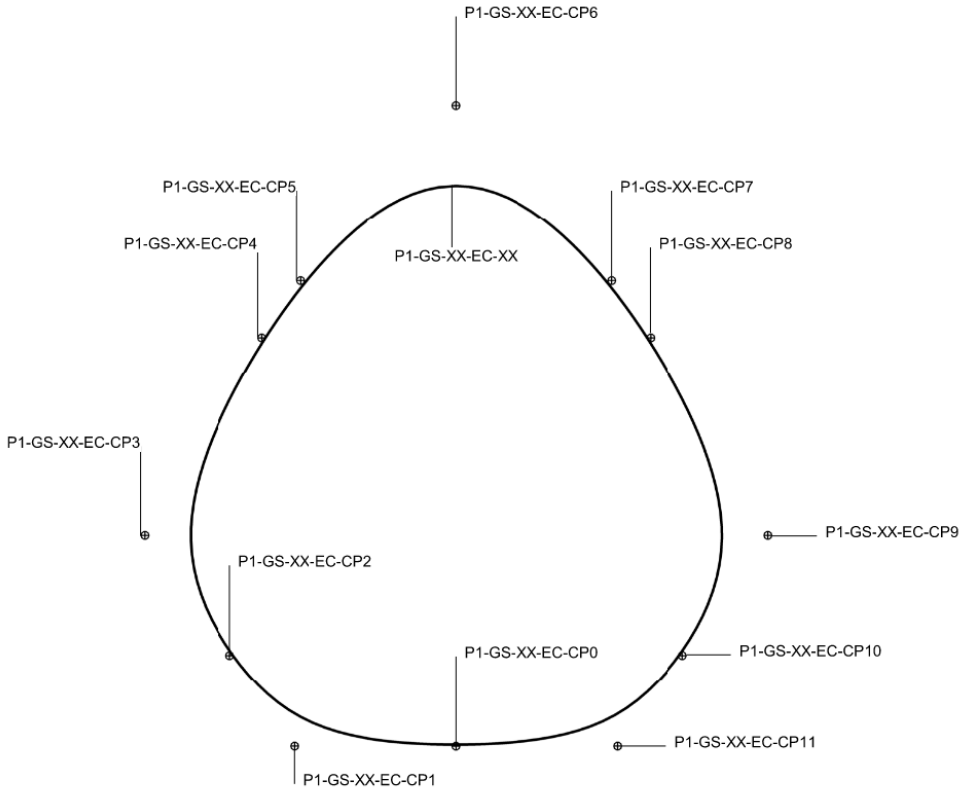
Where does your world starts?

Define your origin, create your grid

Main Curves - Petals

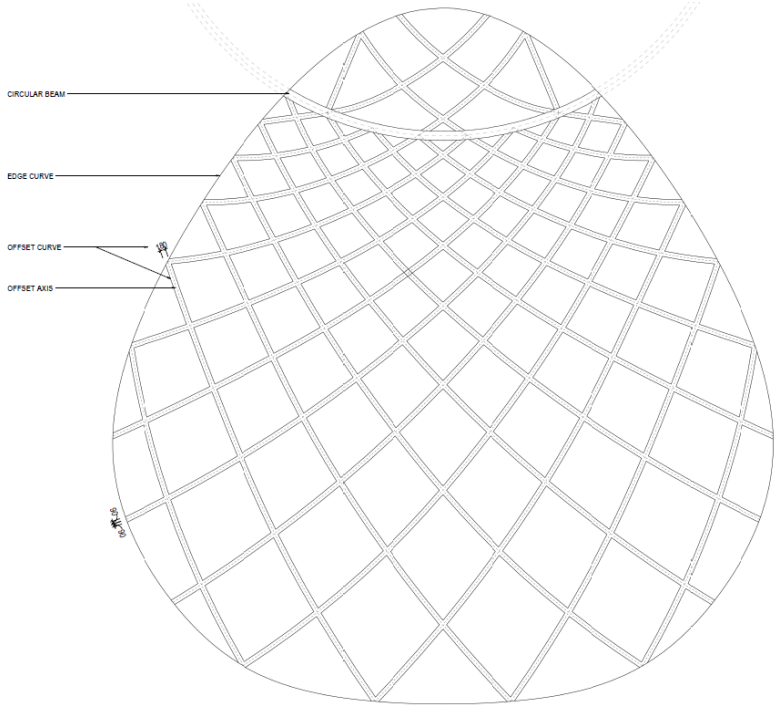
Cone + Edge



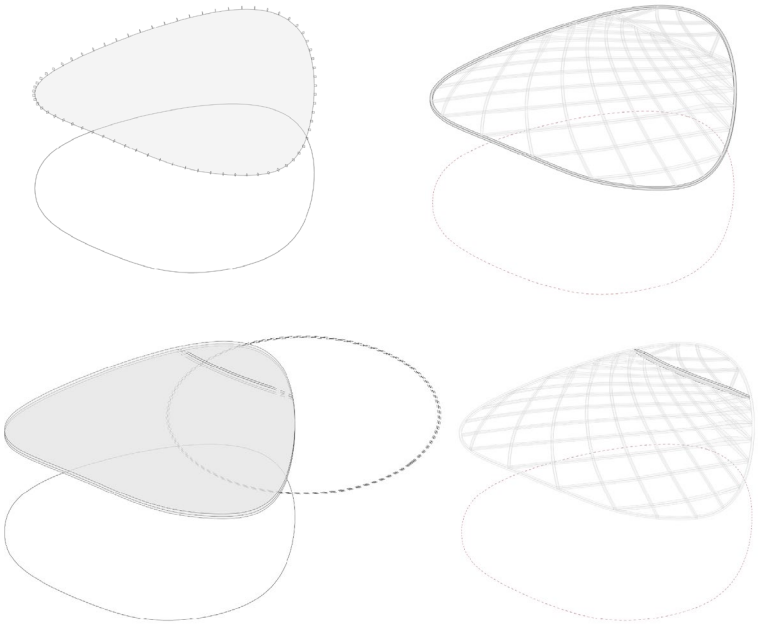


The Edge Curve P1-GS-XX-EC-XX is the curve that defines the overall shape of the petal in plan. It is a 5th degree NURBS periodic curve.

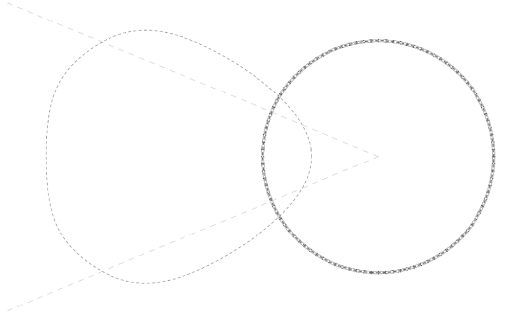
Main Curves - Structure



Edge Beam

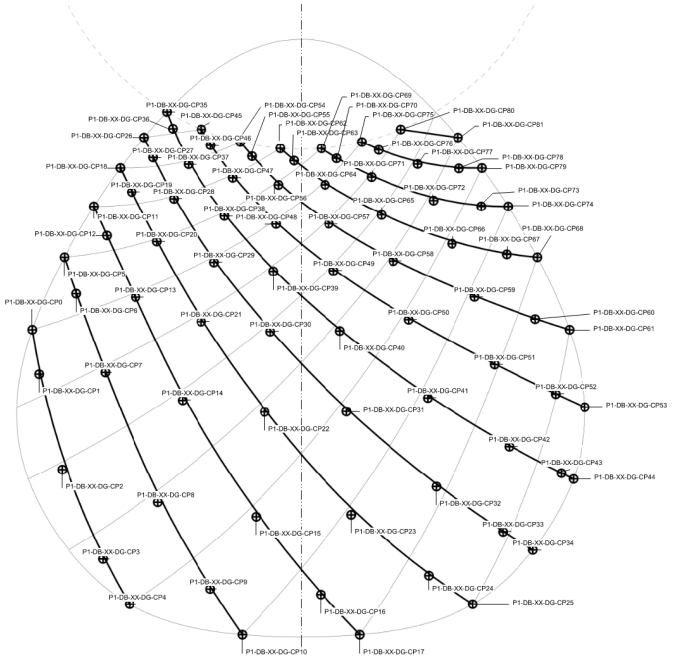


Circular Beam

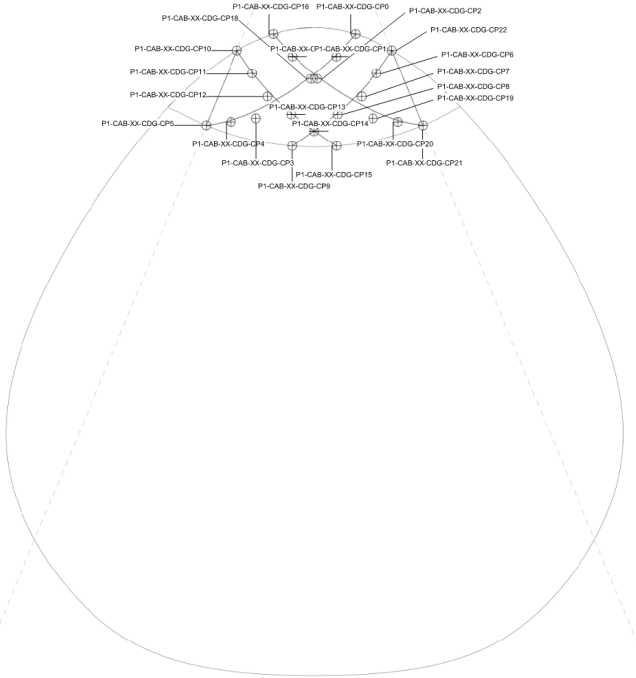


Main Curves - Structure

The diagrid centrelines for the main part of the roof are degree 3 NURBS curves, with control points and knot vectors



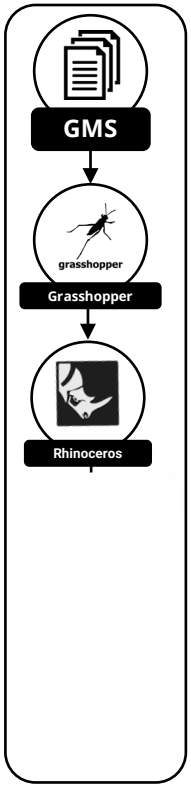
The diagrid centrelines for the central part of the roof are degree 5 NURBS curves, controlled by the respective control points

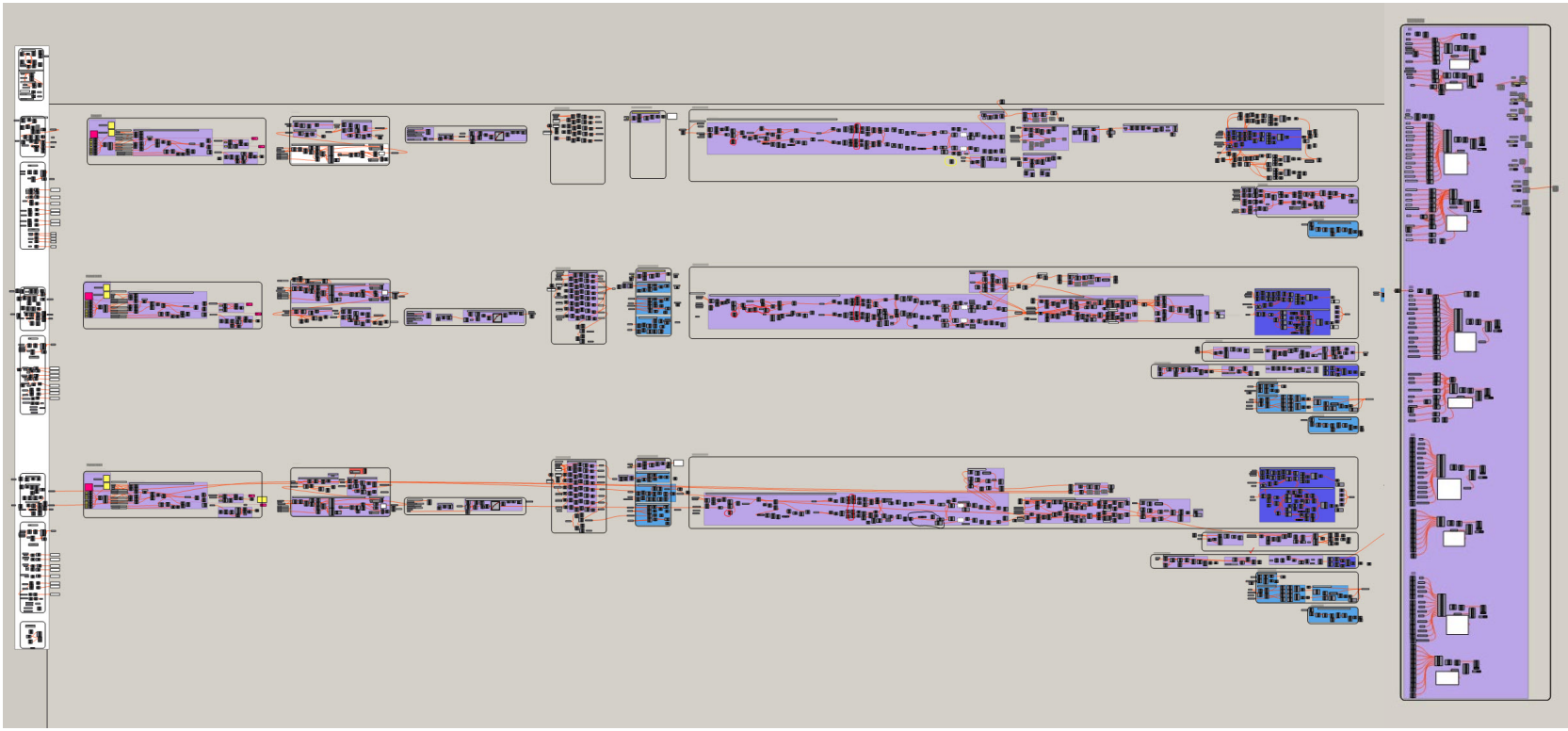


GMS

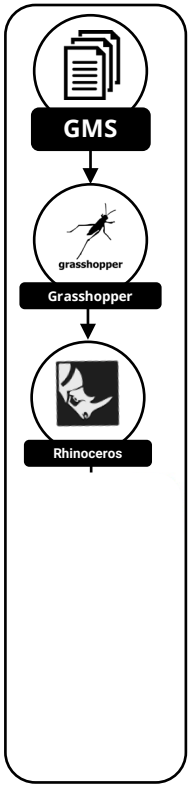
GMS Transcript

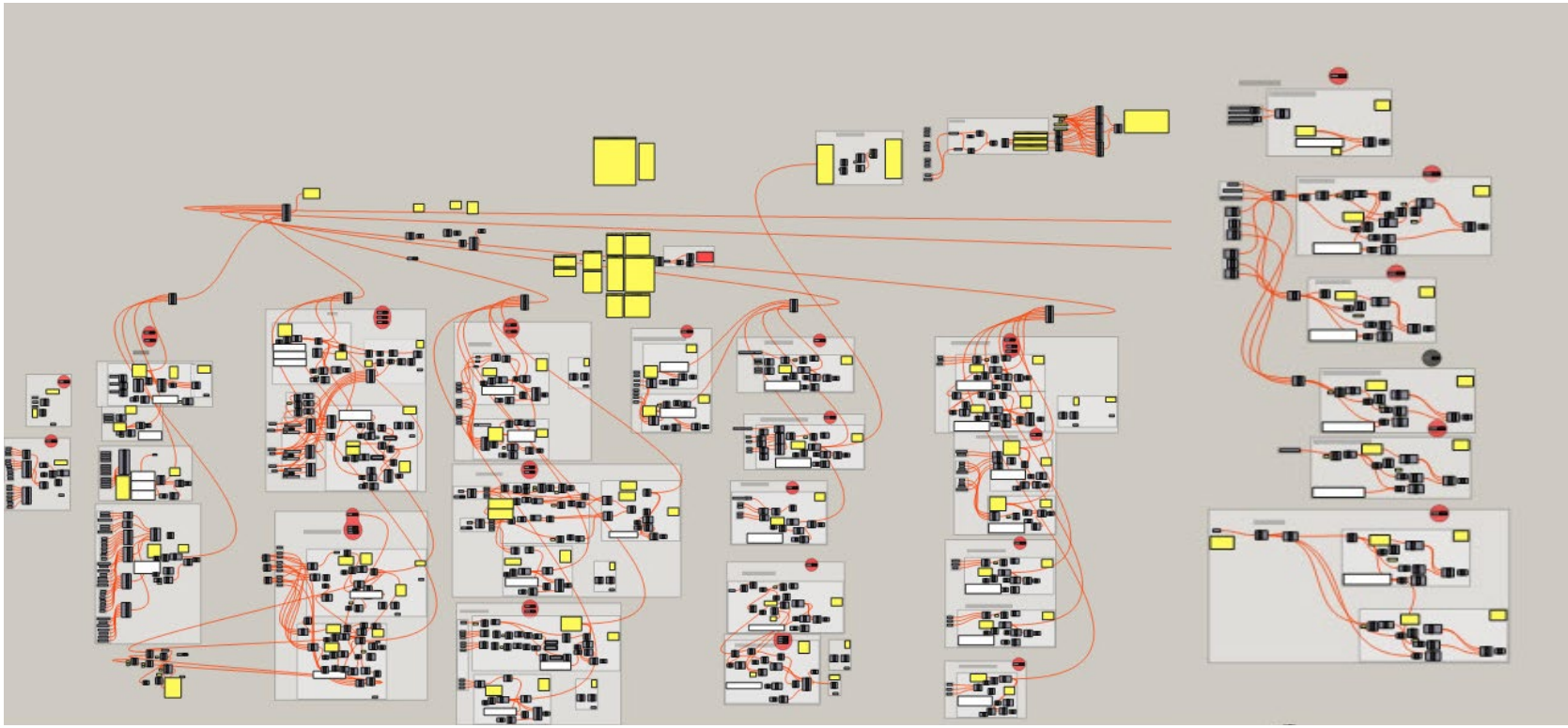
From Grasshopper to Rhino



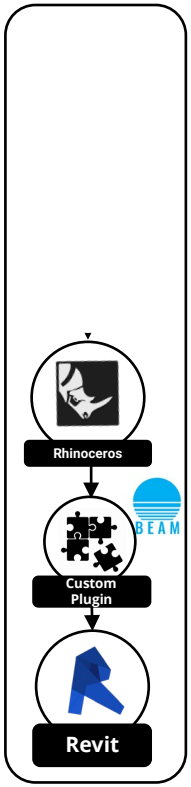


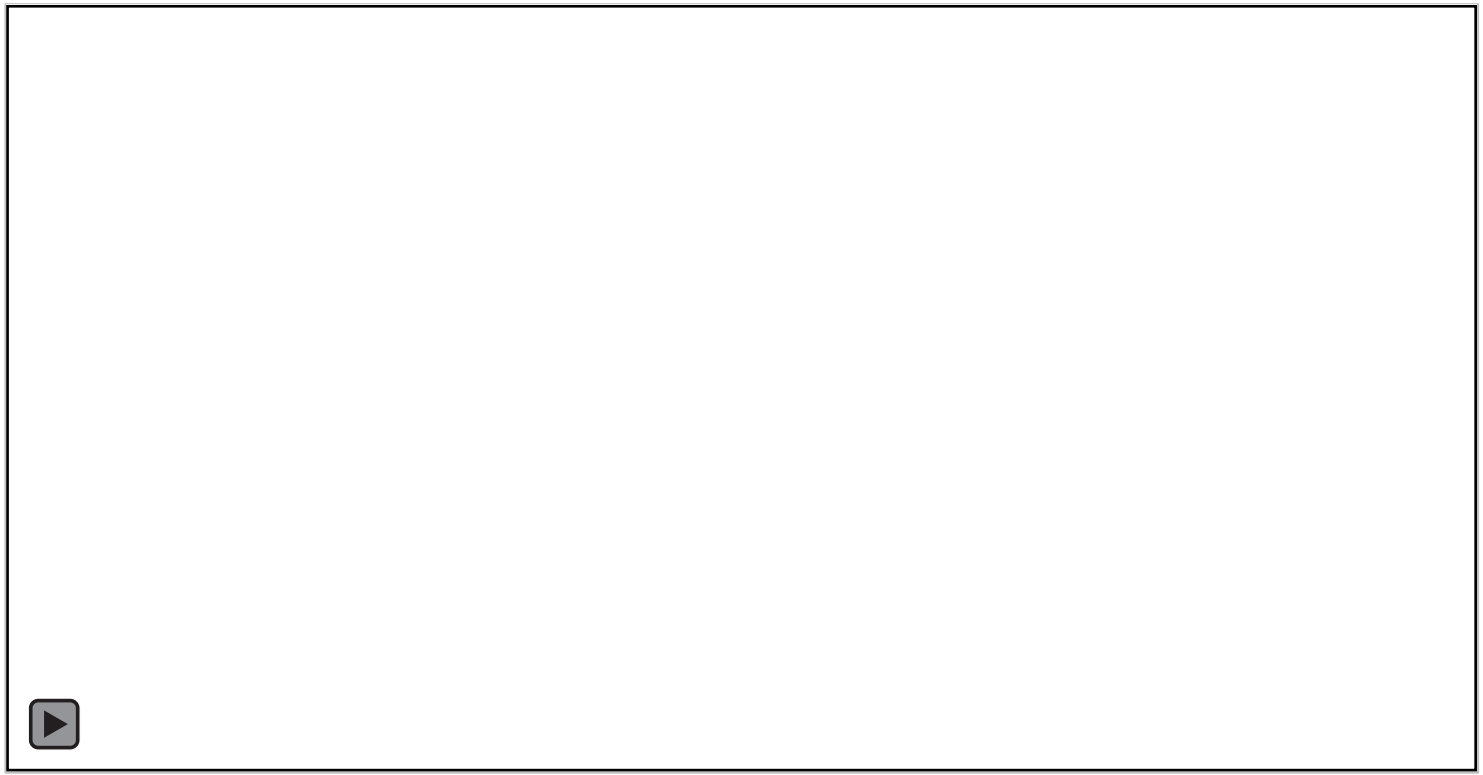
From Grasshopper to Rhino



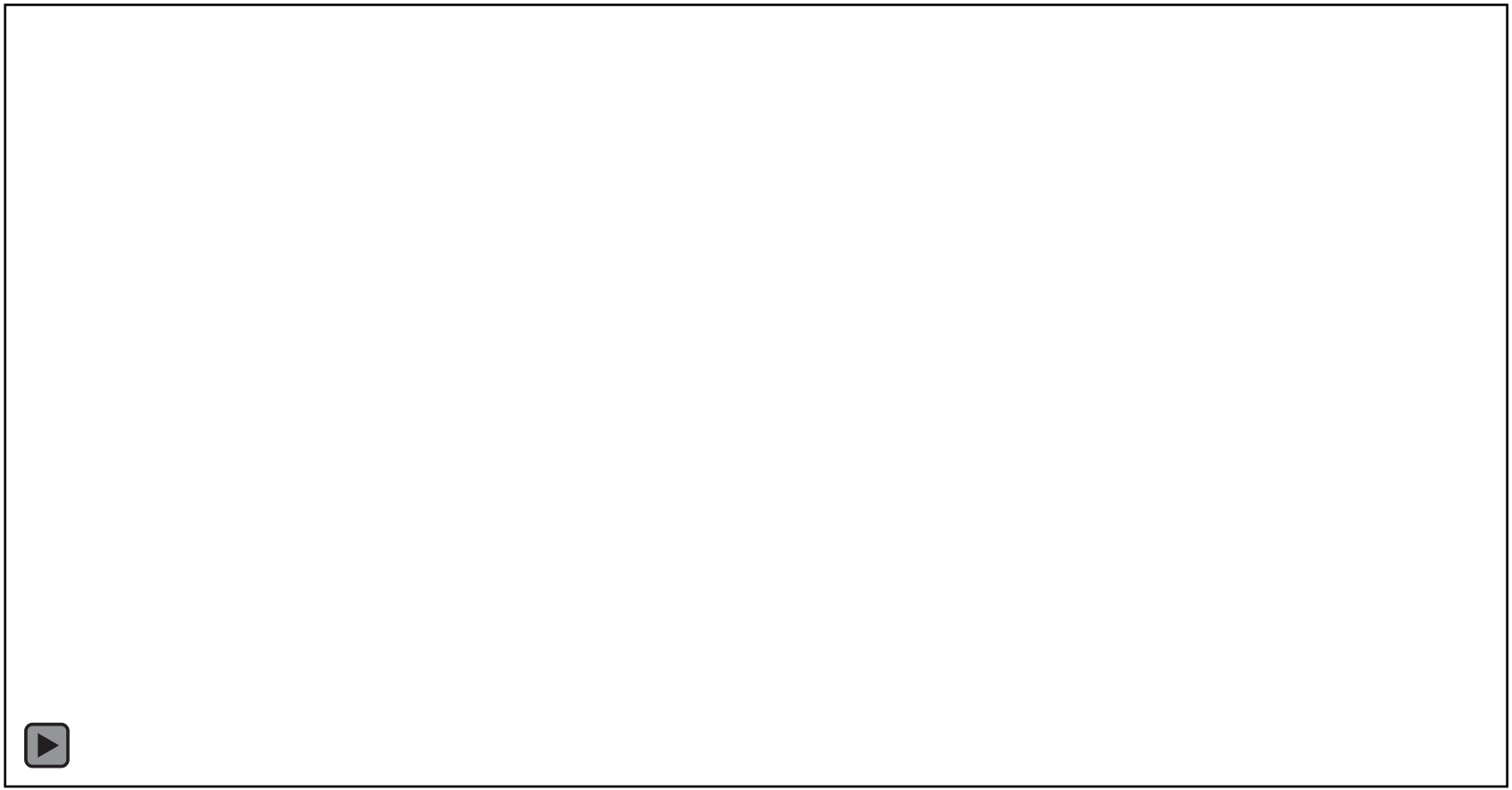


From Rhino to Revit





QA/QC Processes

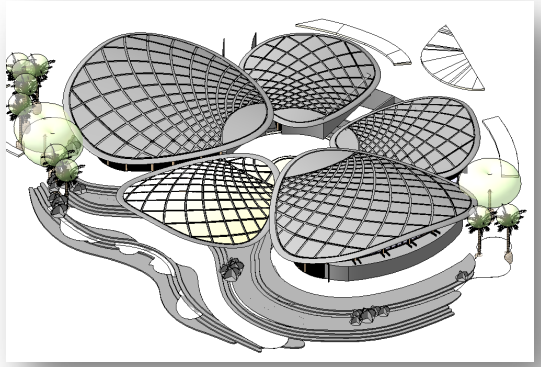


Deliverables

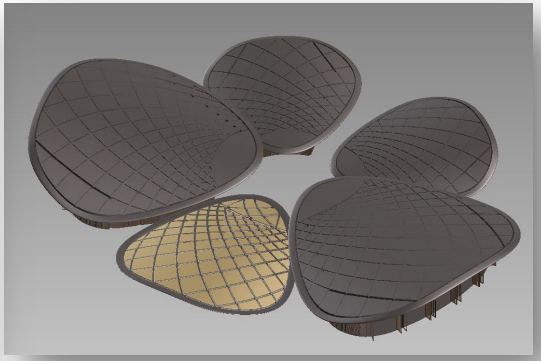
BIM Deliverables

Description		File Format	Data Drops Info Exchange (weekly)	Concept Design		Schematic Design		Design Development		Handover
				50% CD	100% CD	50% SD	100% SD	50% DD	100% DD	
BIM Models	Native Revit	RVT	X *(50% CD onwards)*	-	X	X	X	X	X	*X*
	Industry Foundation Class	IFC	-	-	X	X	X	X	X	-
	Navisworks - Coordination and Clash	NWC	X *(50% SD onwards)*	-	X	X	X	X	X	-
	Detective Models	NWD	X *(50% SD onwards)*	-	X	X	X	X	X	-
	Costing	DWFx	X *(Bi-Weekly -50% SD onwards)*	-	X	X	X	X	X	-
Documents	BEP + BEP Appendices	DOCX	(only if updated)	X	X	X	X	X	X	*X*
		PDF	(only if updated)	X	X	X	X	X	X	*X*
	BIM Exemption List (If applicable)	DOCX	-	-	X	X	X	X	X	*X*
		PDF	-	-	X	X	X	X	X	*X*
	QA/QC (BIM Models QA/QC) - part of the QA/QA Stage Report	XLSX	-	-	X	-	X	-	X	-
		PDF	-	-	X	-	X	-	X	-
Supporting Files	*Revit Templates*	*RTE*	-	-	-	-	-	-	-	*X*
	Revit Setting Out Files	*RVT*	-	-	-	-	-	-	-	*X*
	Rhino Models (if applicable)	*3DM*	-	-	-	-	-	-	-	*X*
	Revit Keynotes Files	*TXT*	-	-	-	-	-	-	-	*X*
	Revit Shared Parameter Files	*TXT*	-	-	-	-	-	-	-	*X*
	Revit Titile Block Families	*RFA*	-	-	-	-	-	-	-	*X*
	Navisworks Templates and Settings	*NWF, TXT*	-	-	-	-	-	-	-	*X*

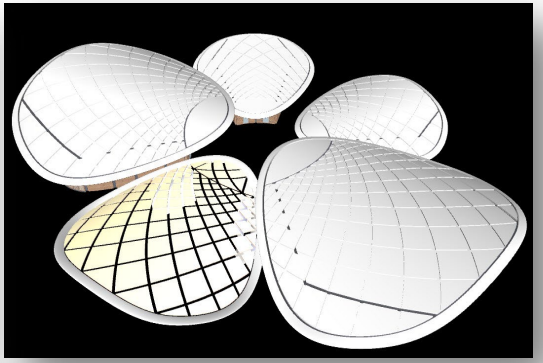
Deliverables



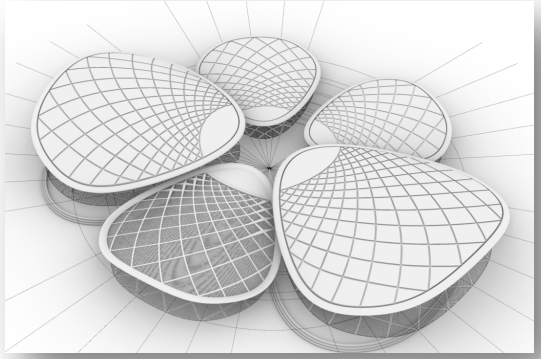
RVT



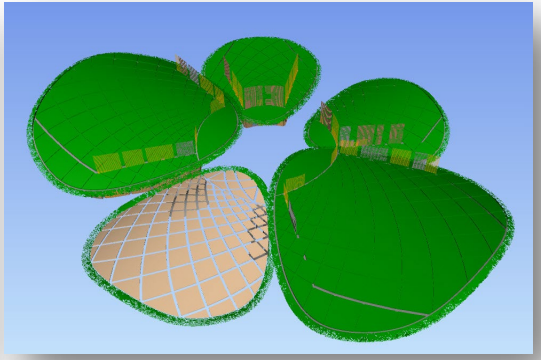
DWFx



NWC



3DM



IFC

NWD

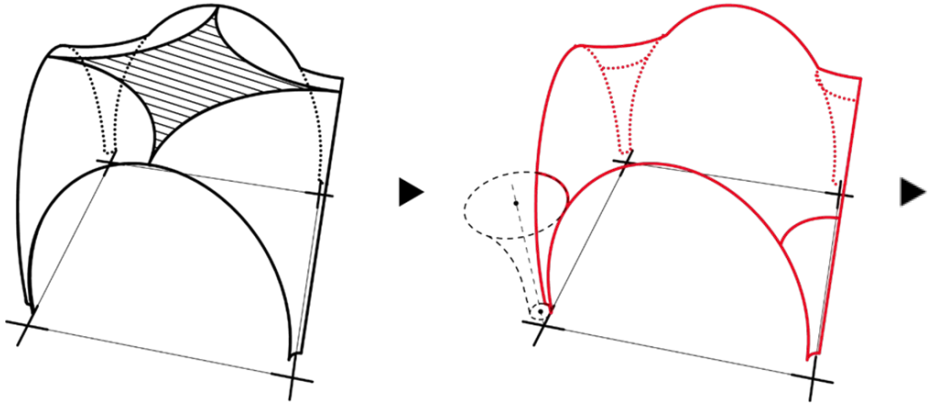
Fabrication

Realizing Visions

Blumer Lehmann

Freeform Engineering

From surfaces to the single prefab pieces and finally to the desired structure

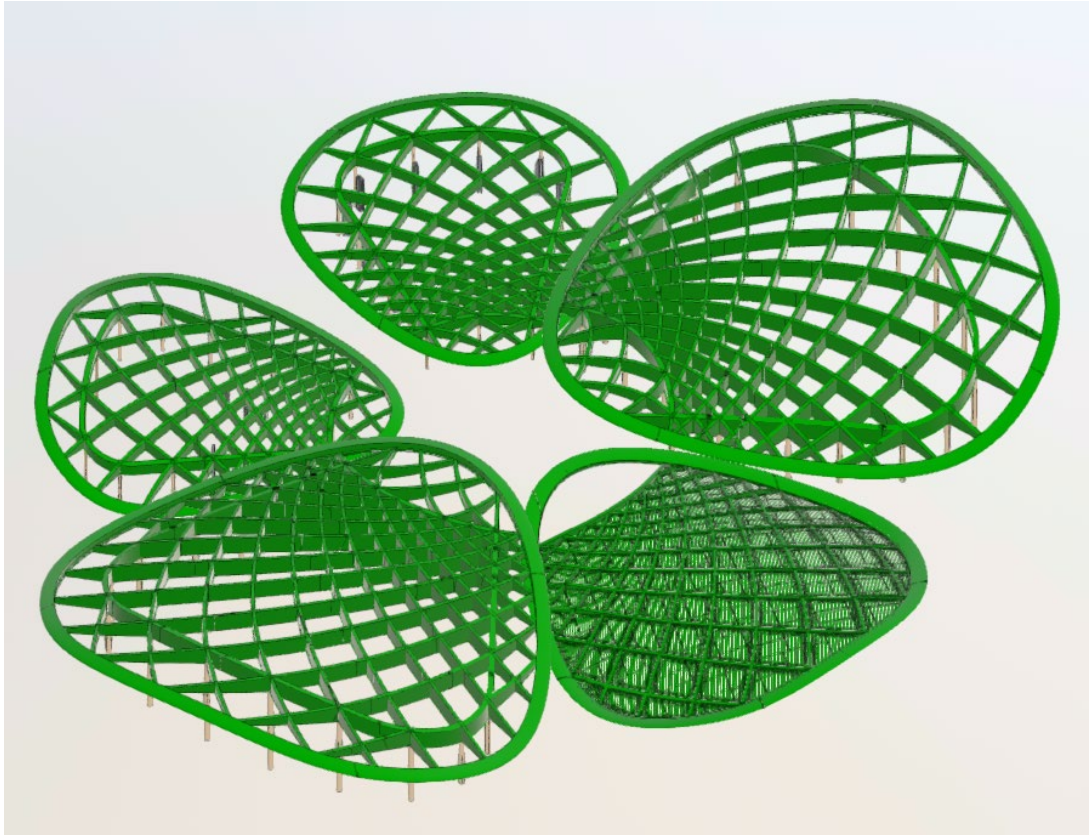


Master surface
(design input)

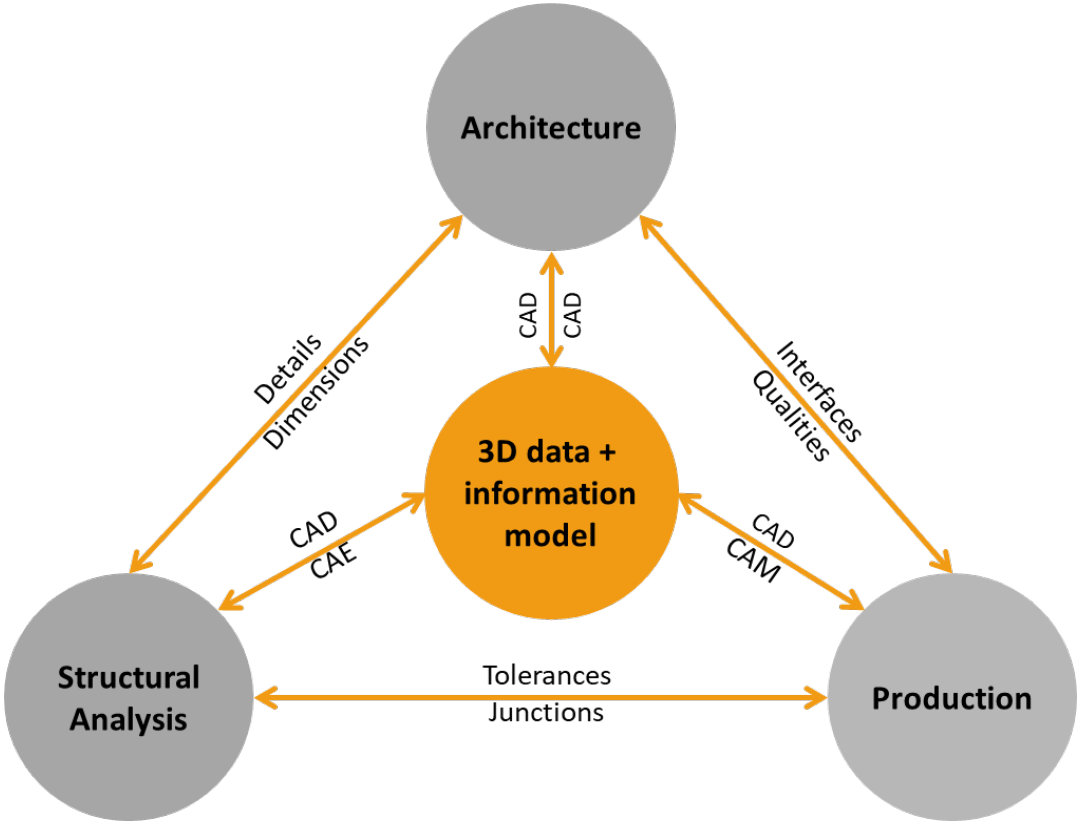
Master surface
(optimized by BL)

Built result

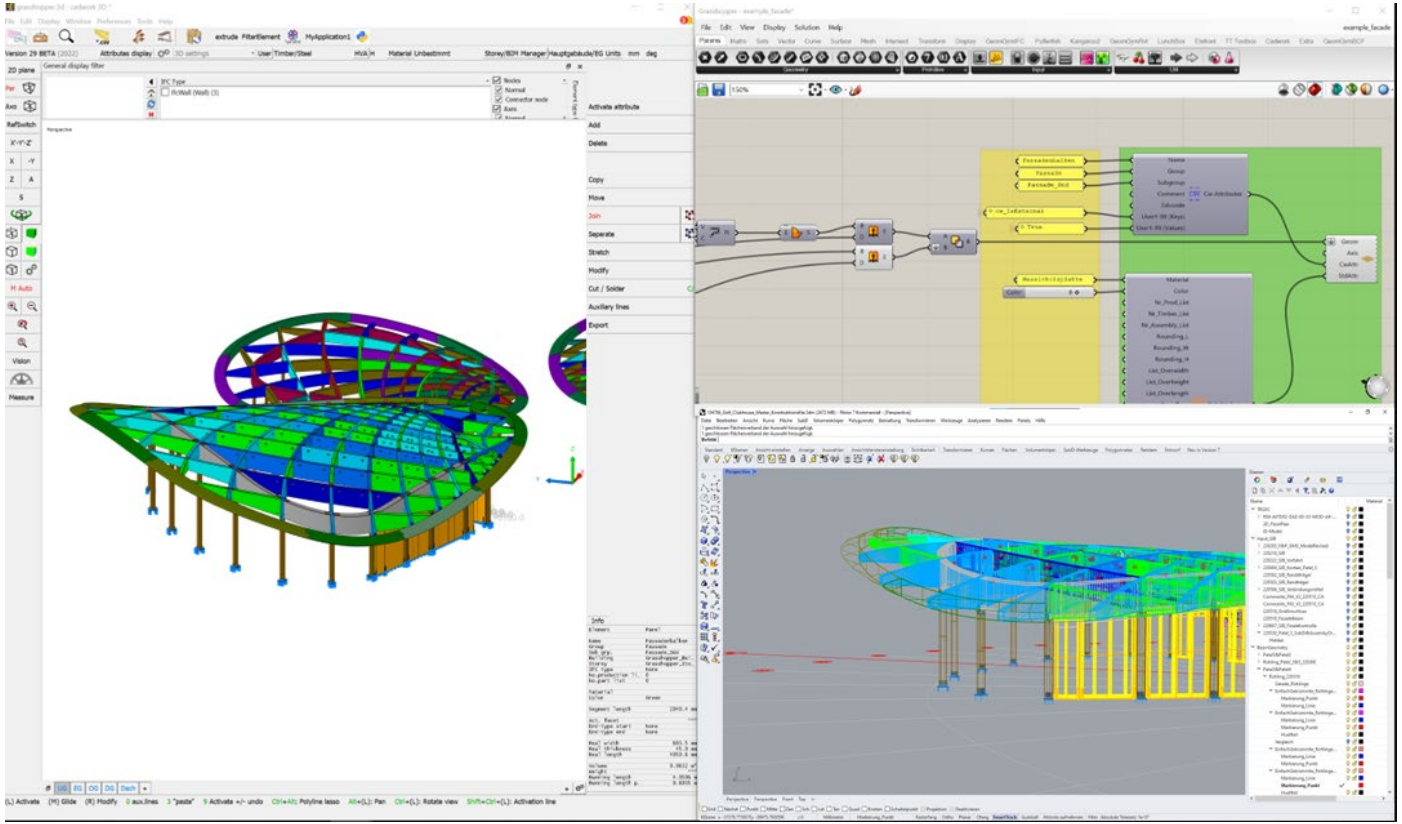
Tender model of the Golf Clubhouse



3D- BIM model at the heart of our processes

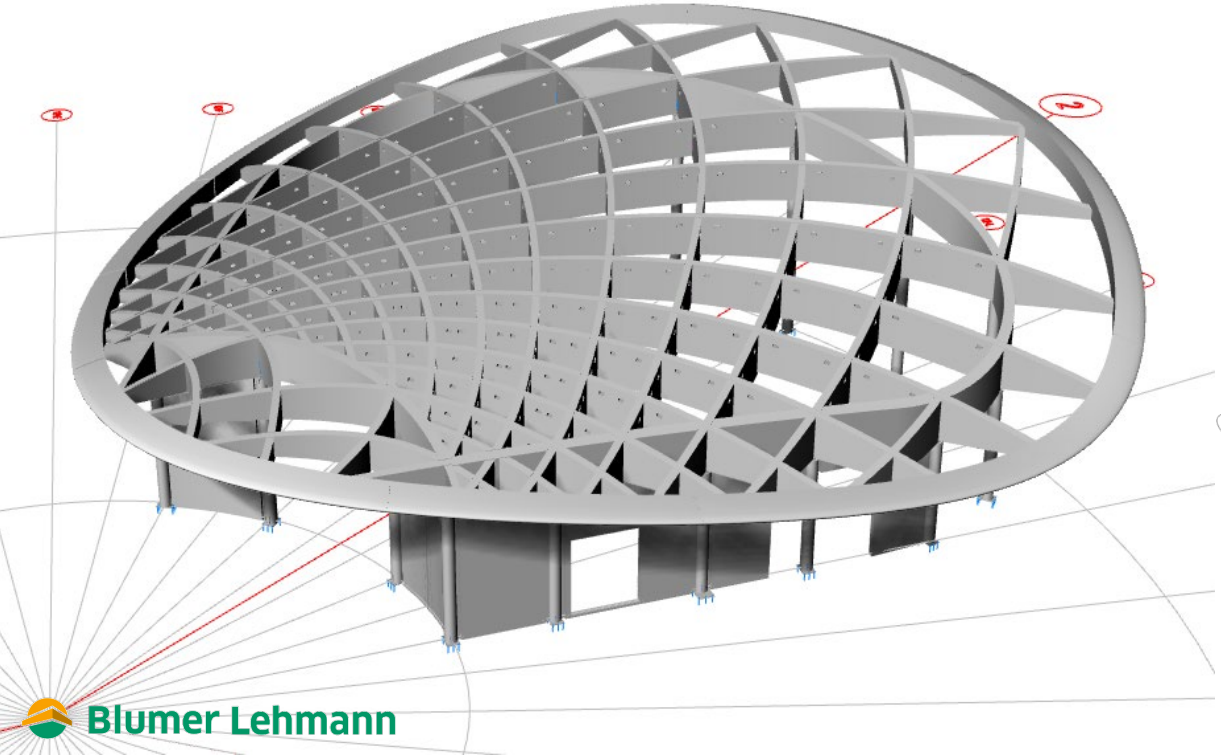


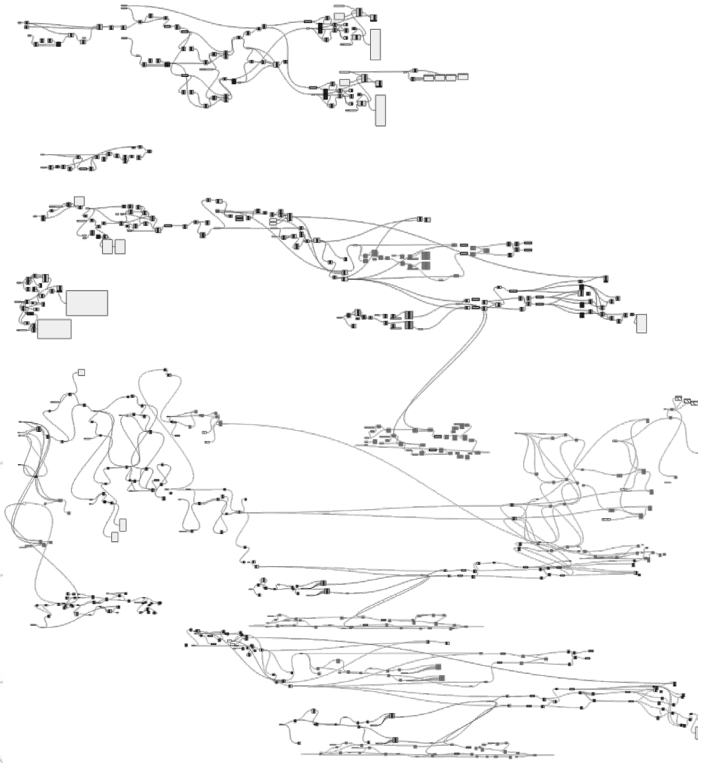
Our mainly used Softwares: Rhino and Cadwork



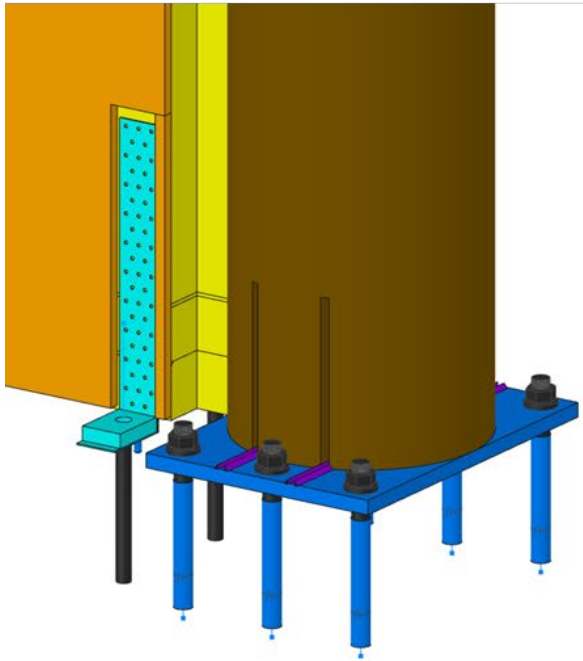
Coding the geometry

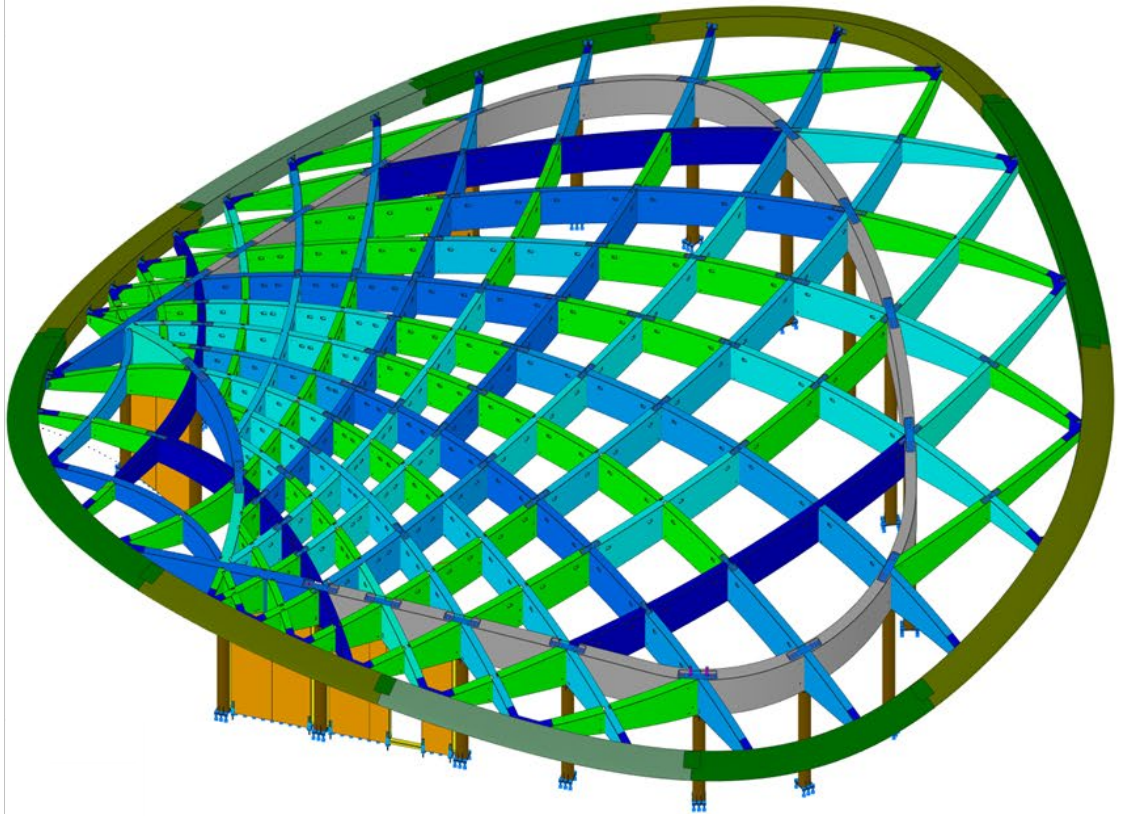
From Rhino and Grasshopper, to Cadwork, (back to Rhino) and onto the machines





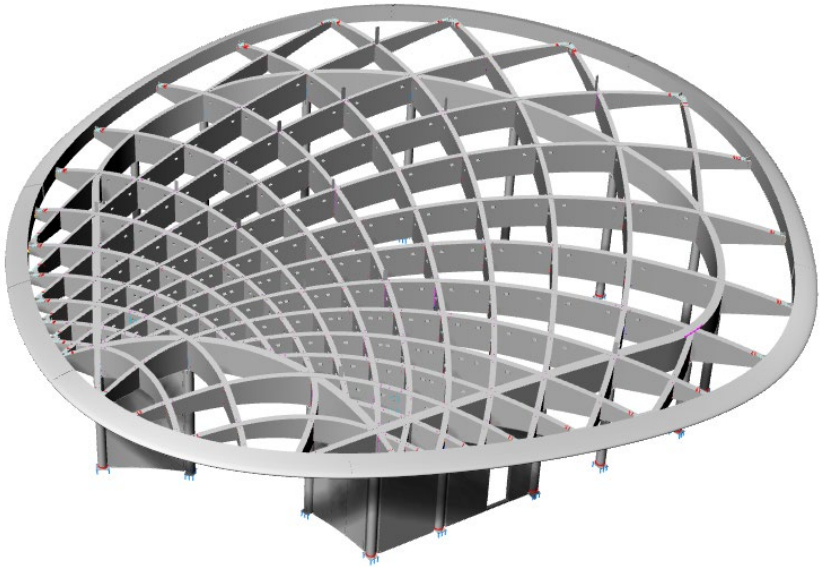
Every Detail is Modelled



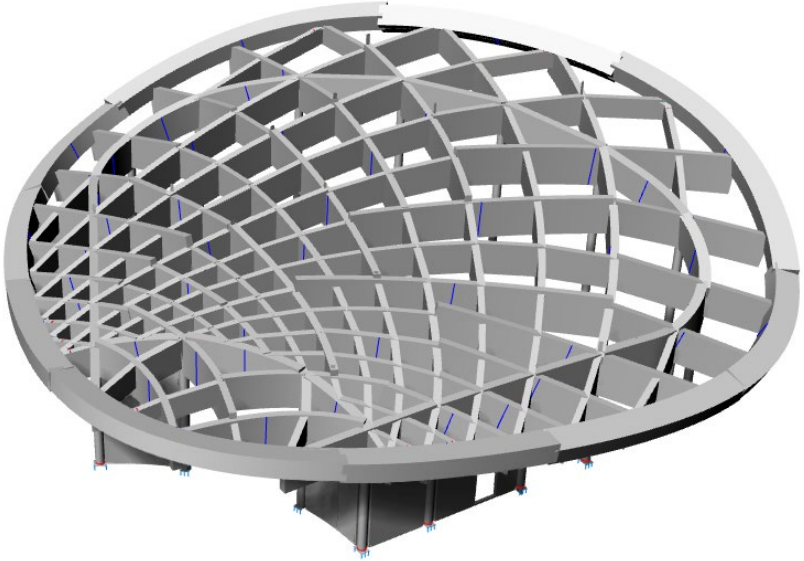


Material Procurement

The geometry is segmented into producible beams and the raw material is ordered



Final geometry



Segmentation and geometry of raw material to be ordered

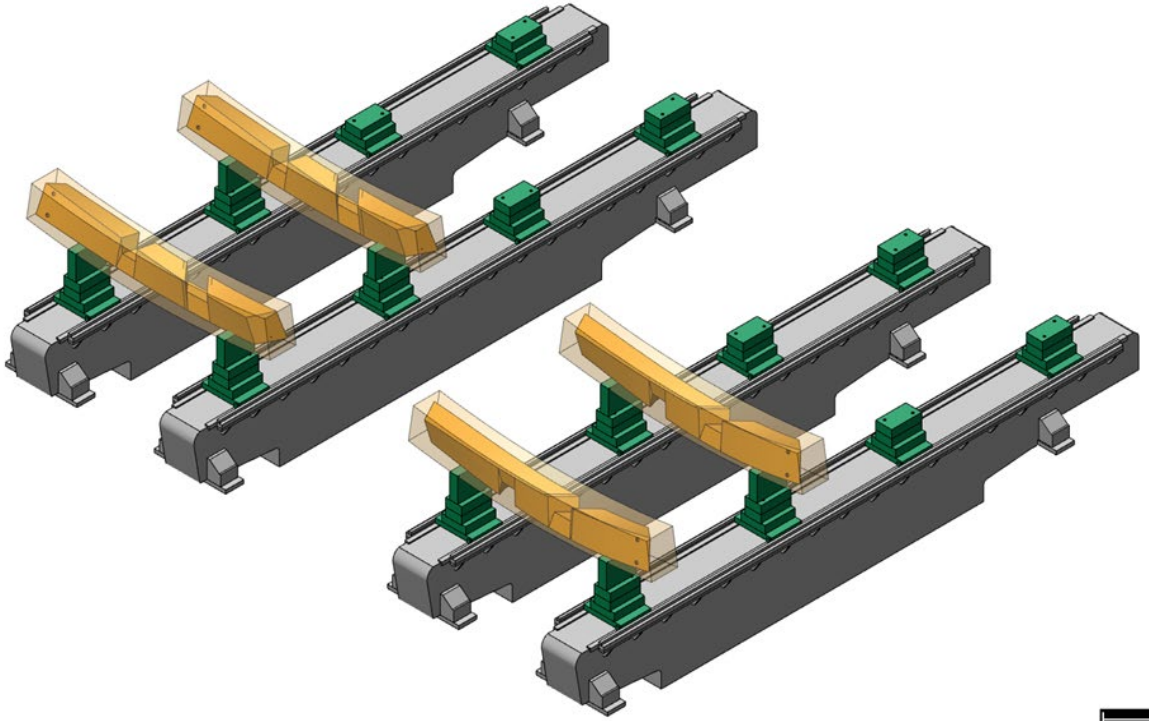
Raw Material

Production on the TW-Mill

Production

Simulation of the G Code in Rhino for the TW-Mill

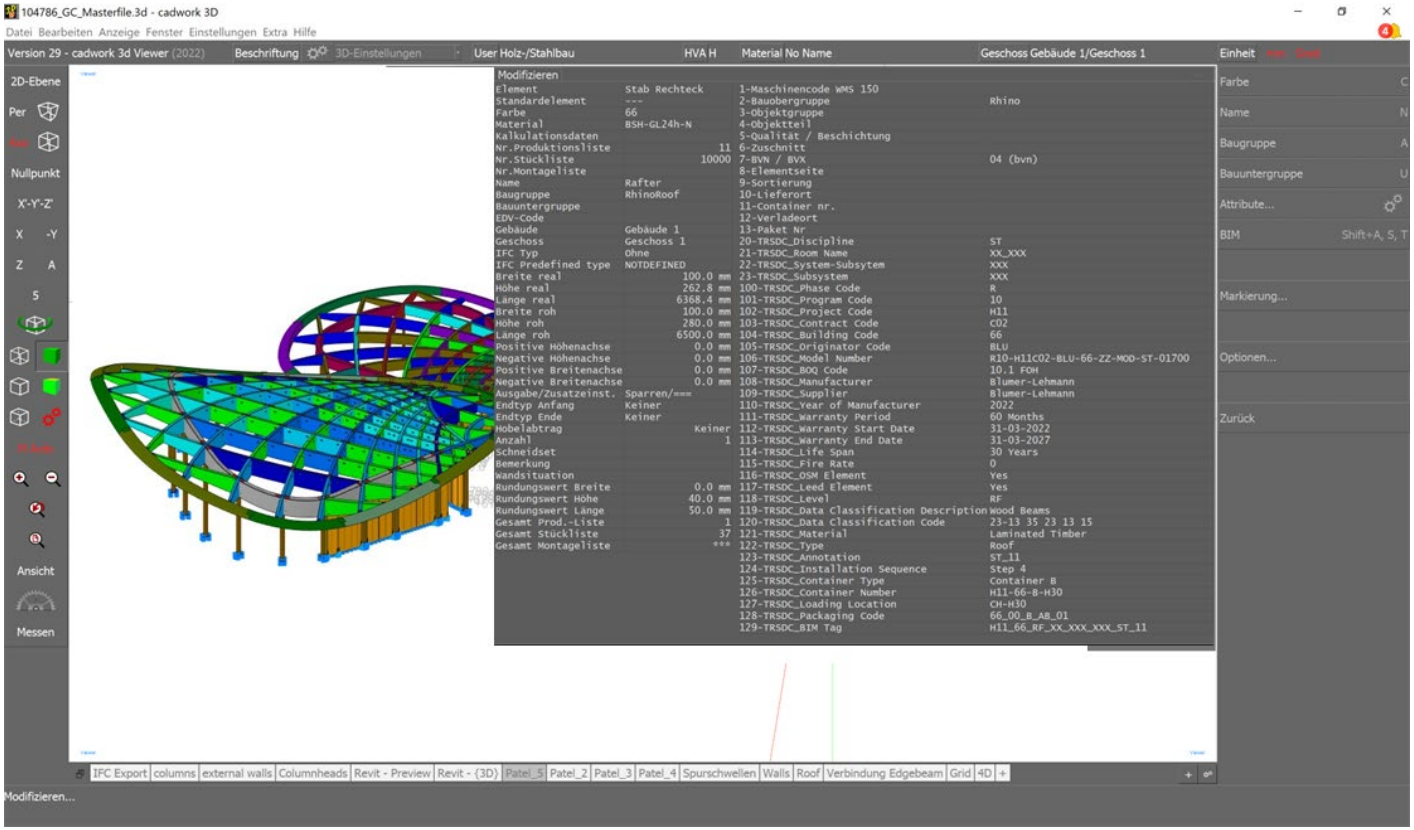
0.00/630 129.90



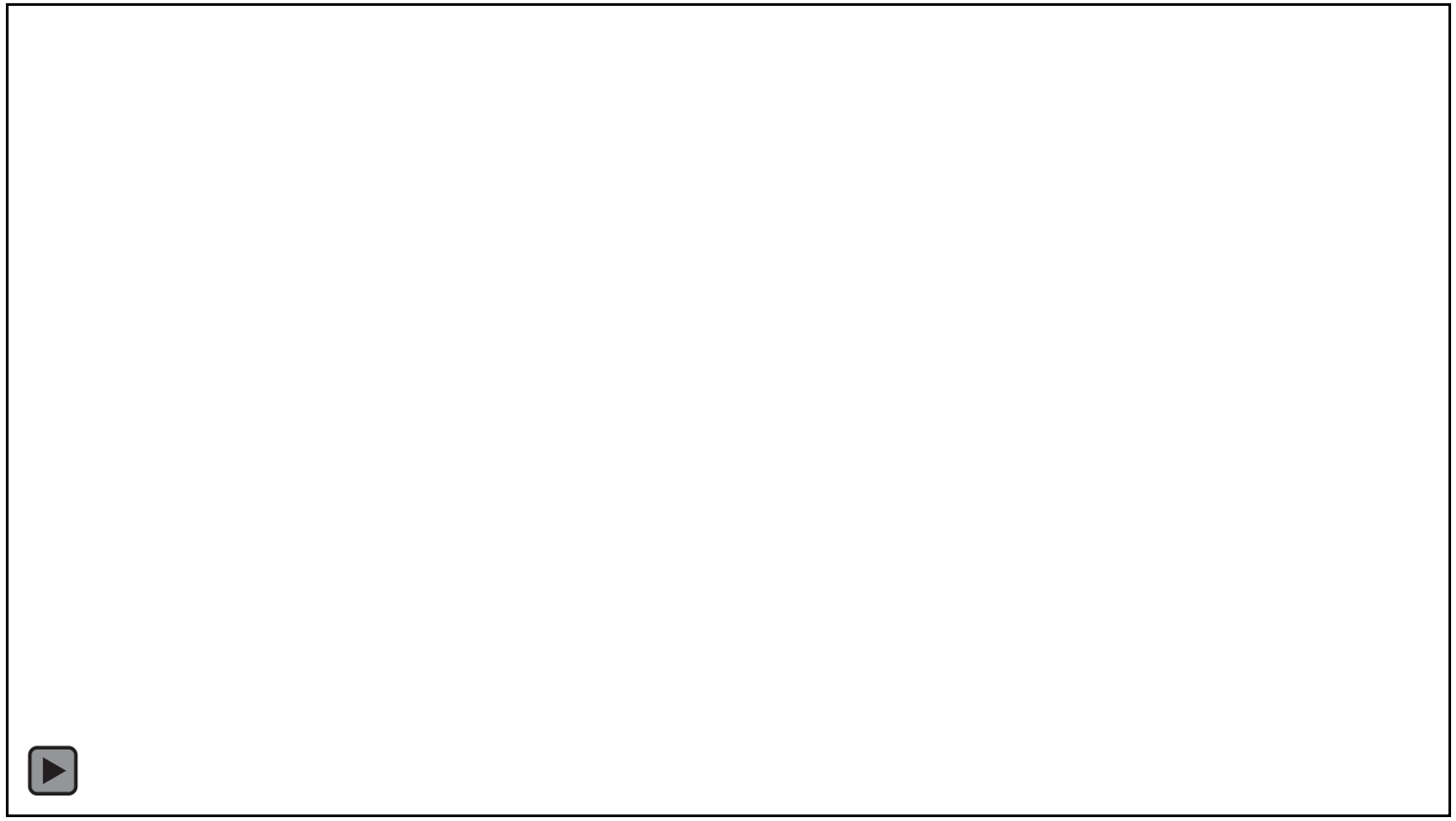
Production

Handover: Prefabricated Timber Pieces

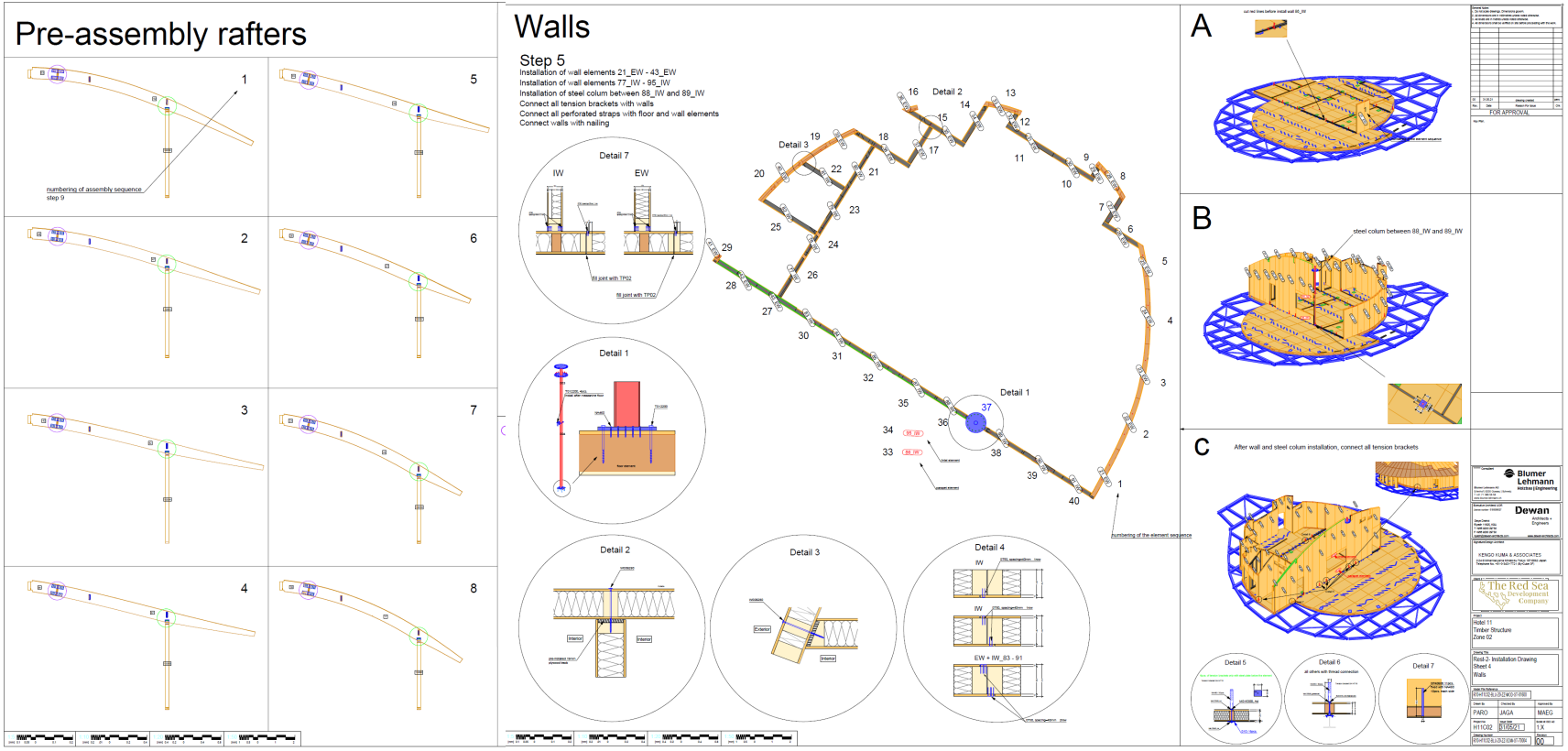
Handover: As-Produced Models



Handover: 4D Simulation



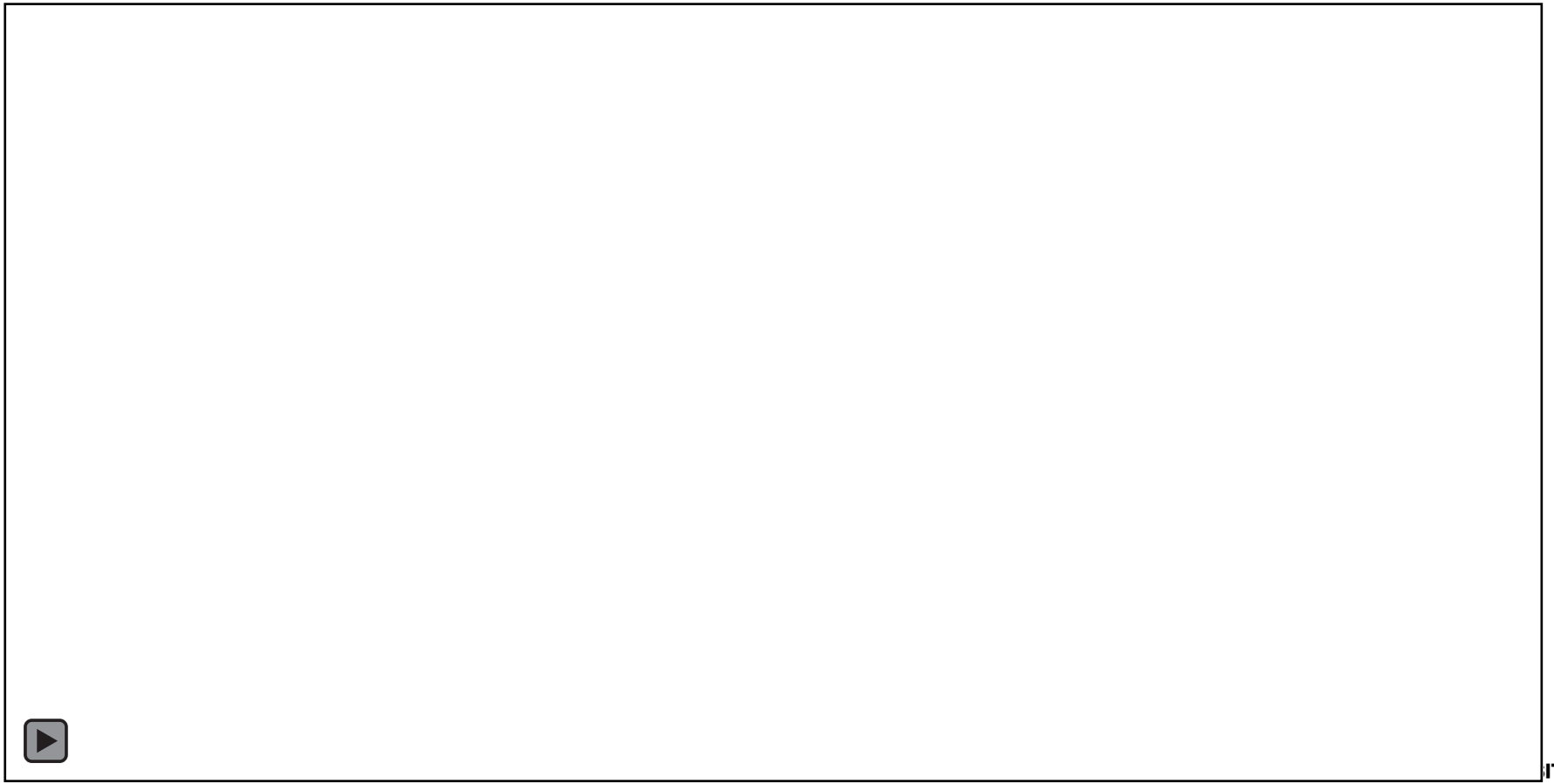
Handover: Assembly Manual



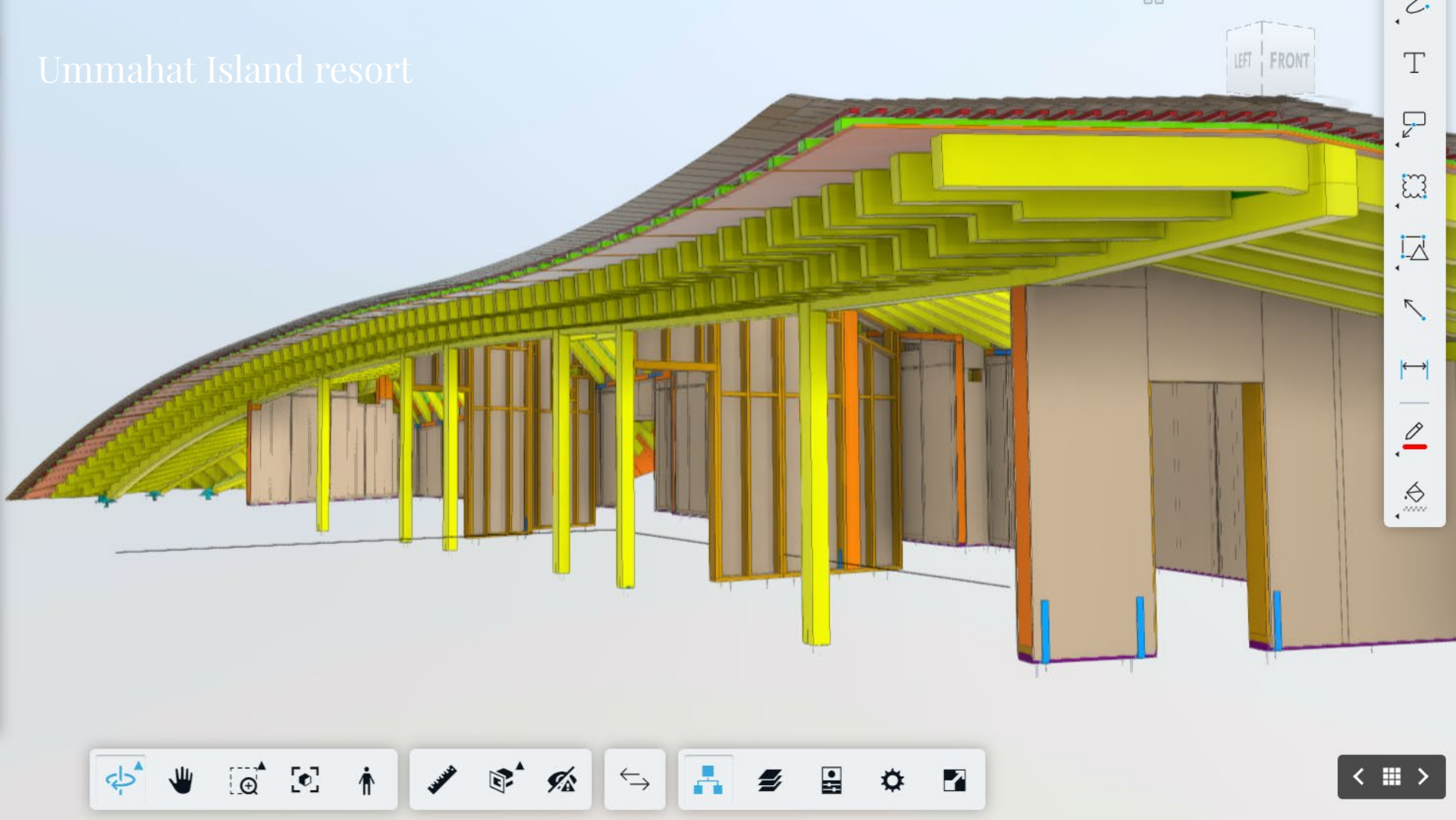
Assembly

Coordination of Systems for Off-Site Manufacturing

The Red Sea Development Company



Ummahat Island resort



Model Based - Assembly Drawings

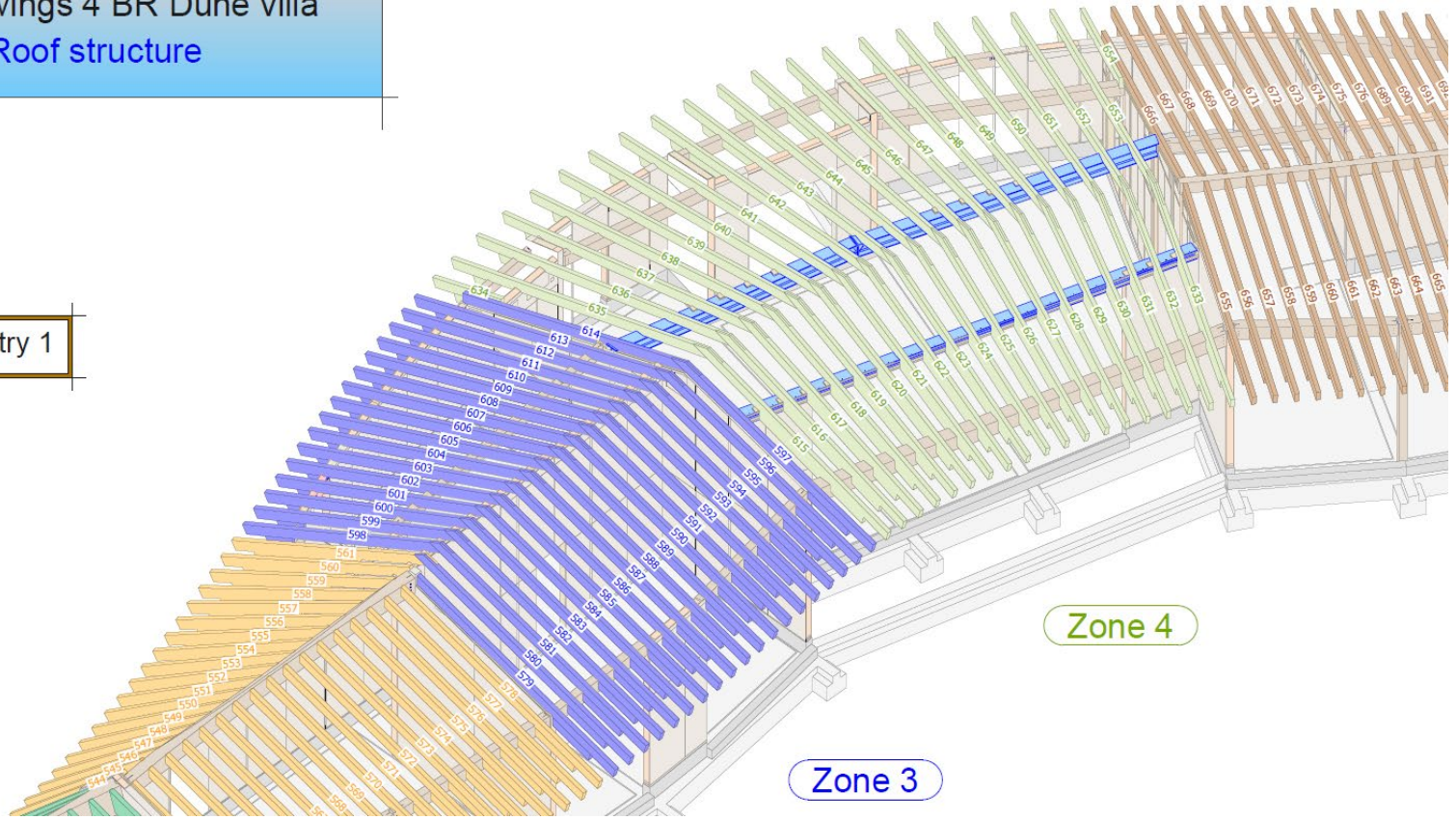
The Red Sea Development Company

Construction drawings 4 BR Dune villa

Stage 4 : Roof structure

Rafters structure : Axonometry 1

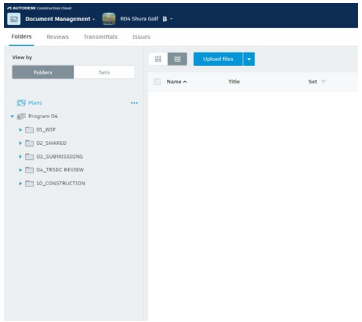
Front view



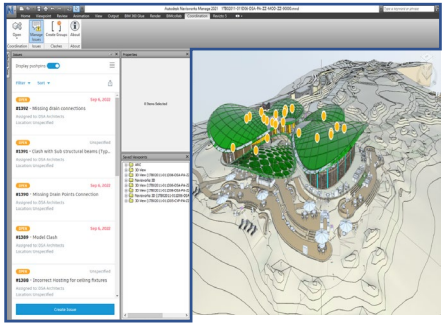

Ummahat Island resort

Summary

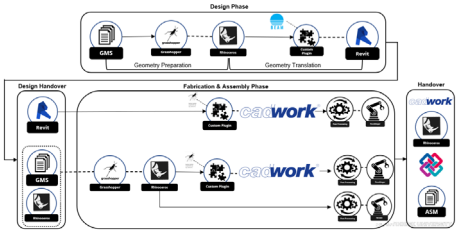
Learn about deploying BIM 360 as an asset owner to work collaboratively and efficiently with all appointed consultants/contractors



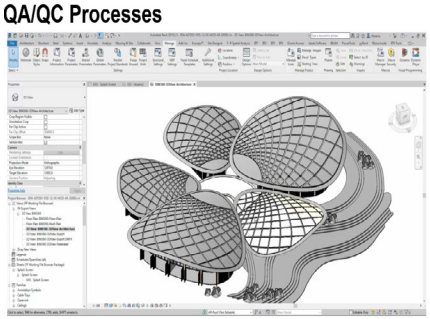
Learn about digitally collaborating with consultants and contractors on achieving your goals for off-site manufacturing



Discover the best practice for
the Interoperability between Revit, Rhino, and cad work.



Discover the critical QA/QC steps required to optimize the Interoperability.



Thank you

Tareq Qassrawi

Linked in

Radu Boeriu

Linked in

Bettina Baggenstos

Linked in