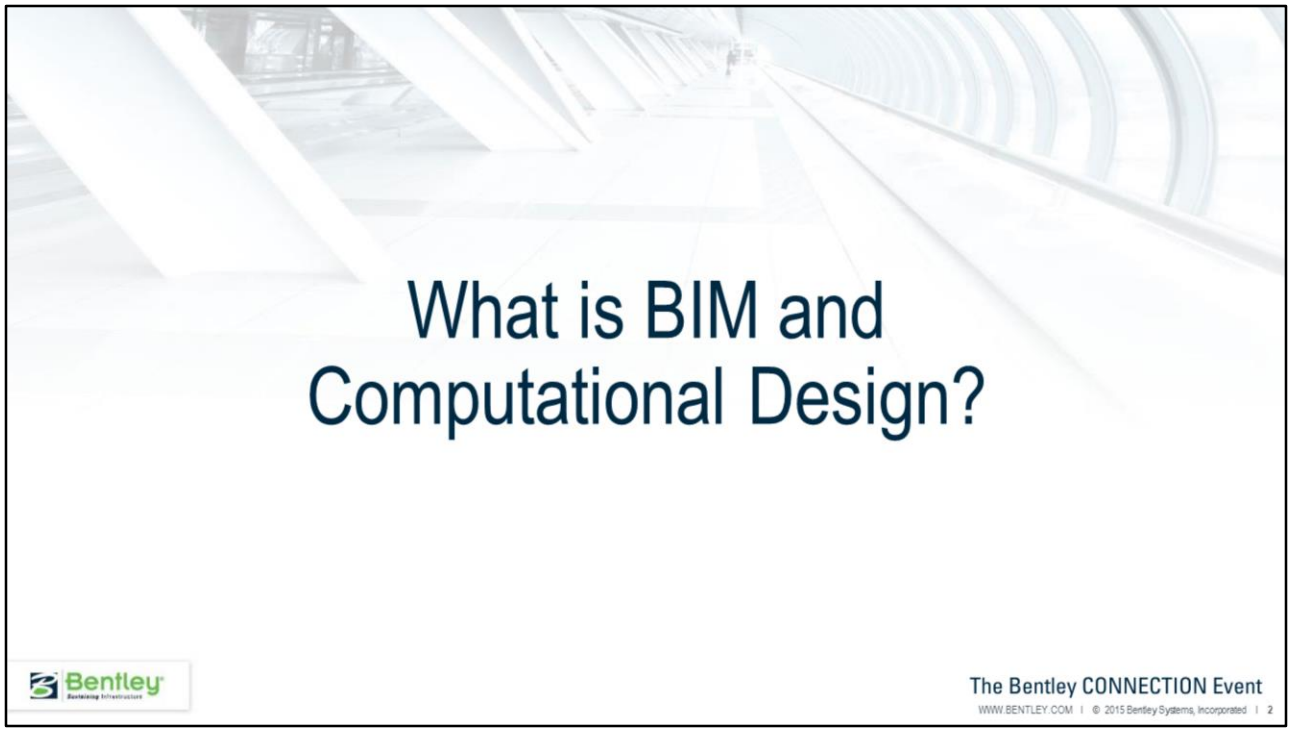
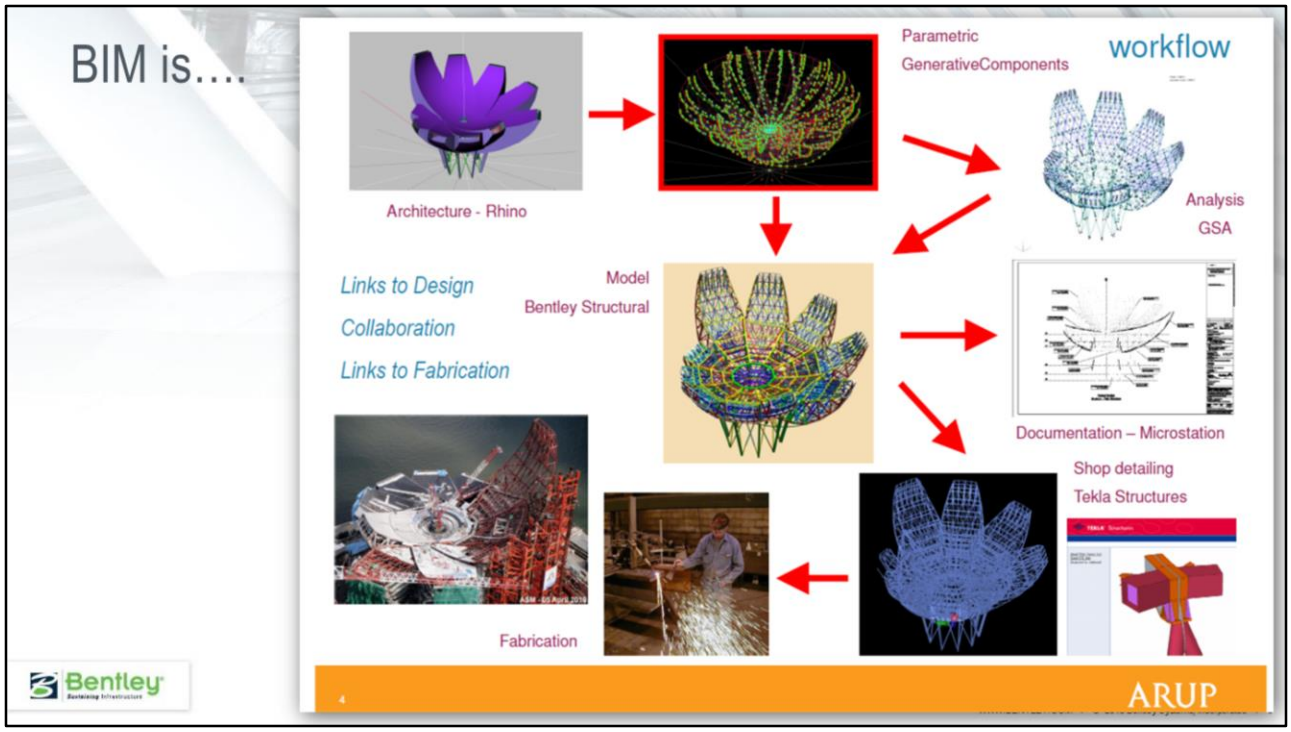
Welcome to Advancing BIM with Computational Design. We'll be focusing on the integration between AECOsim Building Designer, Bentley's Multi-discipline BIM application, and GenerativeComponents, Bentley's computation design application.

I'm **<Insert Name> , <Insert Title>** at Bentley Systems.
<Insert background (optional)>

In this session, we'll discover why AECOsim Building Designer is advancing BIM through greater integration with GenerativeComponents, Bentley's computational design software.



- Let's start off with what BIM and Computational Design are defined as.
- A quick survey who has heard of BIM? Who has heard of Computational Design?
- Most importantly has anyone experience of using them together on a project?



- Lets say **BIM is a process involving the generation and management of digital representations** of physical and functional characteristics of places.

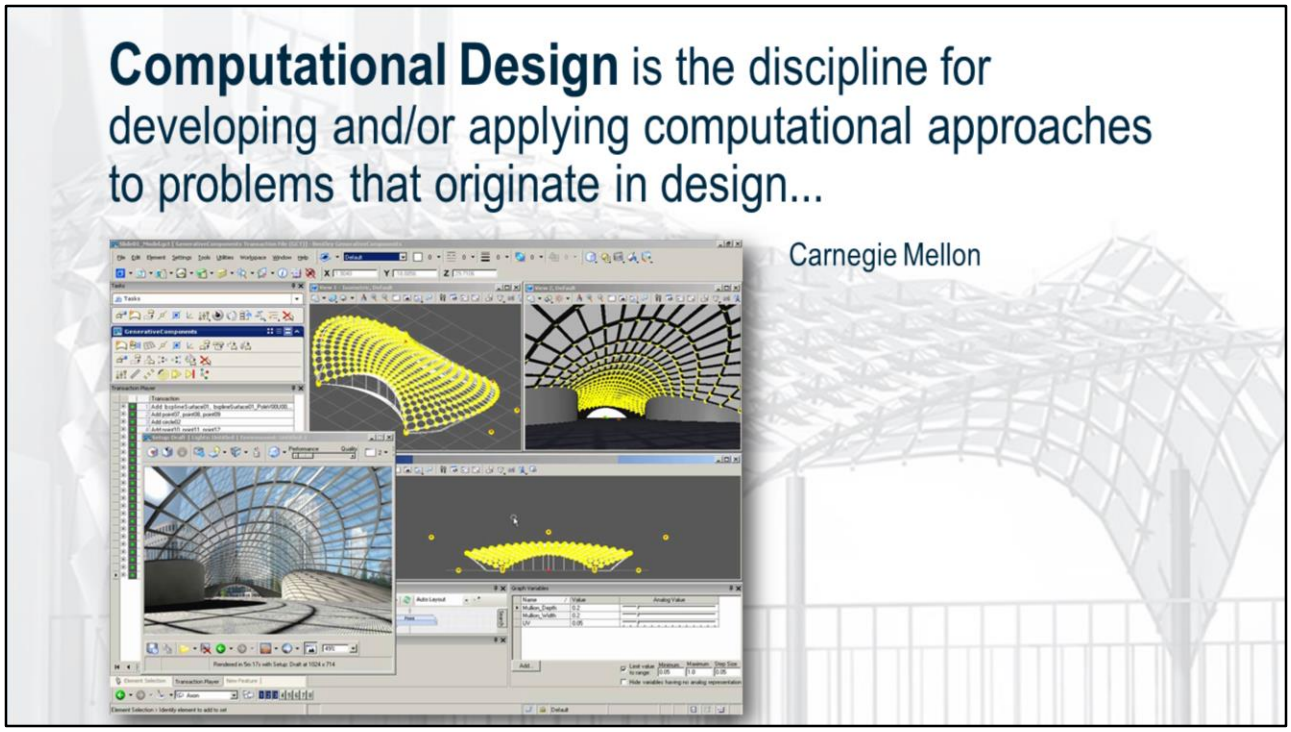
- Its about **generating information, multiple sets of information,** because you need to find the correct set of conditions to satisfy your design ambitions.

- Its about **moving data from design to analysis and fabrication effectively**, to deliver the optimal solution. That could mean multiple tools each optimised and or dedicated to a purpose.

- The example above shows the Structure of the Science Museum in Singapore. Notice the wide variety of applications used for purpose, from differing vendors, to

produce results for each piece of the design and build.

- Generative Design was a small but integral piece of the design process. It took the form, and progressed the form from a concept, to something that contained BIM elements, which allowed for Analysis, Documentation, and Fabrication,



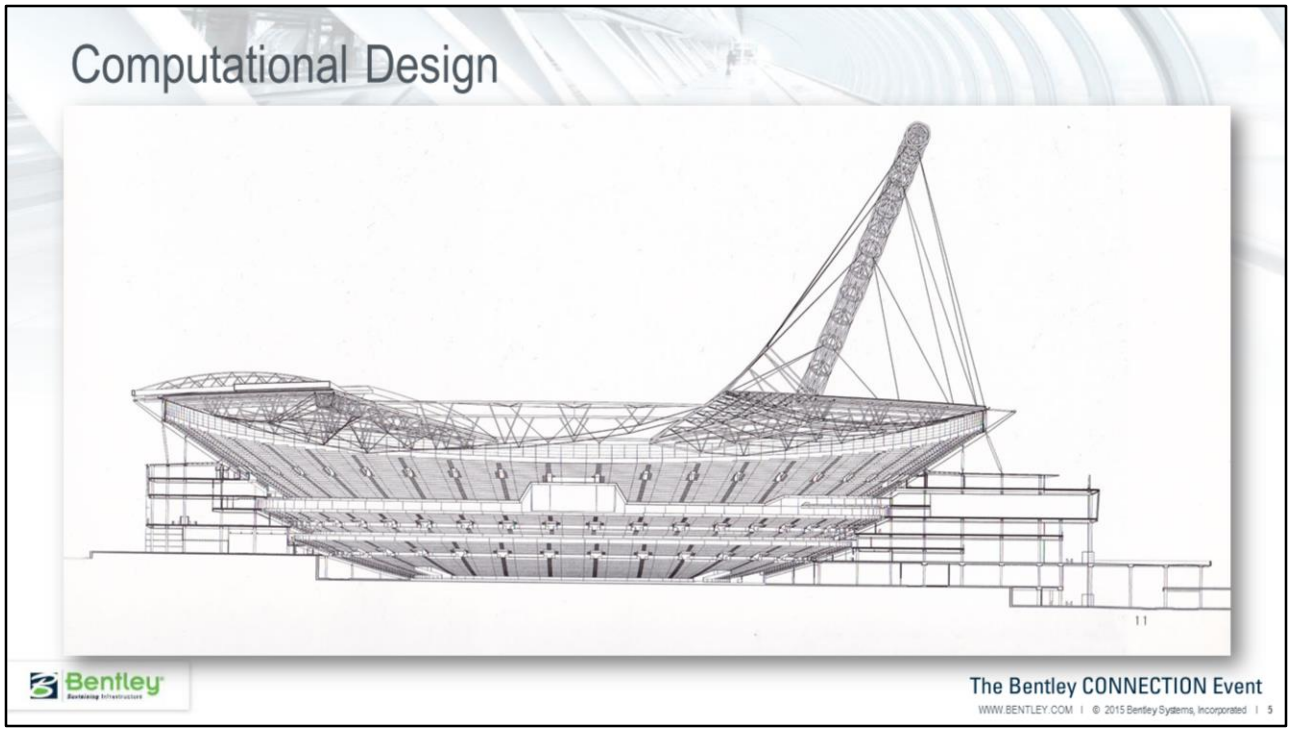
So, what is Computational Design? Computational design can also be described in a number of ways:

- "**A method in which the design is generated by a set of rules**, normally by using a computer program. Most computational design is based on parametric design and is a **fast efficient and effective method of exploring design possibilities.** "

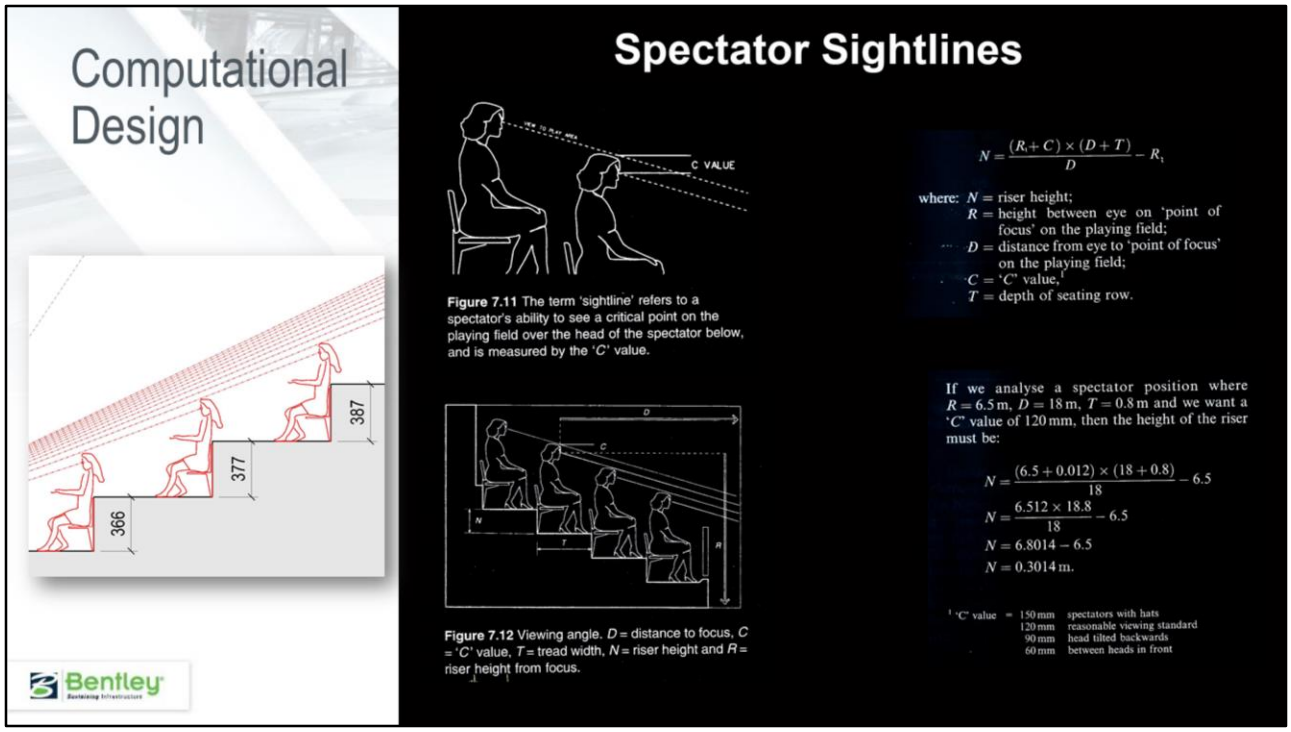
Or you can see on the slide

- **Computational design is an approach that grew out of academia initially** but has over the last few years found an enthusiastic and appreciative audience in the professional world

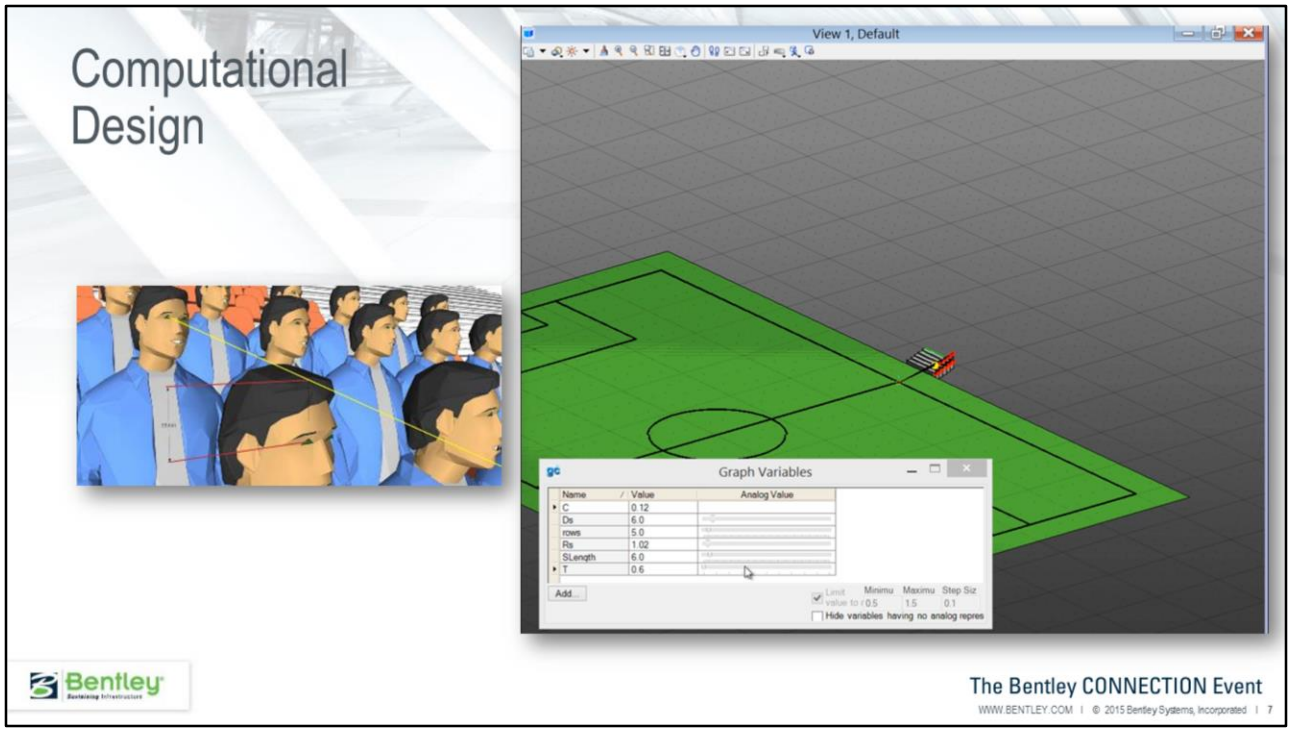
- This movie shows the ability to **apply variation's to a design** and to visualise the results very quickly **allows the designer to make more informed decisions**.
- The decision inputs to be reduced to **the simplicity of a value slider**.
- **GC is based on relational and dependency models** – so it captures relationships between **parameters and objects**. When you change a design midway through…that **change will propagate throughout the model based on the relations and dependencies**. What normally would have taken you **several days to incorporate one change**, now you can do in a few hours. **Computational design automatically propagates changes** without the need to manually re-build the entire model. This reduces a lot of re-work for you since it **eliminates the need for one-off modeling.**



- Lets take one of the classic examples for Computational Design is the Stadium**. Firstly Seating bowls** follow a formula which produce a parabolic array in section. It allows for the spectators to see over the person in front.
- **Secondly we have non conventional geometric structure and architecture**. There is little repetition and the repetition there is tends to be on the component level, which changes direction around the stadium. Computational Design allows of a single instance of the component, to be replicated and explored throughout the design.

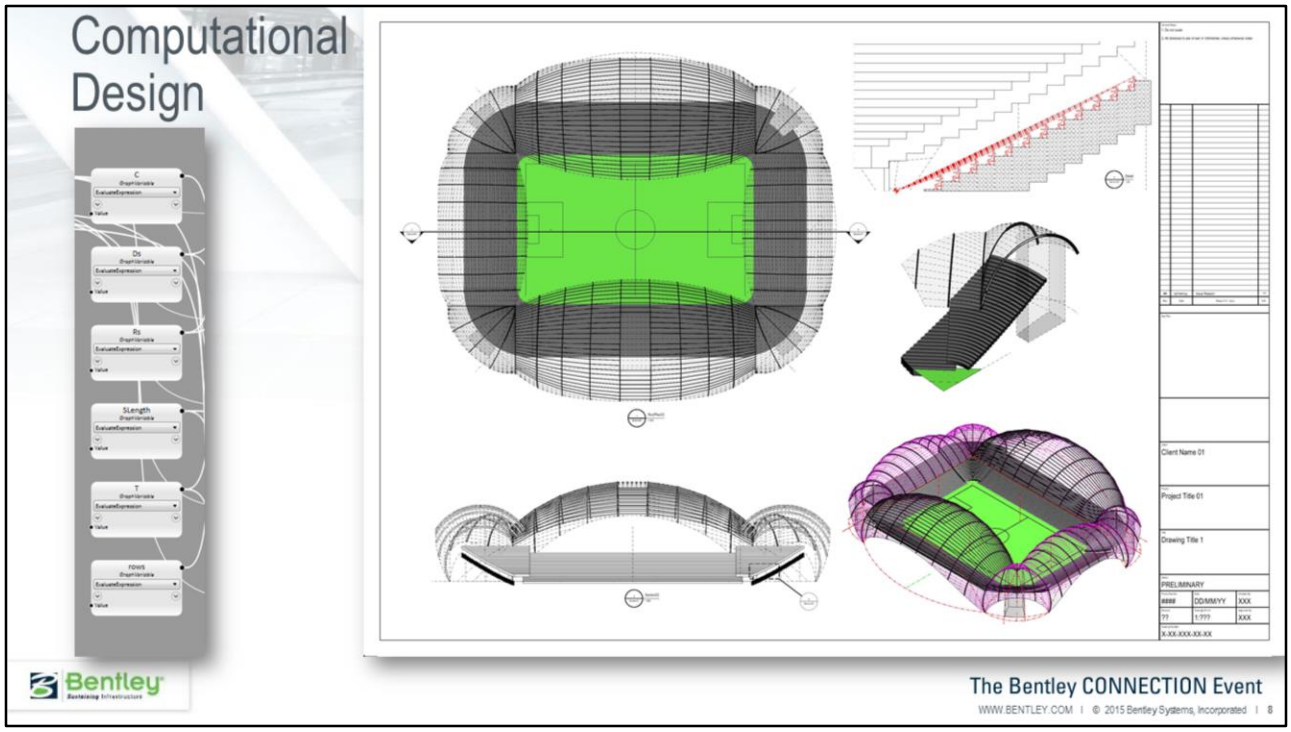


- **Seating bowls are slightly parabolic in section.** It allows for the spectators to see over the person in front. A formula is used to calculate the height of one row to the next.
- **Using the formula above, the end result produces an "N" value and that "N" value is the height of one row to the next**. As you proceed up the rows, the "N" value increases to produce a parabolic curve allowing the spectators to see over the top of the people in front.



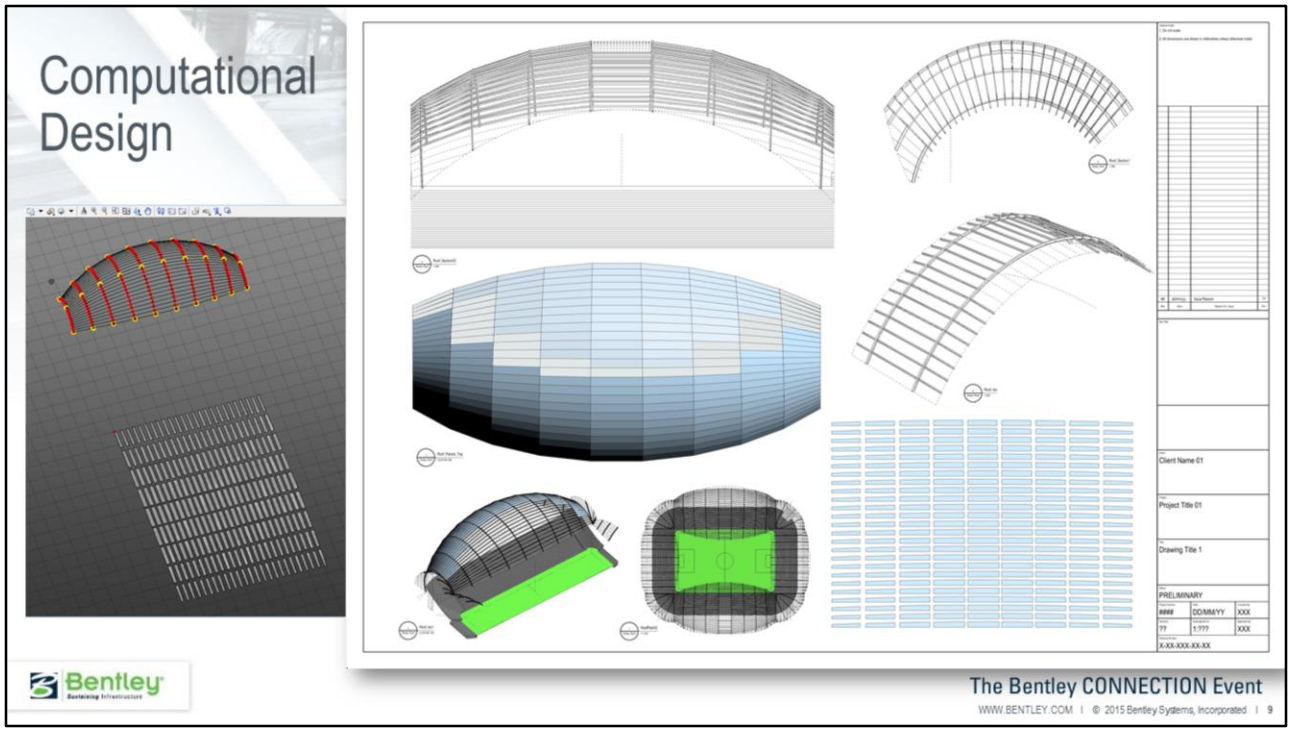
- Taking a computational approach **we can achieve a level of automations and flexibility** that allows the user more **time to explore and examine a greater number of options**. We can then link these explorations to outputs to further enhance productivity.

- **We've added that values as variables and included a slider bar** where the values can be dynamically adjusted. The result is a dynamically adjustable stadium, drawings and the script can be used over and over again.



- In the Stadium Example the ability to change values quickly has allow the creation of the seating bowl with correct sightline parameters.

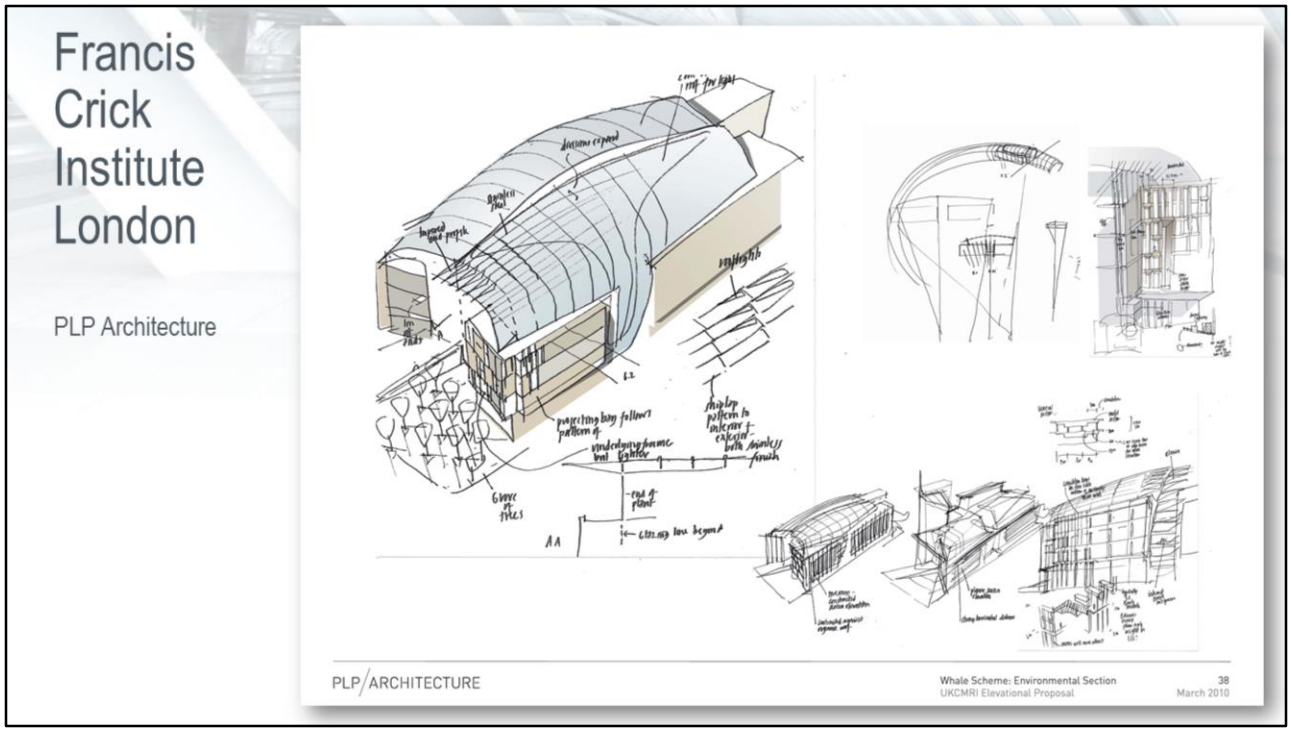
- **Using Dynamic Views, part of all Microstation based design applications** all the views to be placed on the sheet. **As the design changes in generative components, the drawings are automatically updated to suit.** A single change in Generative Components can mean a change on many drawings at once.



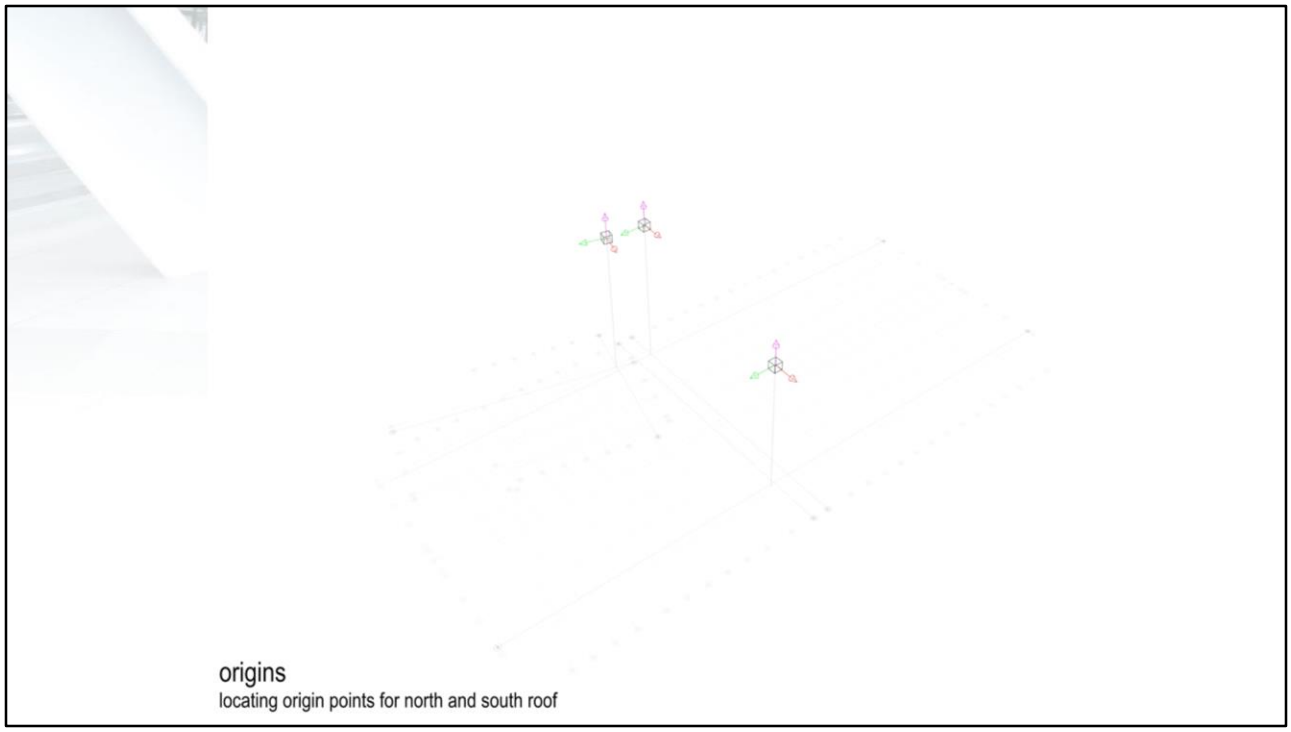
- **Secondly the rationalisation of the curved roof geometry is a key use of generative components**. Something that is **almost impossible to achieve in a direct modelling process**, is done quickly and easily using the tools in Generative Components.

- **The structural members and the panels are all by products of GC**.

- **Taking it further we can flatten the panels, which can be used in fabrication or model making**. As the form changes the panels re-build in both the model and in the flatten variety.



Lets look at an example of where GC was used, The Francis Crick Institute in London, designed by PLP Architecture used GenerativeComponents **to link the key aspects**, **controlling the design for the main building**, to aspects that needed **to control the roof structure**.



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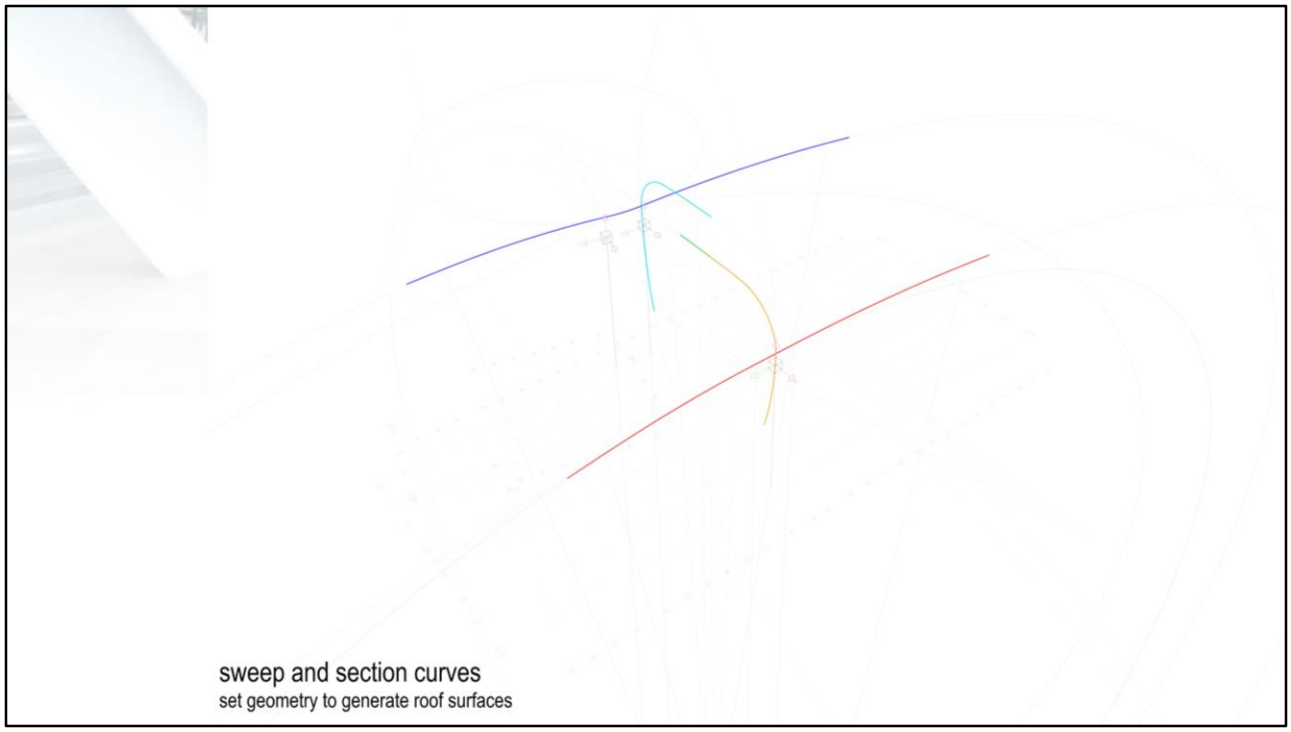

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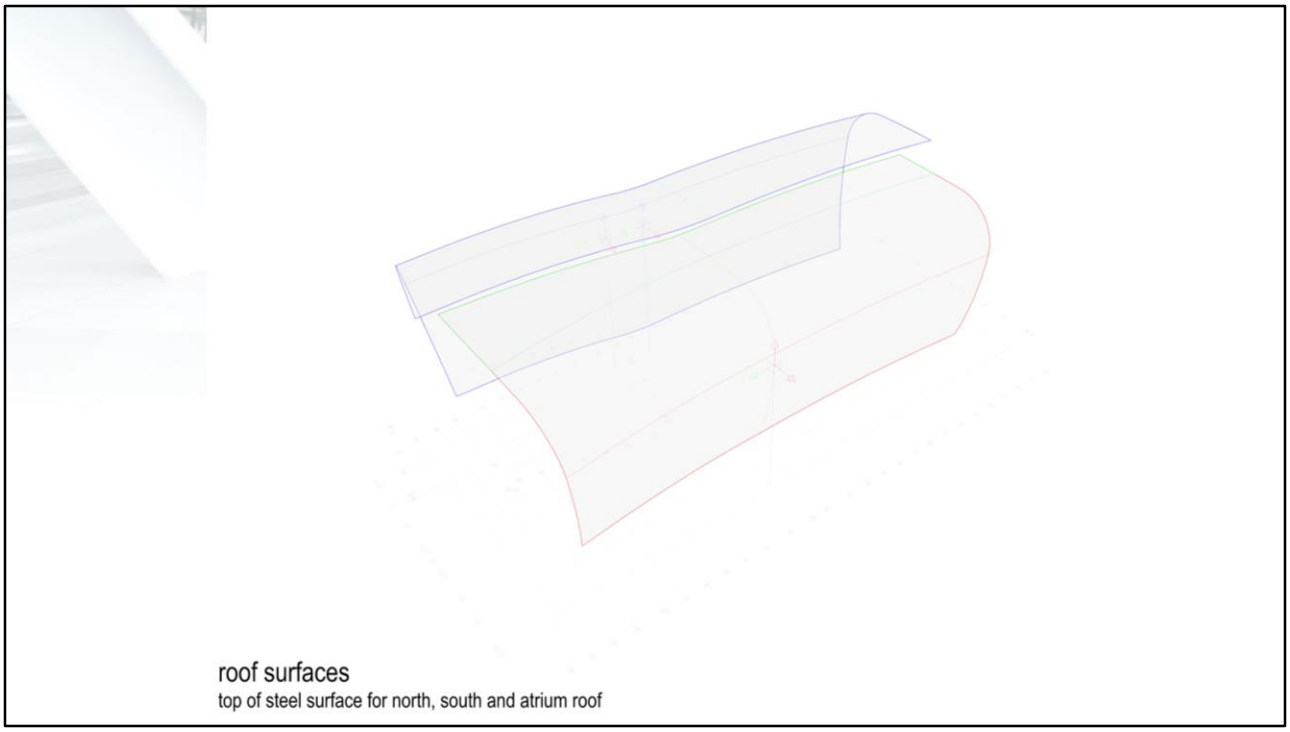

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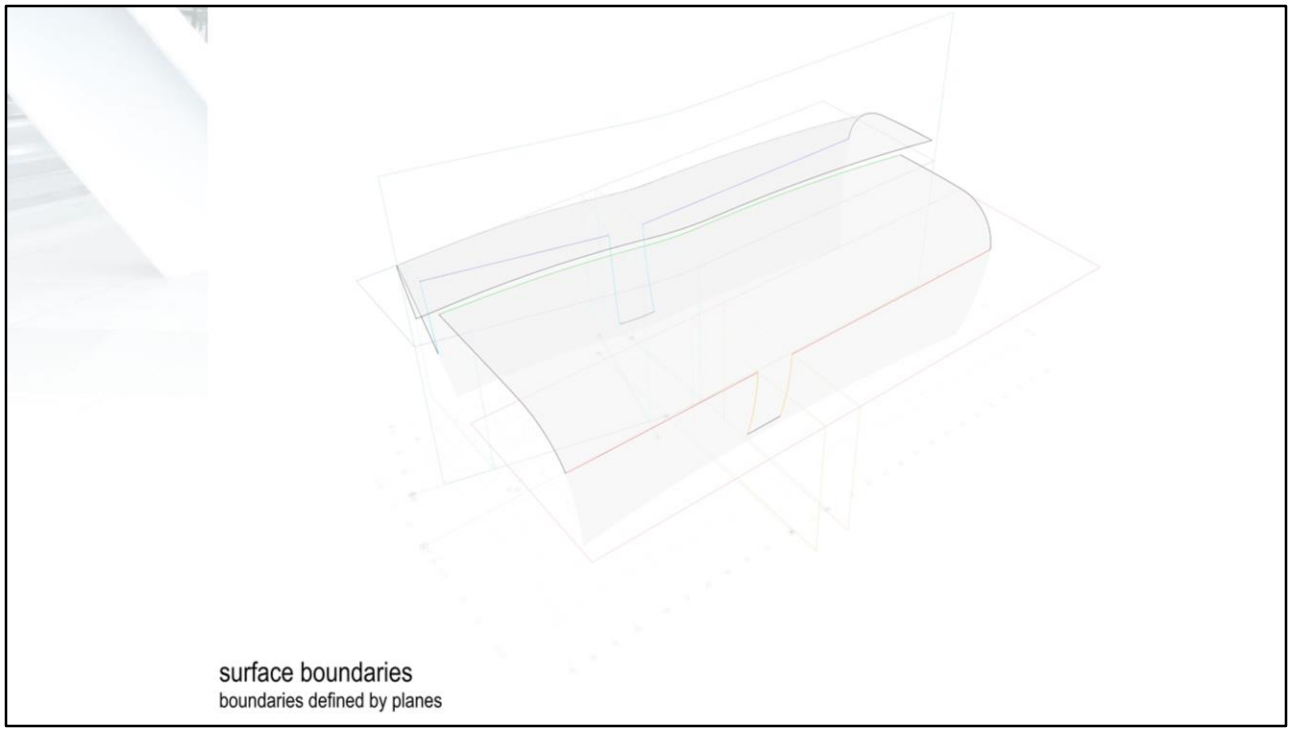

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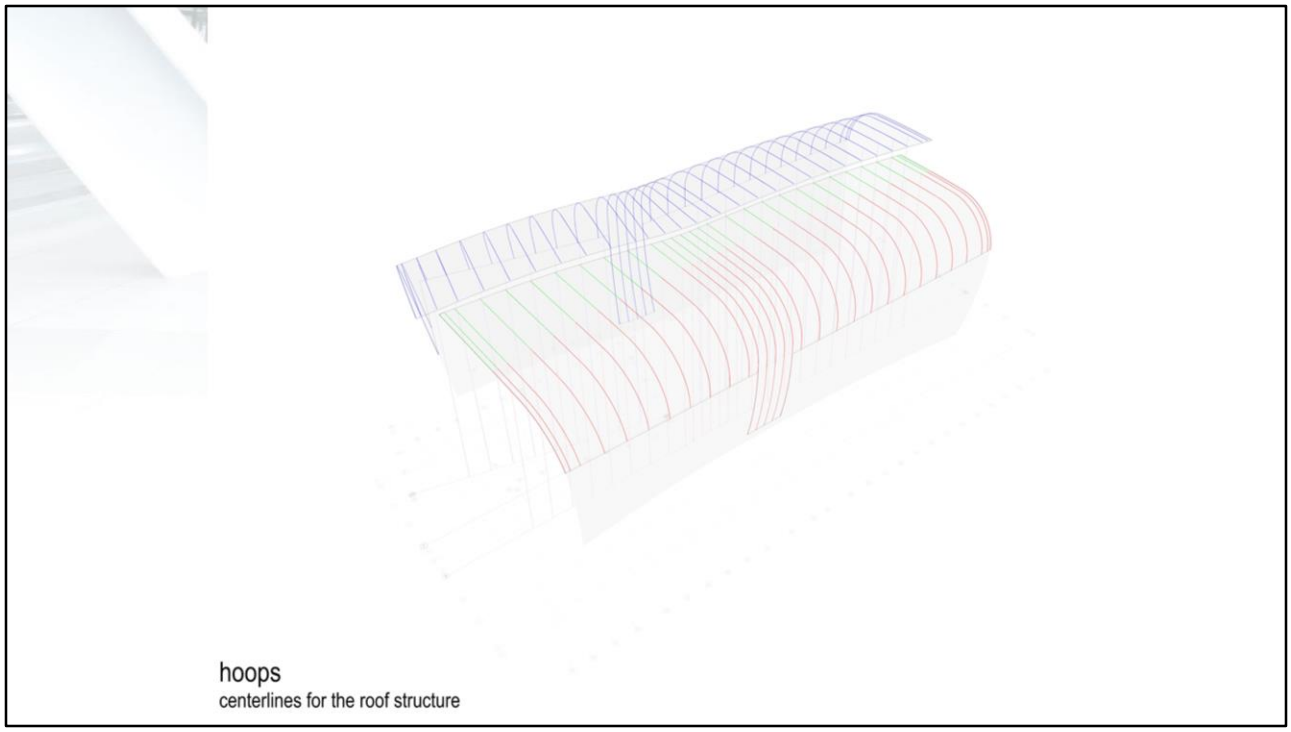

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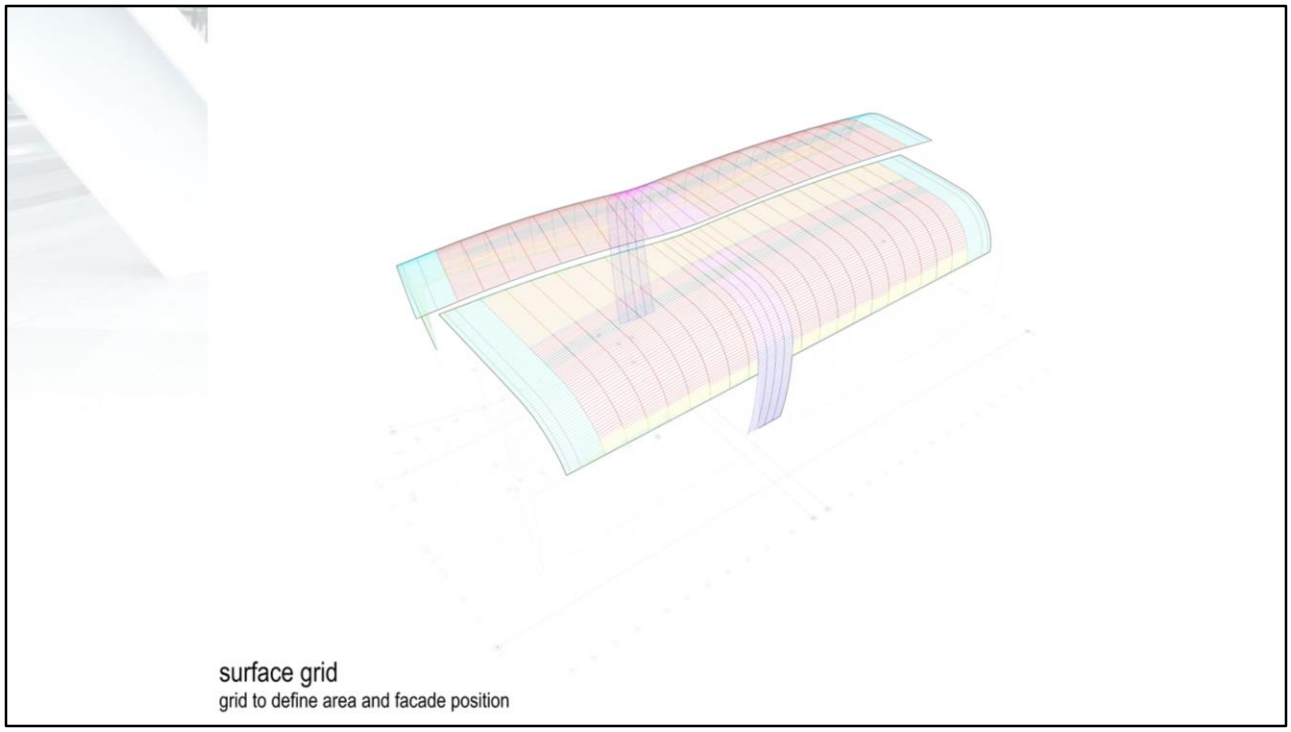

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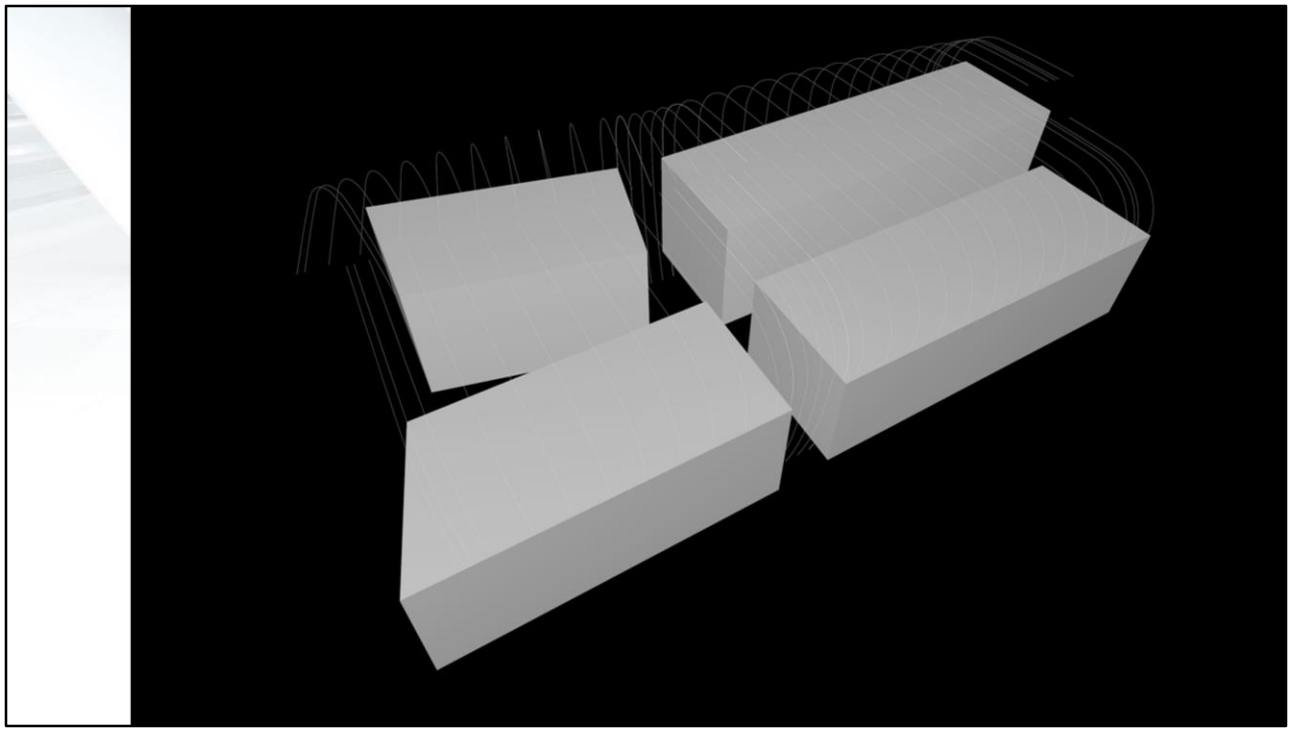
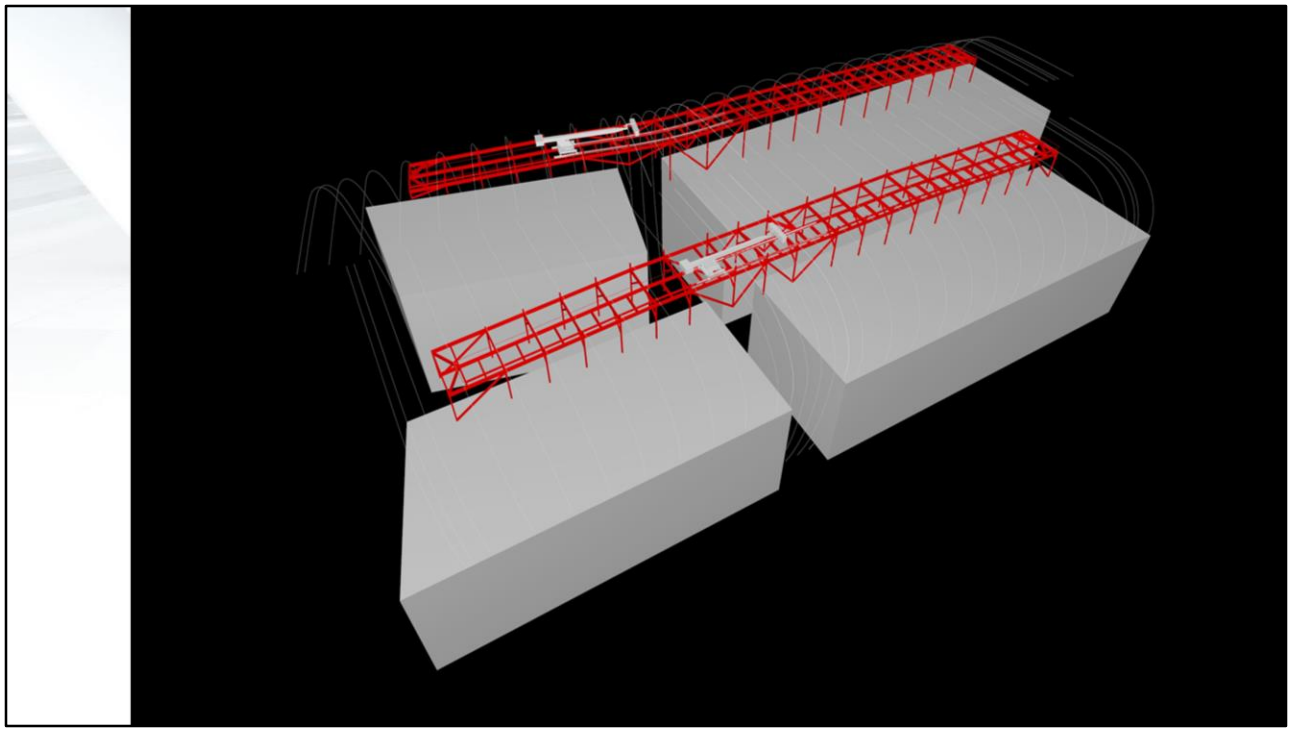
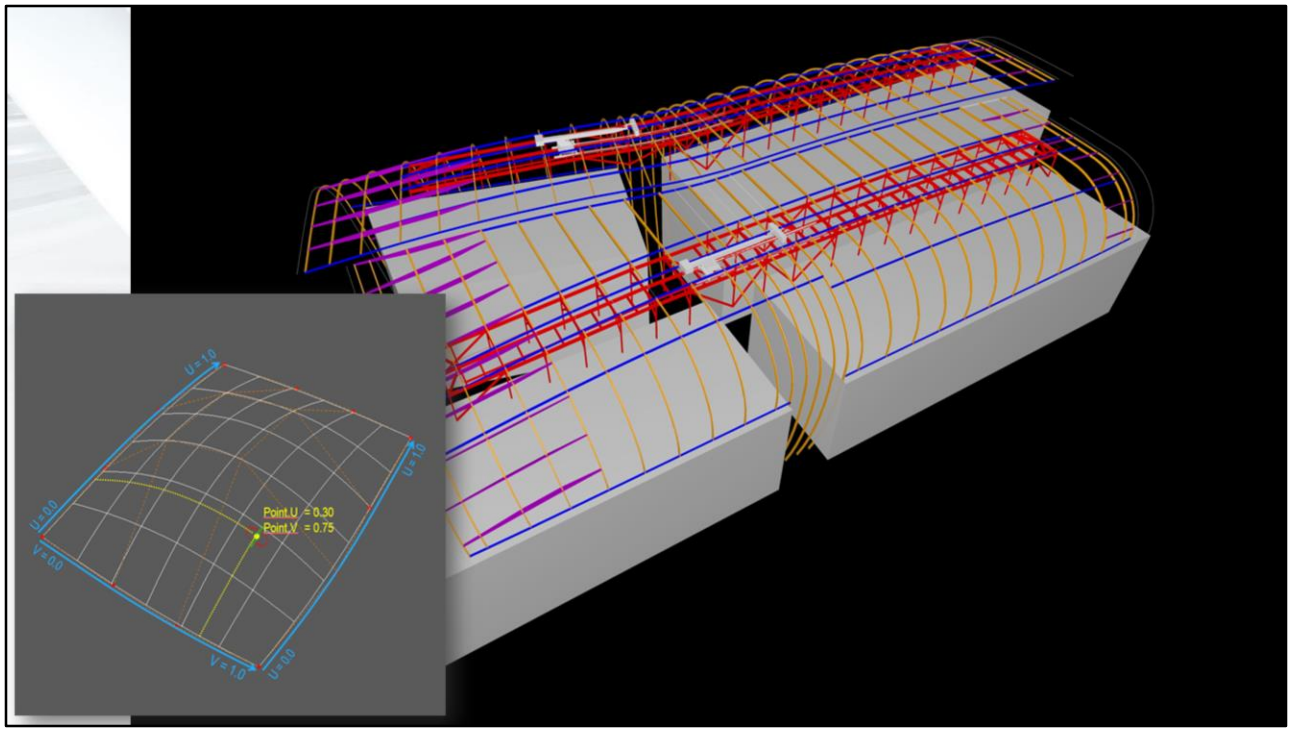


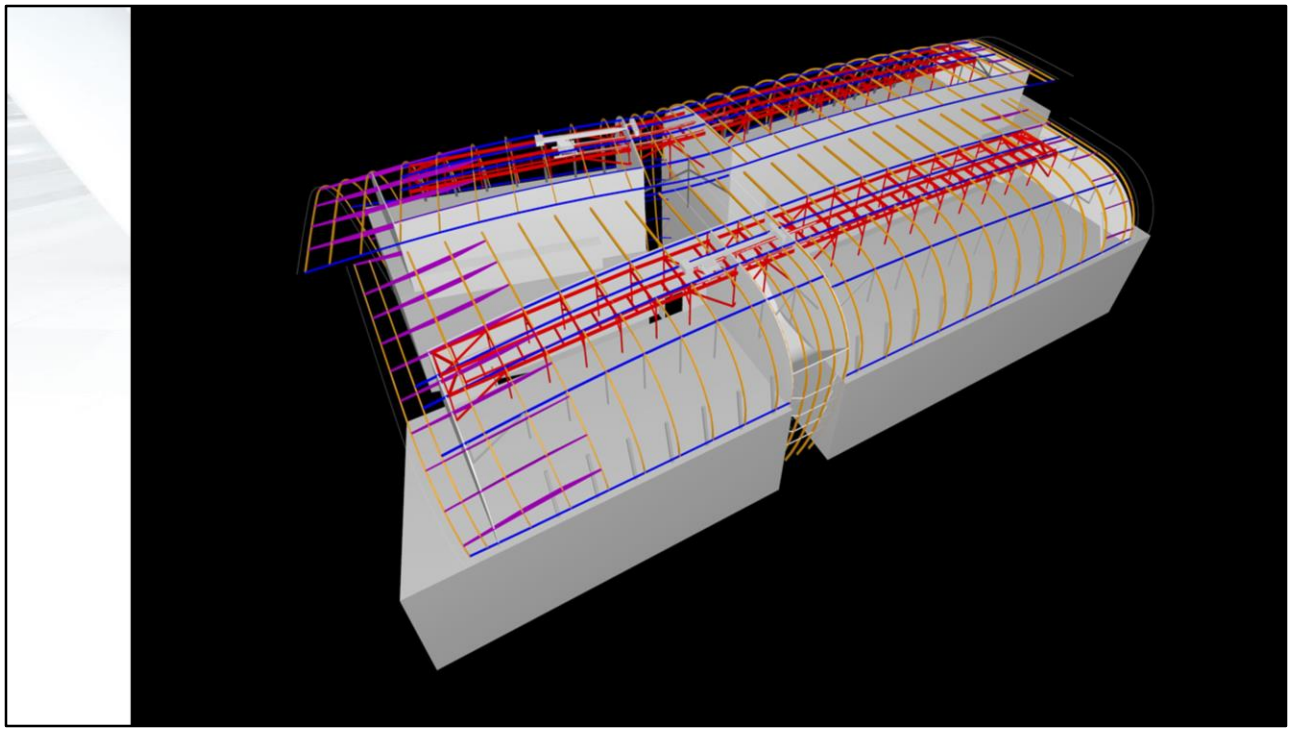
Looking at the detail, the main body of the building was zoned into 4 areas and linked to the roof.



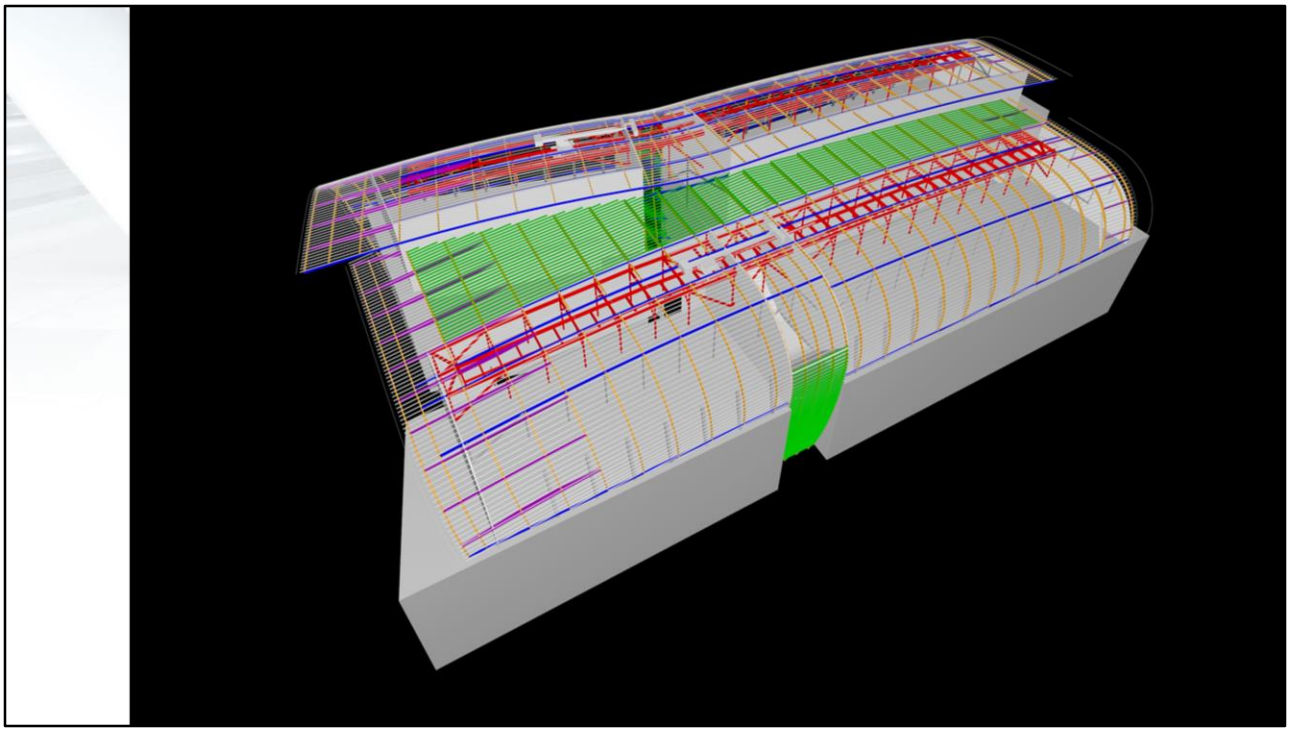
The cleaning cradle structure was a direct result of the roof geometry



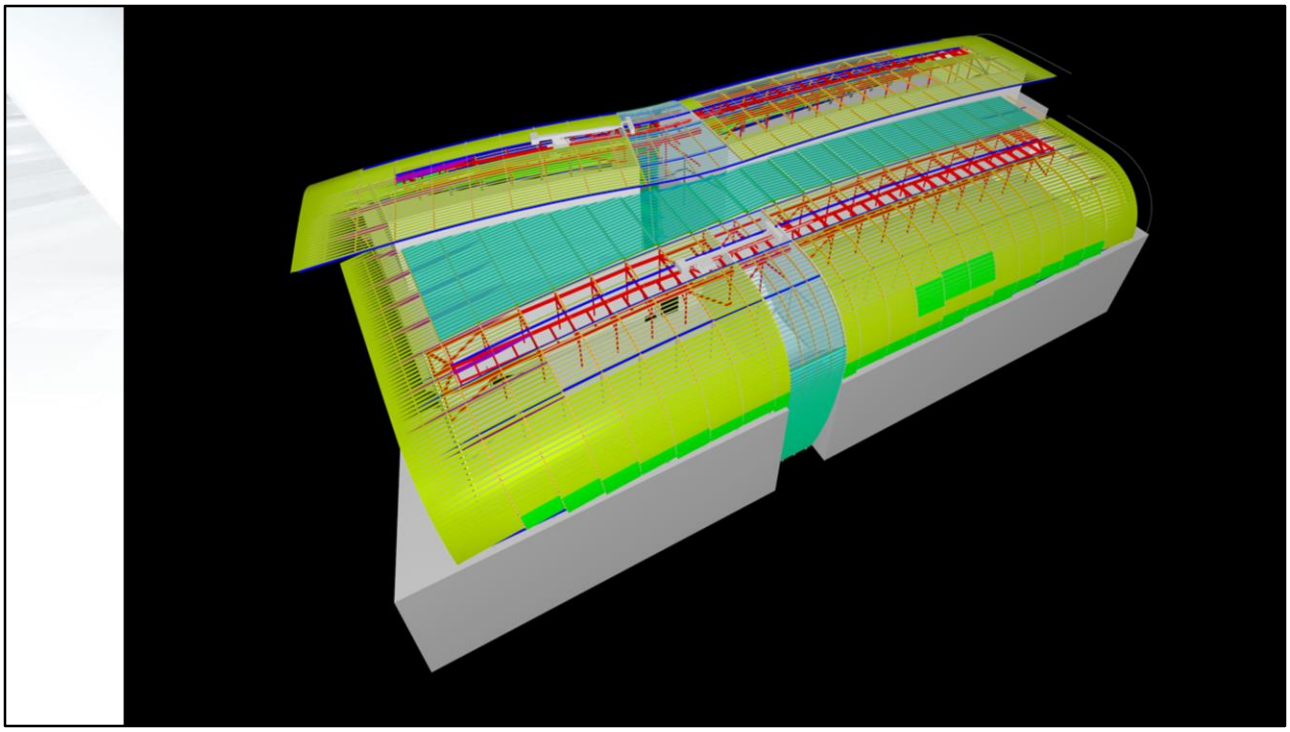
The structural members were then designed and fabricated to follow the roof at the UV and paramter.



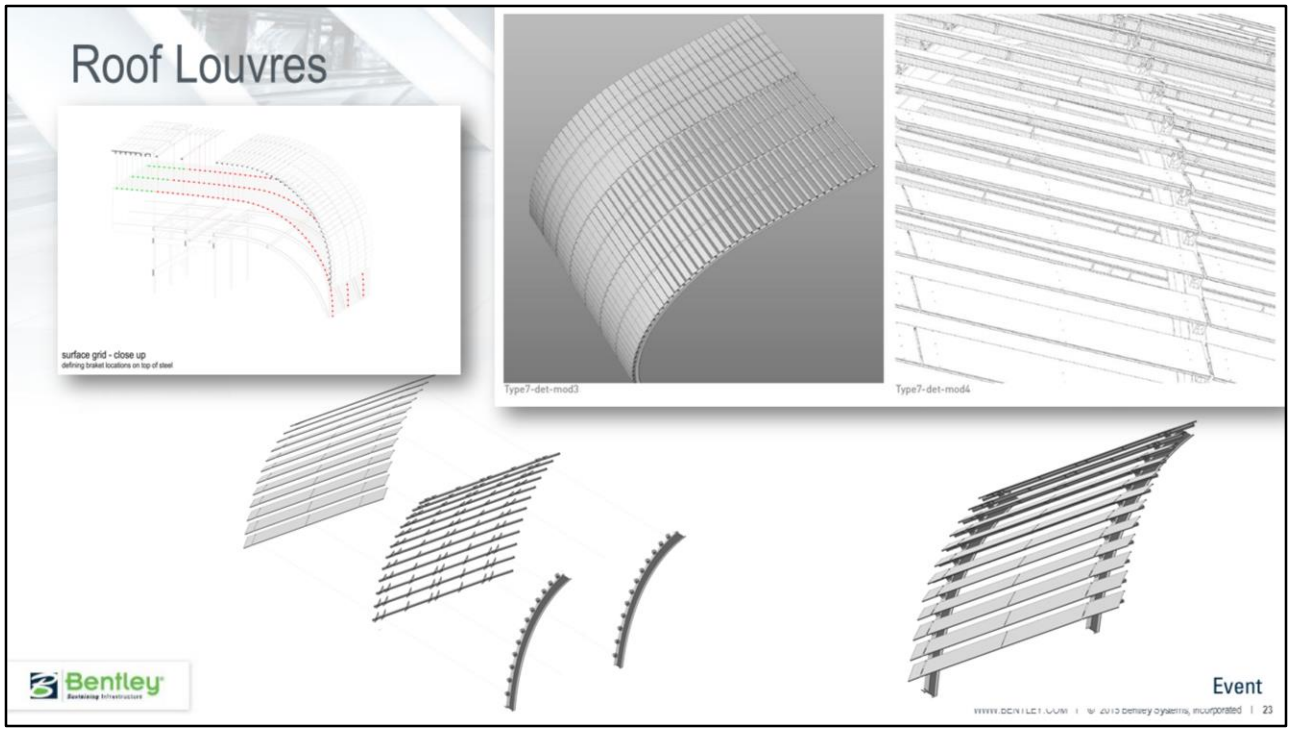
The main internal walls were extruded to mean the curve of the roof



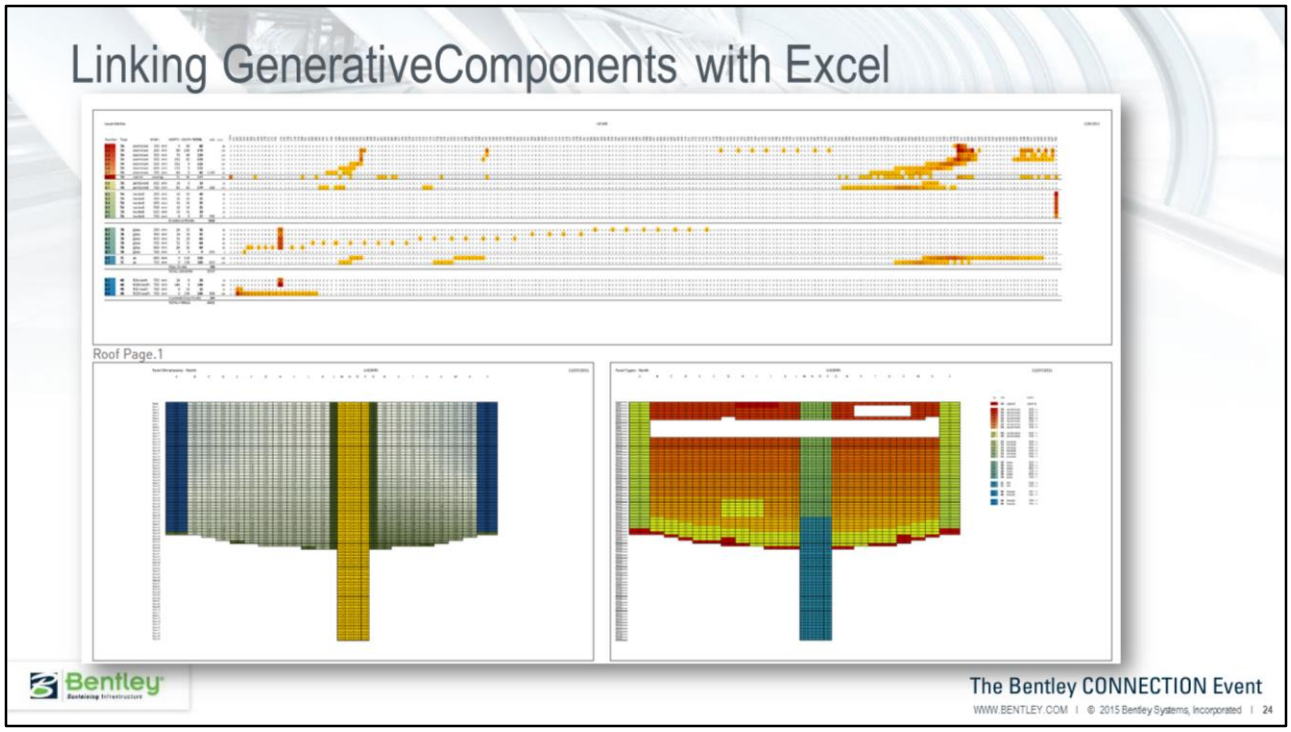
The panels of the roof were added added to the geometry at the precise place of the overall roof form



..... And finally the lourves were added, which in themselves took on a new geomtrical direction while still sitting on the form.

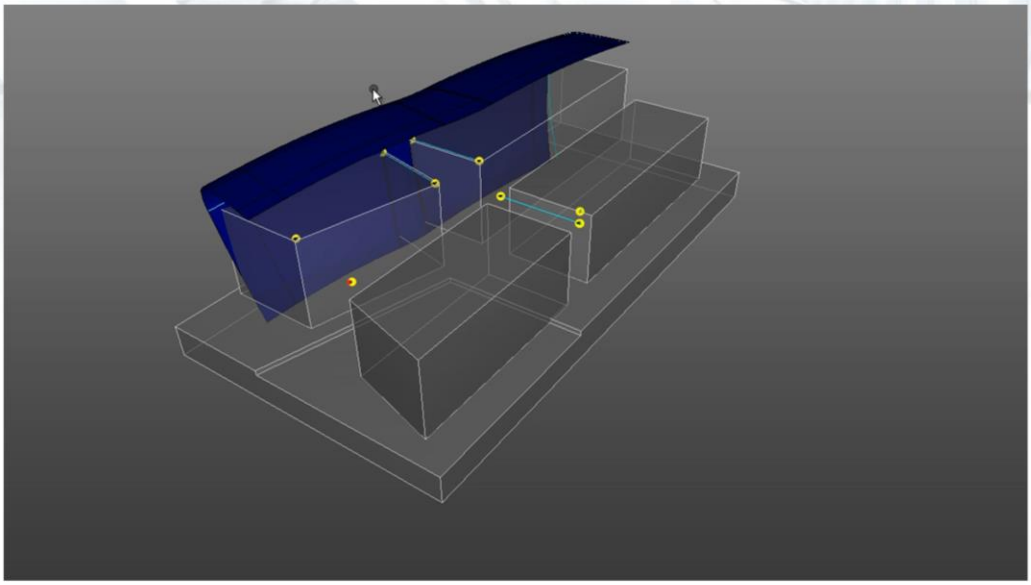


Then most importantly, the documentation for construction could occur rapidly and easily without best guessing the geometry



Linking the panel angles to excel we can get a good understanding of heat loads on the panels through certain times of the year

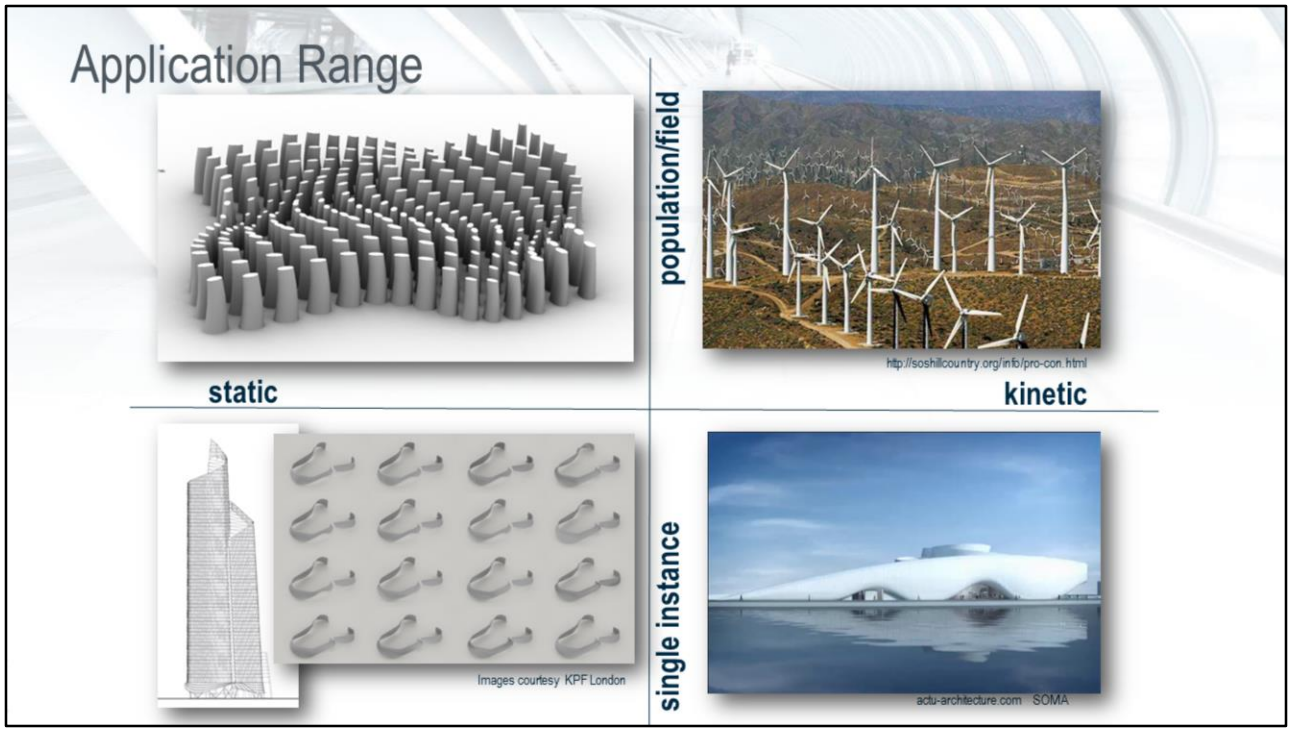
The Francis Crick Institute: HOK – PLP Architecture



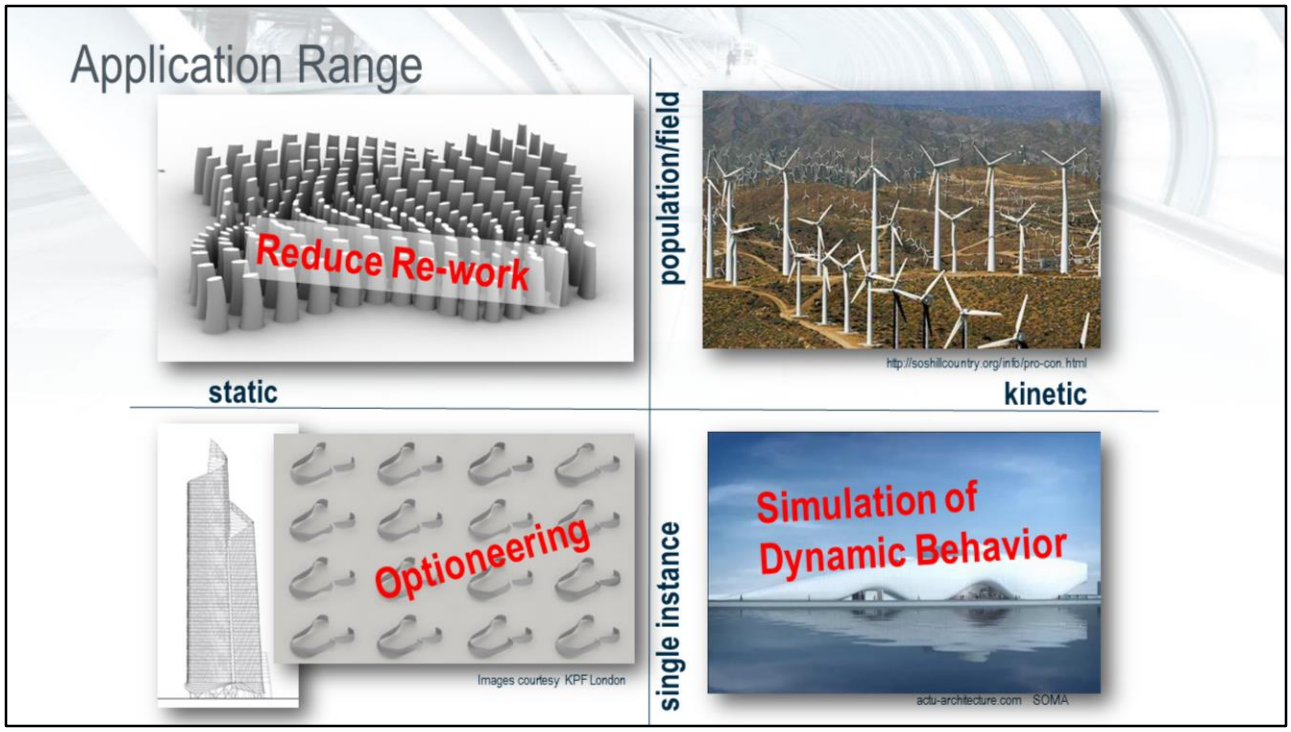
<Play 5 minute video>
<Note: You might want to omit or edit this video down>

Lets look at this in action

As the images show, the roof whilst being challenge has a large effect on relatively standard design below it. **Both together required integration between standard building elements and computational design.**



GenerativeComponents is commonly used **across a range of design problems to help provide a viable solution**.



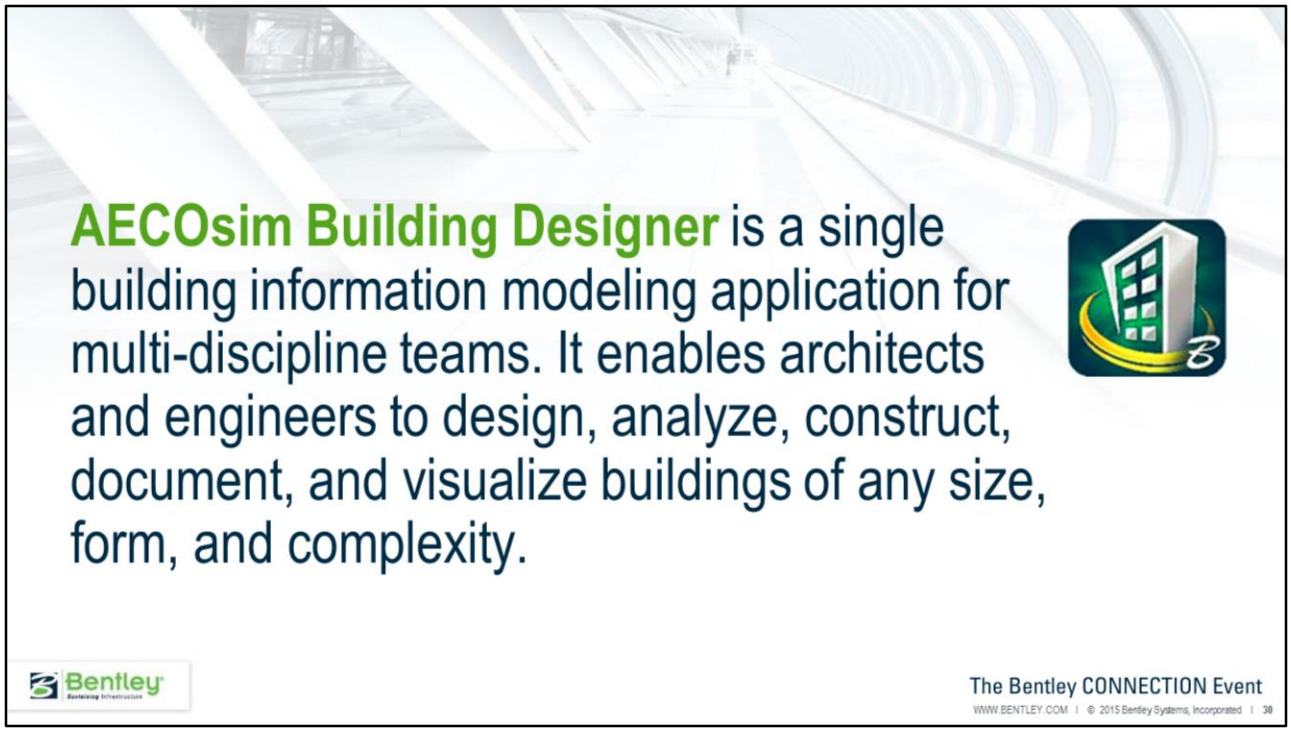
Just to summarise then GC is commonly used across a range of design problems to help provide a viable solution.

- Application range of parametric design:
- single instance to field
- static to kinetic
- Leveraging adaptable variation*
- continuous differentiation *

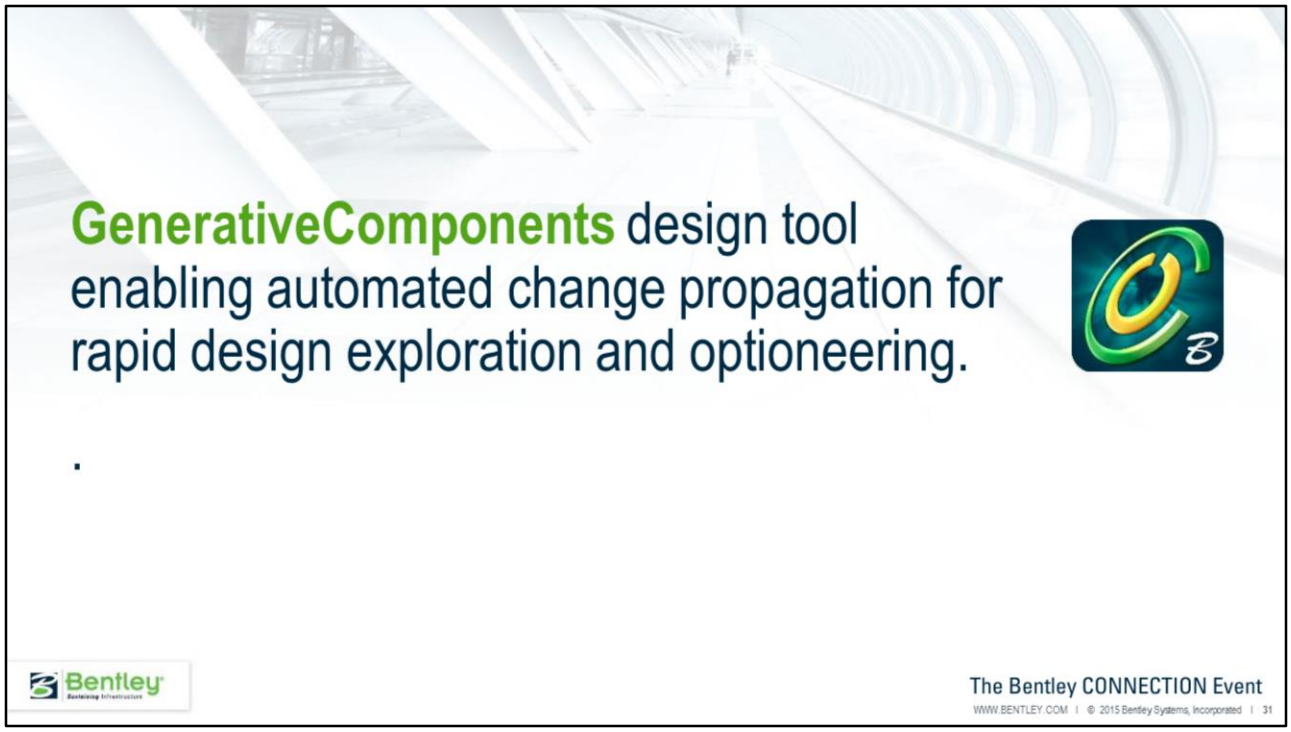
* Source: Parametricism manifesto, Patrik Schumacher

- When we talk about advancing BIM with computational design, **one strategy is to strengthen the ties and interoperability between AECOsim Building Designer, Bentley's multi-discipline BIM software, and GenerativeComponents, Bentley's computational design software**.

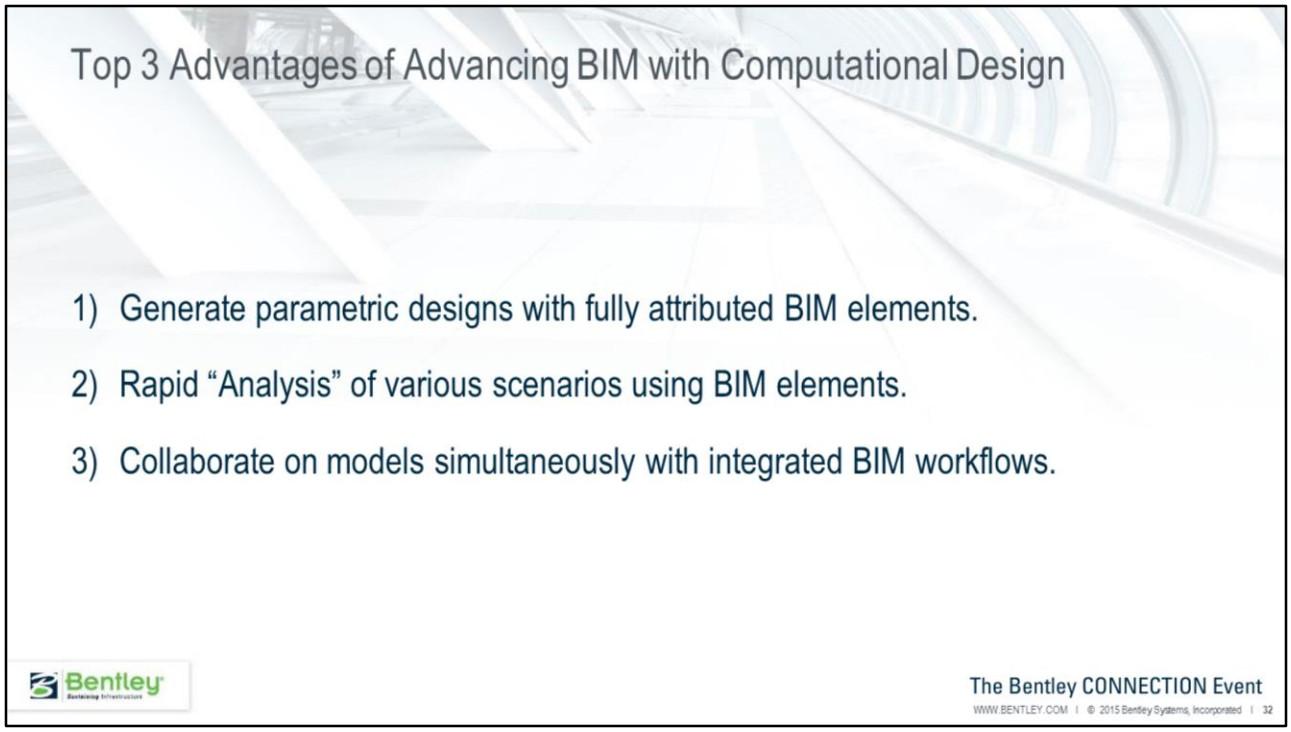
- When you integrate these two applications together and marry BIM with computational design, you get a powerful tool that helps designers rapidly explore designs, respond to changes faster, model with design freedom, deliver information-rich deliverables, and much more.



- AECOsim Building Designer **is our multi-discipline BIM application** that provides **a complete set of tools for** architectural, structural, mechanical and electrical design.

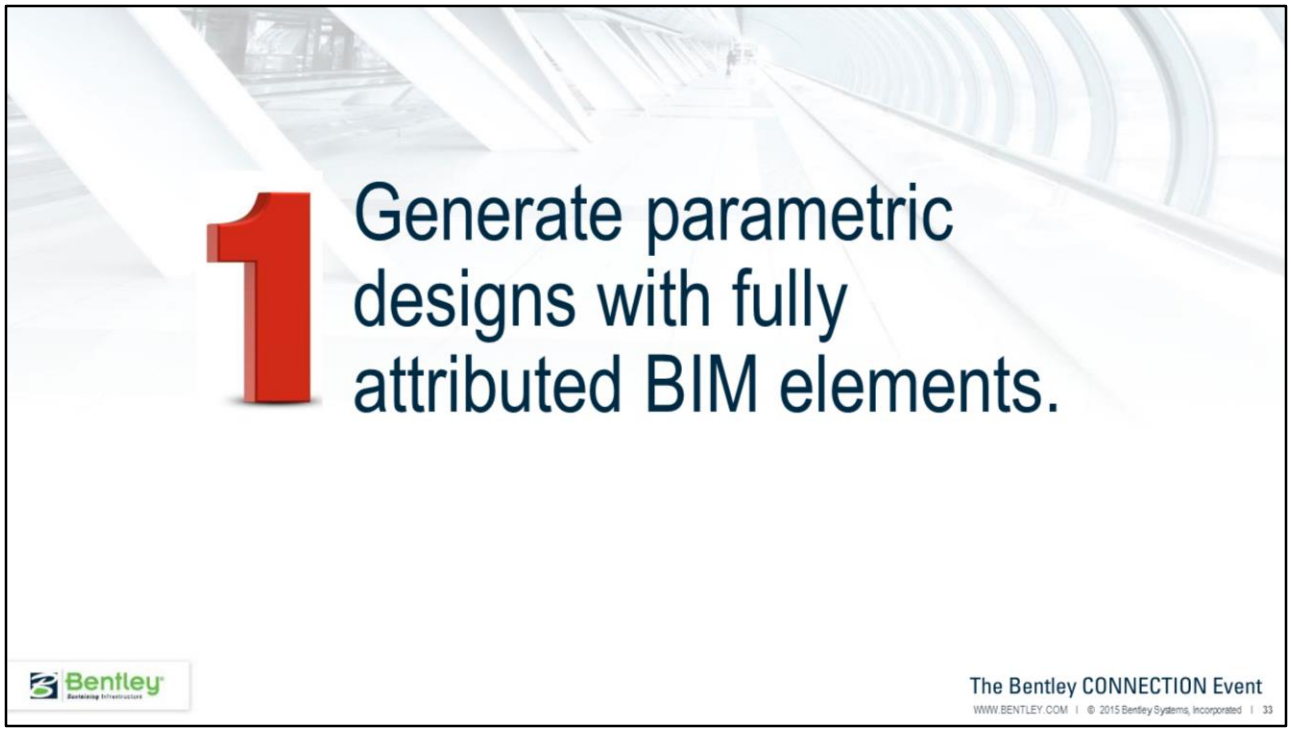


- GenerativeComponents **enables designers to explore more possibilities**, in less time, create better designs and efficiently **create, manage and fabricate complex geometric relationships**. It is a great tool for exploring conceptual modeling and refining designs using **“what-if” scenarios**.



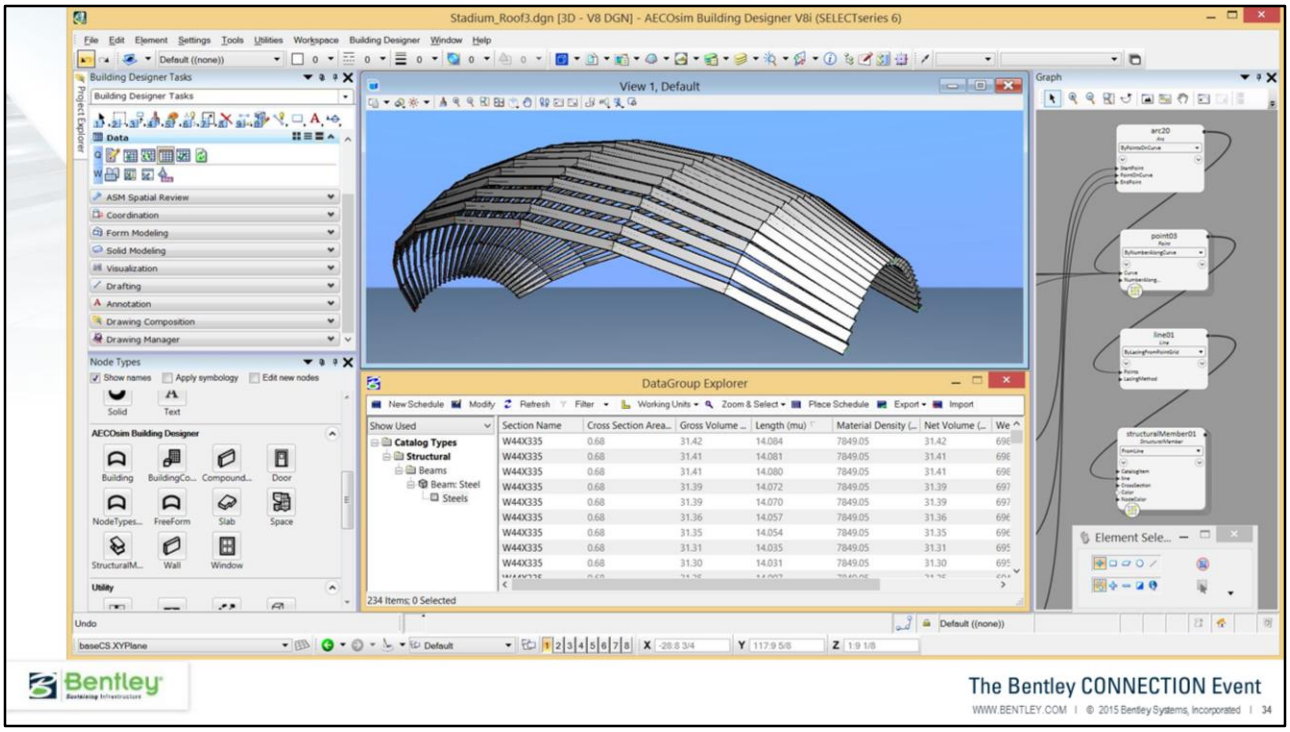
When integrating ABD and GC, here are the top advantages:

1) Generate parametric designs with fully attributed BIM elements.
2) Rapid "Analysis" of various scenarios using BIM elements.
3) Collaborate on models simultaneously with integrated BIM workflows.

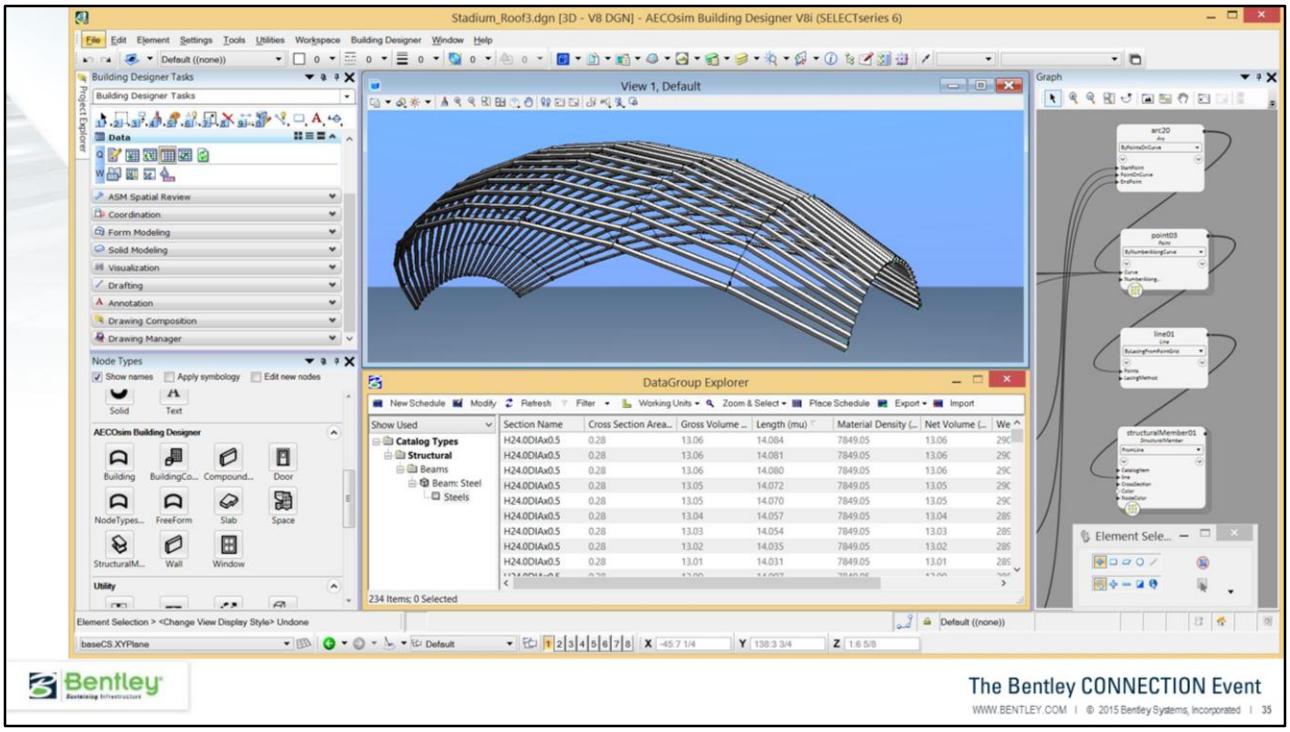


- **AECOsim + Generative Components will allow you to generate parametric designs and explore various scenarios while maintaining the information within models with fully attributed BIM elements**. So walls, doors, window, slabs, beams, columns, spaces, floors will all have GC features for placement and control. And once placed in the model, the objects behave just as if they were modelled manually with ABD.

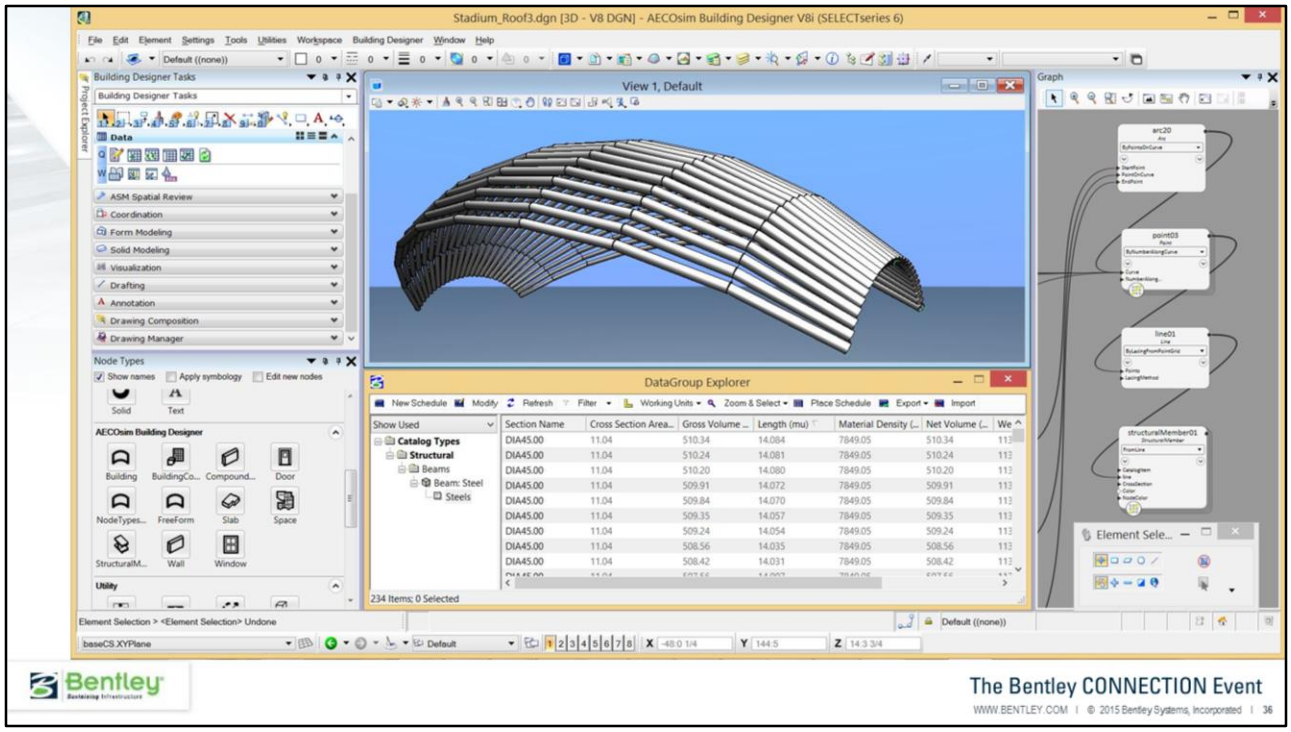
- Having fully attributed BIM elements and parametric designs **allows you to make reliable, informed design decisions based upon complete information on building materials, assemblies, systems performance, and environmental conditions**



ABD + GC maintains the **AECOsim Task menus and Datagroup Explorer** for information observation, editing and extraction, with the **GC nodes and GC graph.**



In much similar example we can elevate this technique a step further and introduce the ability for GC to drive "BIM ELEMENTS" such as Structural elements. Maintaining the flexibility of design exploration but the deriving the benefits of outputs such as quants and schedules,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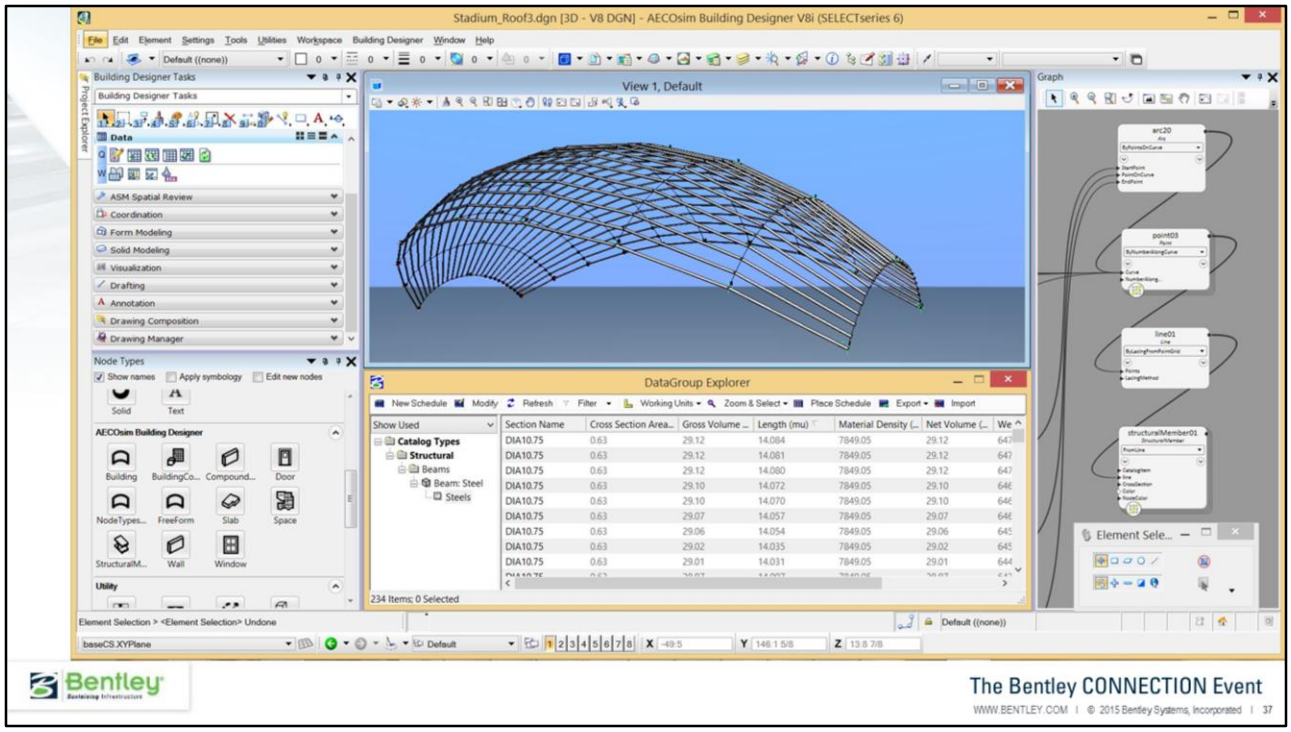
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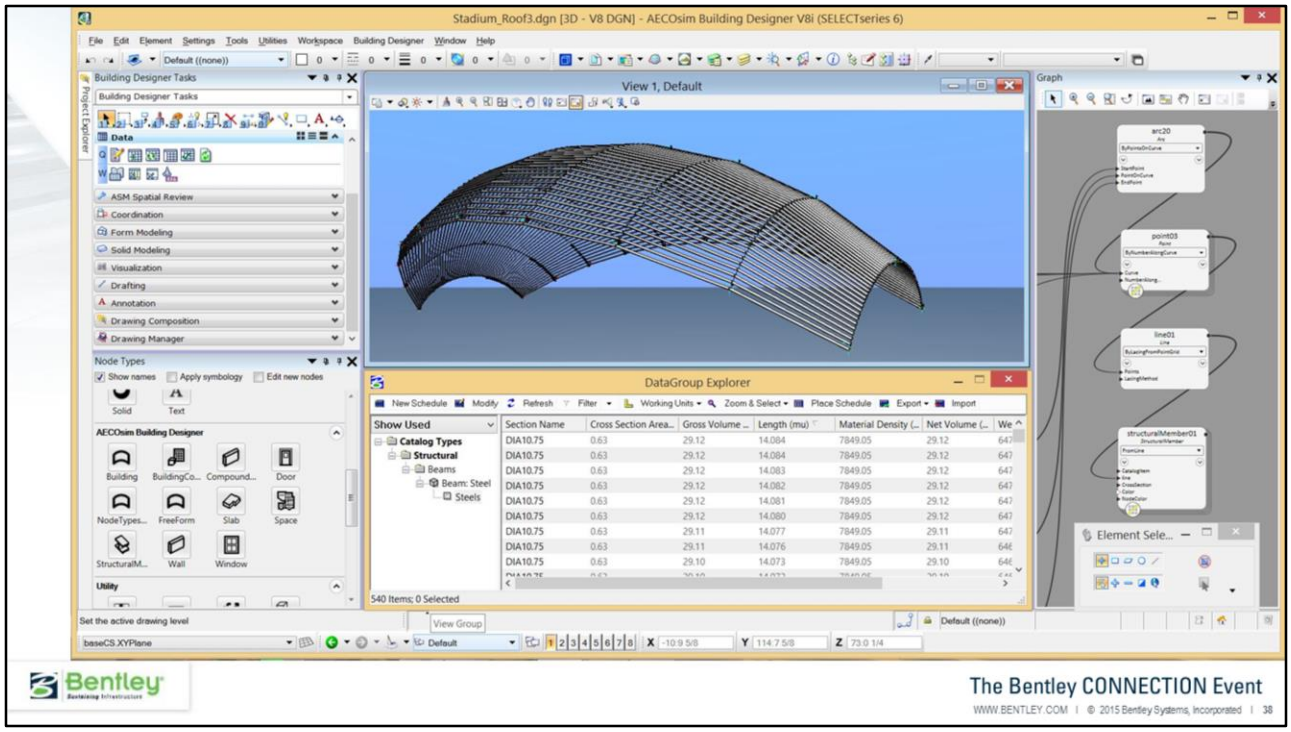
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DIA10.75 0.63 29.12 14.081 7849.05 29.12
DIA10.75 0.63 29.12 14.080 7849.05 29.12
DIA10.75 0.63 29.11 14.077 7849.05 29.11
DIA10.75 0.63 29.11 14.076 7849.05 29.11
DIA10.75 0.63 29.10 14.073 7849.05 29.10
540 Items; 0 Selected
Set the active drawing level
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Default ((none))
baseCS.XYPlane
Default
X -10 9 5/8
Y 114 7 5/8
Z 73 0 1/4
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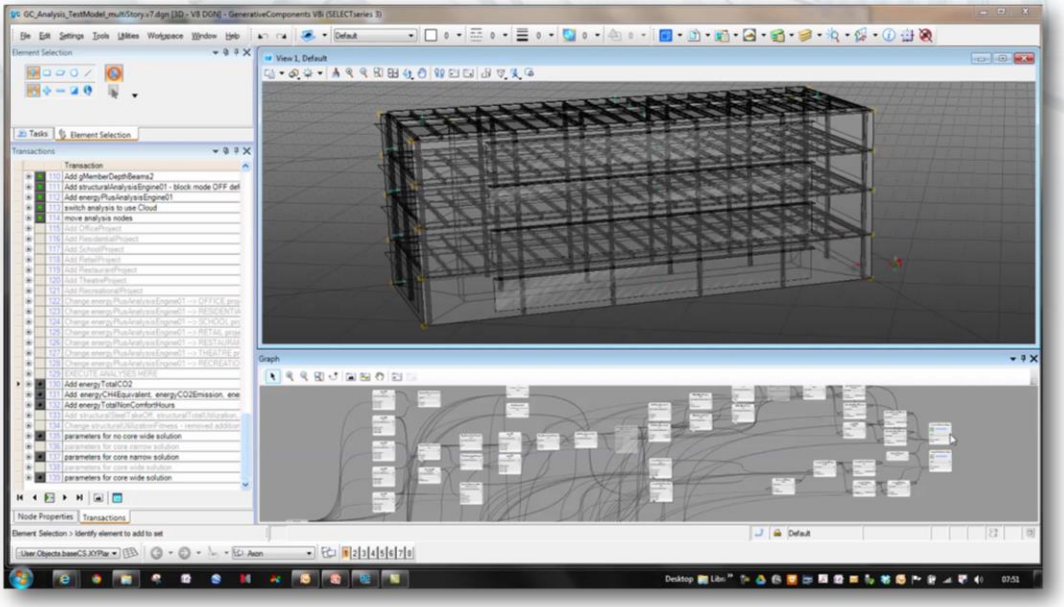
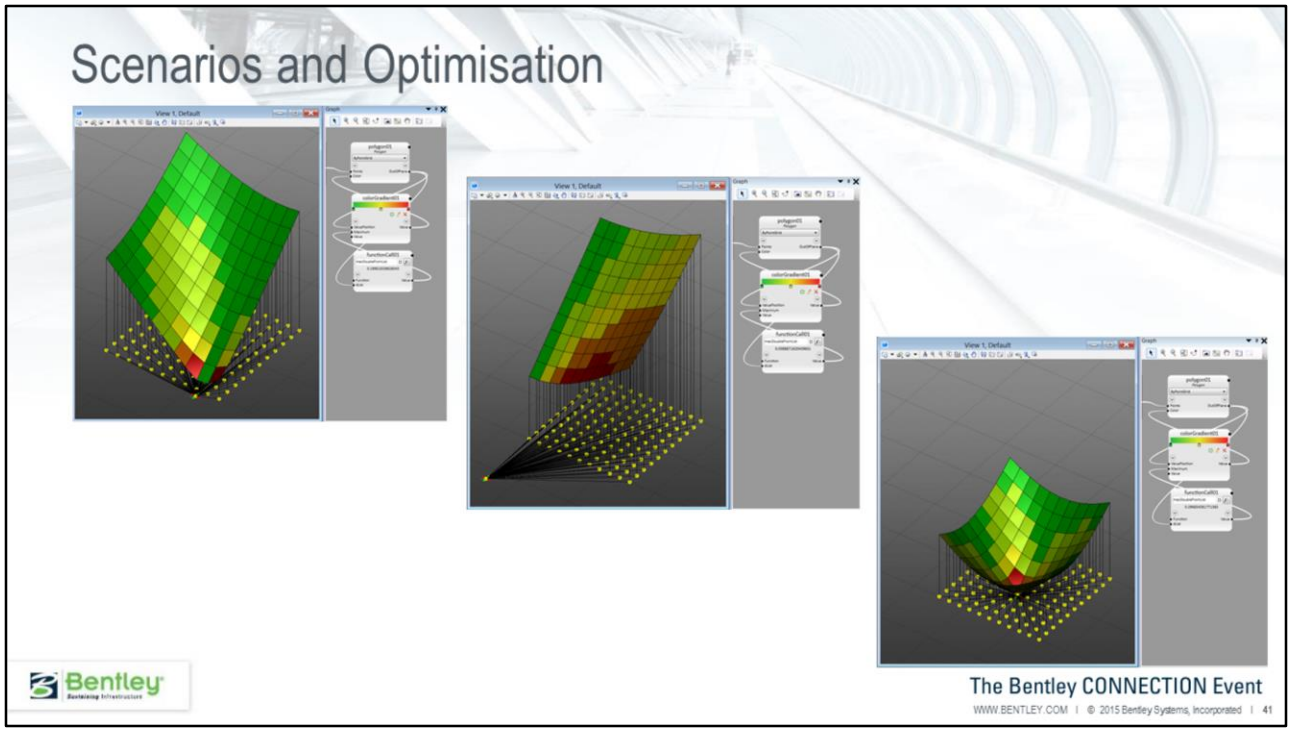
With GC, you can quickly make edits and changes to designs without creating multiple models**. This allows you to quickly and easily produce variations, using results generated for external forces,** of the model allowing for the exploration of a broad range of “what if” alternatives without manually building the detailed design model for each scenario.

Scenarios and Optimisation

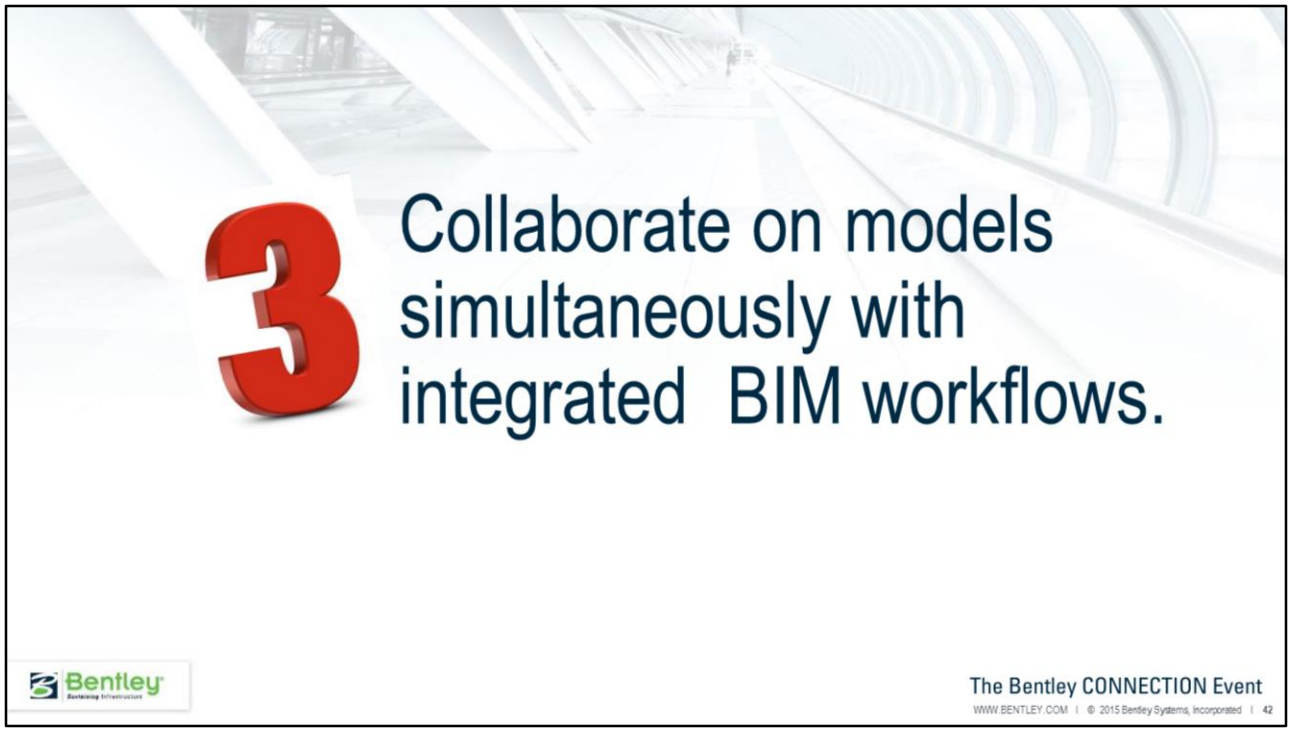


- In this movie we have both a structural model and an analytical space model. Both are driven by user defined parameters and variables.
- Which combination of those settings gives me the best answer to my problem.
- Do I have time to create and test each one?

- This is where scenario services built into our GC product allows the use of either the cloud, or local resources for computational power to test and examine various combinations to find THE optimal solution.
- The result can be email back or viewed and examined on screen



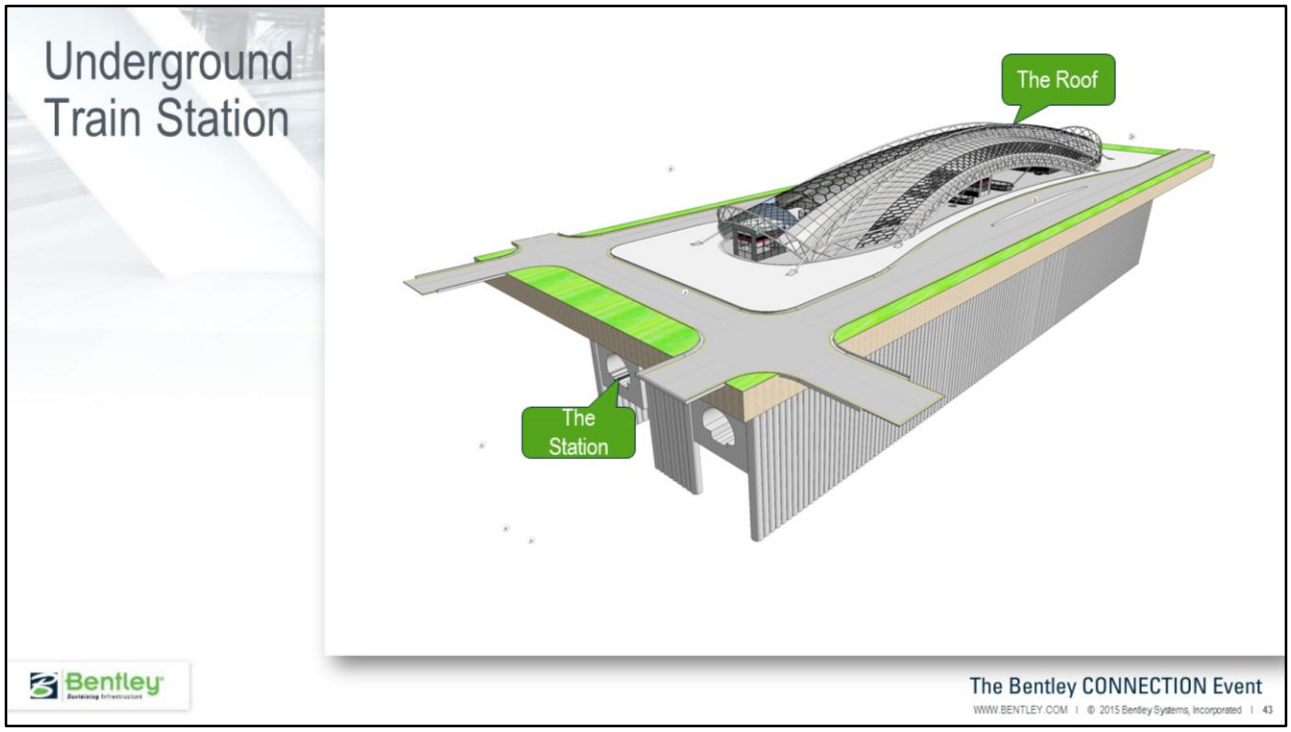
Here we are using color gradients to show is which panels fall steeper out of a pre-defined plane. As we move the point the colors change, instantly visualising the results



But we never work in isolation. BIM is Team game with a Team centric goal. Leveraging the federated approach that all BIM solutions demand

You can collaborate on models simultaneously with integrated BIM workflows.

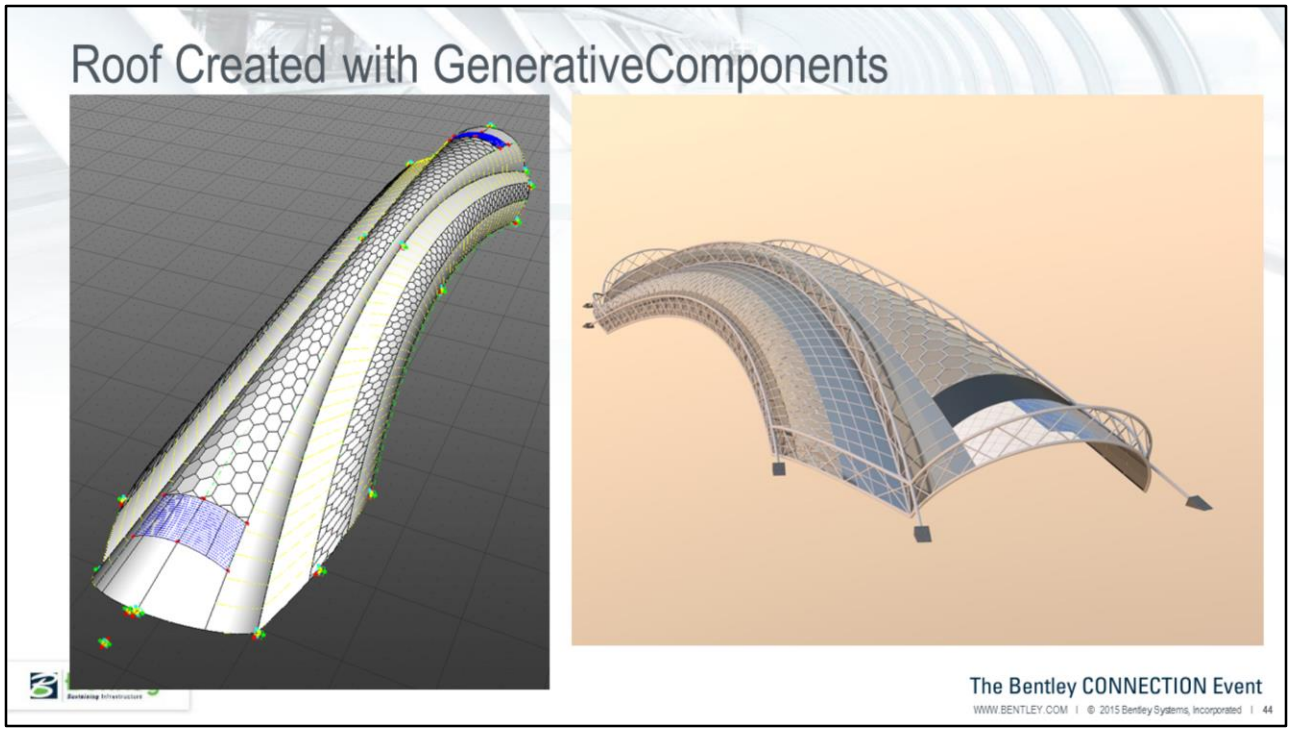
The integration between ABD and GC establishes a robust connection between the two with the goal of supporting Bentley's BIM workflows parametrically. This is a differentiator as it enables you to create innovative parametric models that others can collaborate on. Additionally, with the design analysis and optimization in the cloud, we have a compelling design solution for AE firms.



This underground train station uses both GC and ABD. GC leverages its base file format , that of DGN which is common across the Bentley portfolio and the interoperability that the Bentley platform provides , to collaborate with other users in the team.

This model created in AECOsim Building Designer and Generative Components, takes the concept of an underground train station and includes Architectural, Structural, and Mechanical Design. Generative Components was used to drive the roof geometry. The model is used to drive drawing generation and the Generative Components model can then be used to drive geometrical setout and fabrication of the roof components. Generative Components was able to out setout co-ordinates of the roof geometry to Excel, but in some does not assign this information to the geometry itself. An i-model

transform was used to combine the objects with the information generated to Excel.

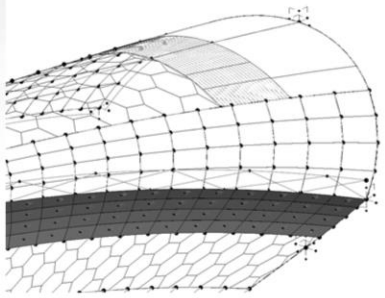


There are 2 reasons for using Generative Components to create the roof.

1. The roof form, required tweaking and changing in order to get the geometry right.

2. Secondly the Sturctural Members and panels could be created far more accurately and efficiently but creating relationships between the geometry and the constructable elements.

Panel Fabrication



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2441078	::User.Objects.polygon05[15][2]	Panel [15][2]	7.0442 Metres	7.0442 Metres	1.60205q. Metres	0.7736 Metres	-592801.465313951,-26893.4690515823,155368.762731019
2441079	::User.Objects.polygon05[15][3]	Panel [15][3]	7.1770 Metres	7.1770 Metres	1.73025q. Metres	0.8638 Metres	-608407.472506713,-22589.5457043556,153366.314253103
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2441108	::User.Objects.polygon05[23][0]	Panel [23][0]	6.6378 Metres	6.6378 Metres	1.74495q. Metres	0.5505 Metres	-489318.484109464,7317.9640014996 5,196442.203375388

Bentley

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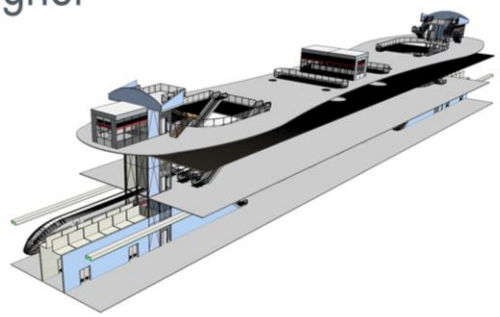
The panels could then have the information on the display in a schedule for fabrications

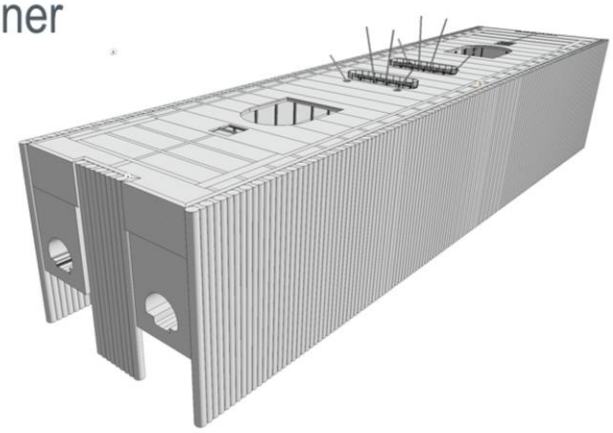
Station Architecture Modeled with AECOsim Building Designer



Bentley

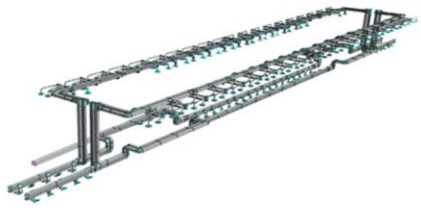
So we can take a project that has bene federated into distinct models

Structural Modeled with AECOsim Building Designer



And begin to assemble them together

Mechanical Modeled with AECOsim Building Designer

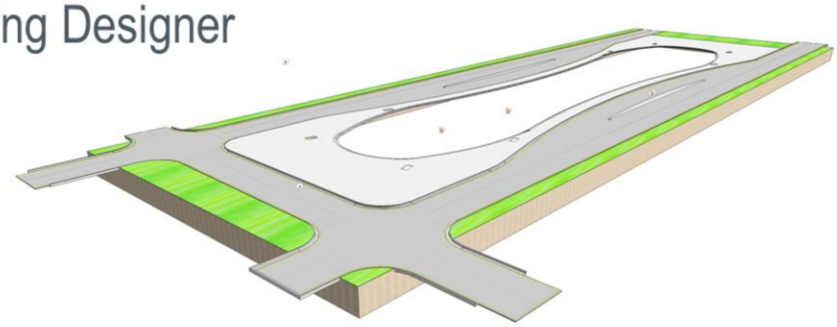


Bentley

The Bentley CONNECTION Event

And begin to assemble them together

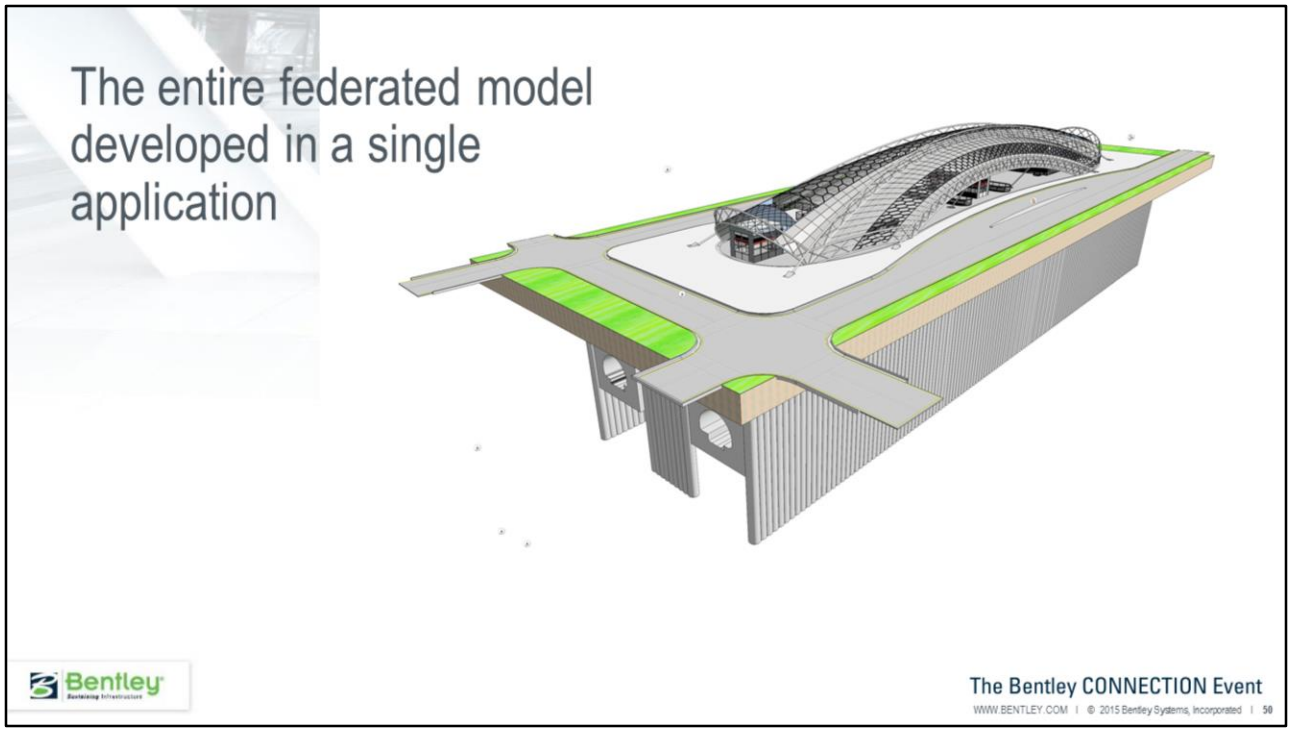
Site Modeled with AECOsim Building Designer



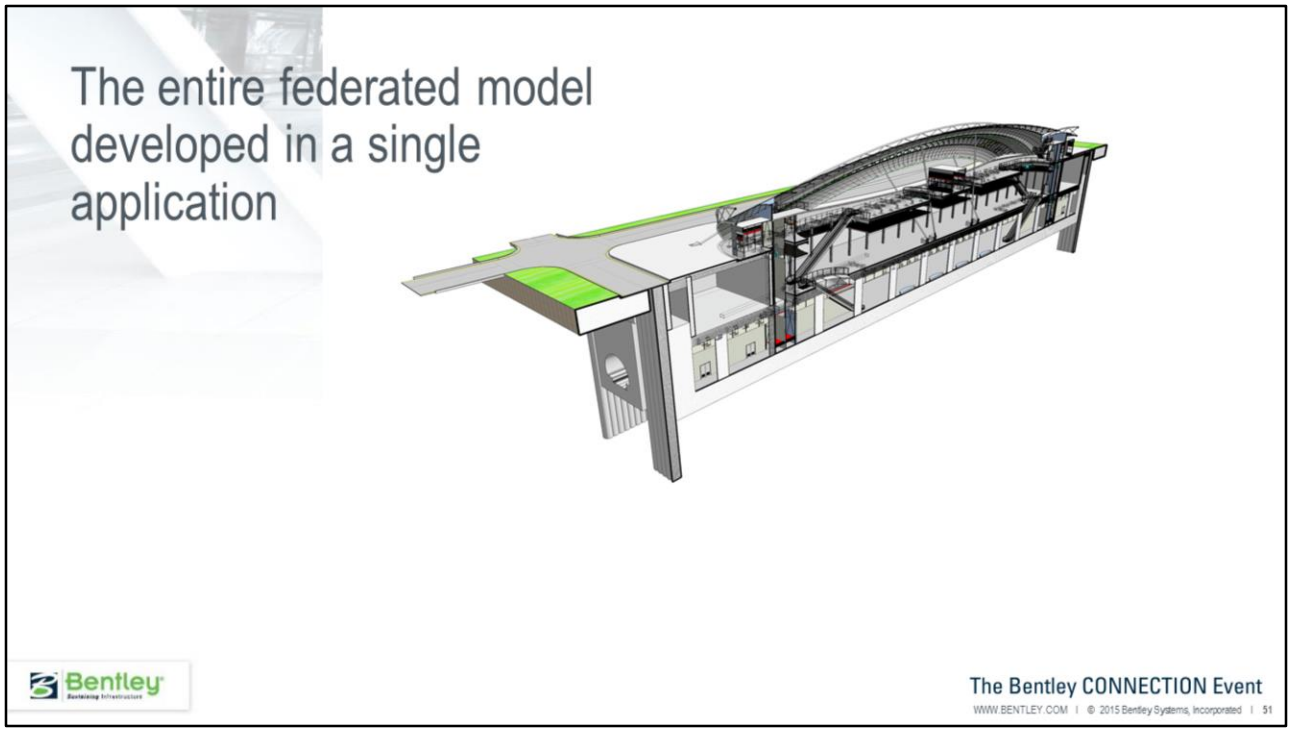
Bentley

The Bentley CONNECTION Event

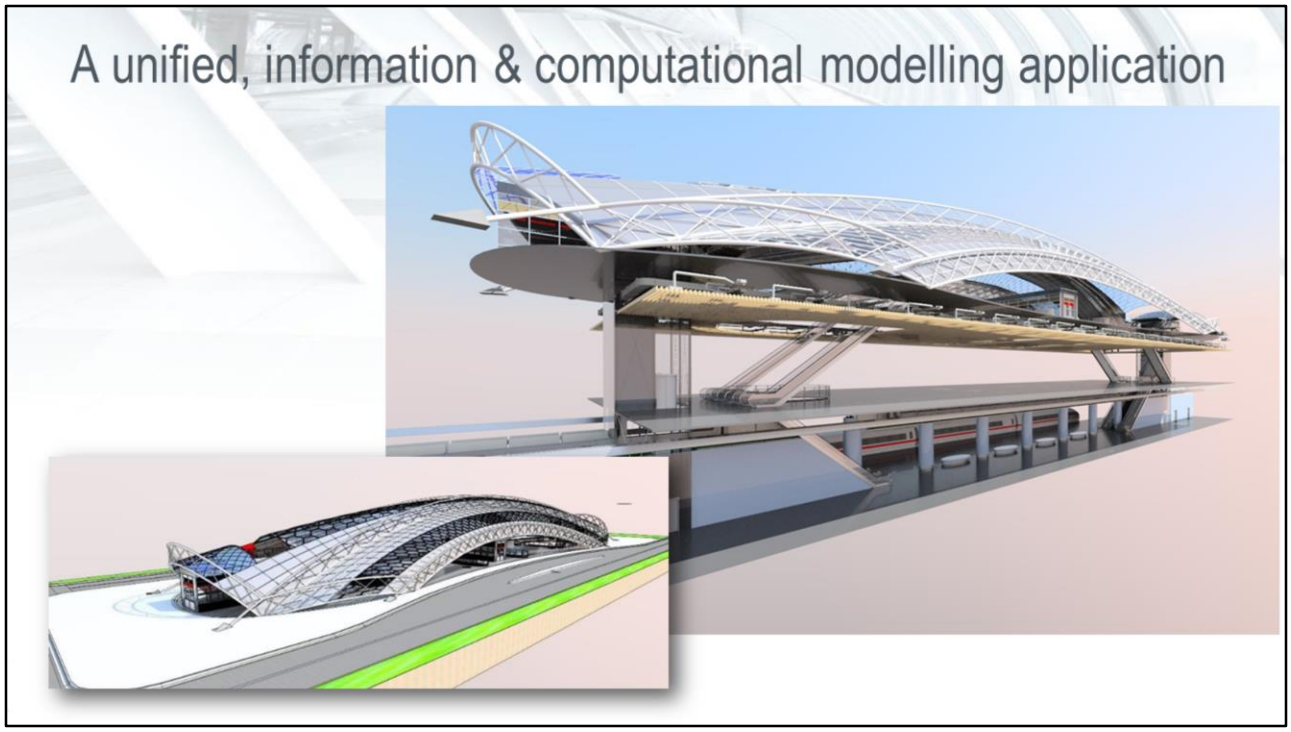
And begin to assemble them together



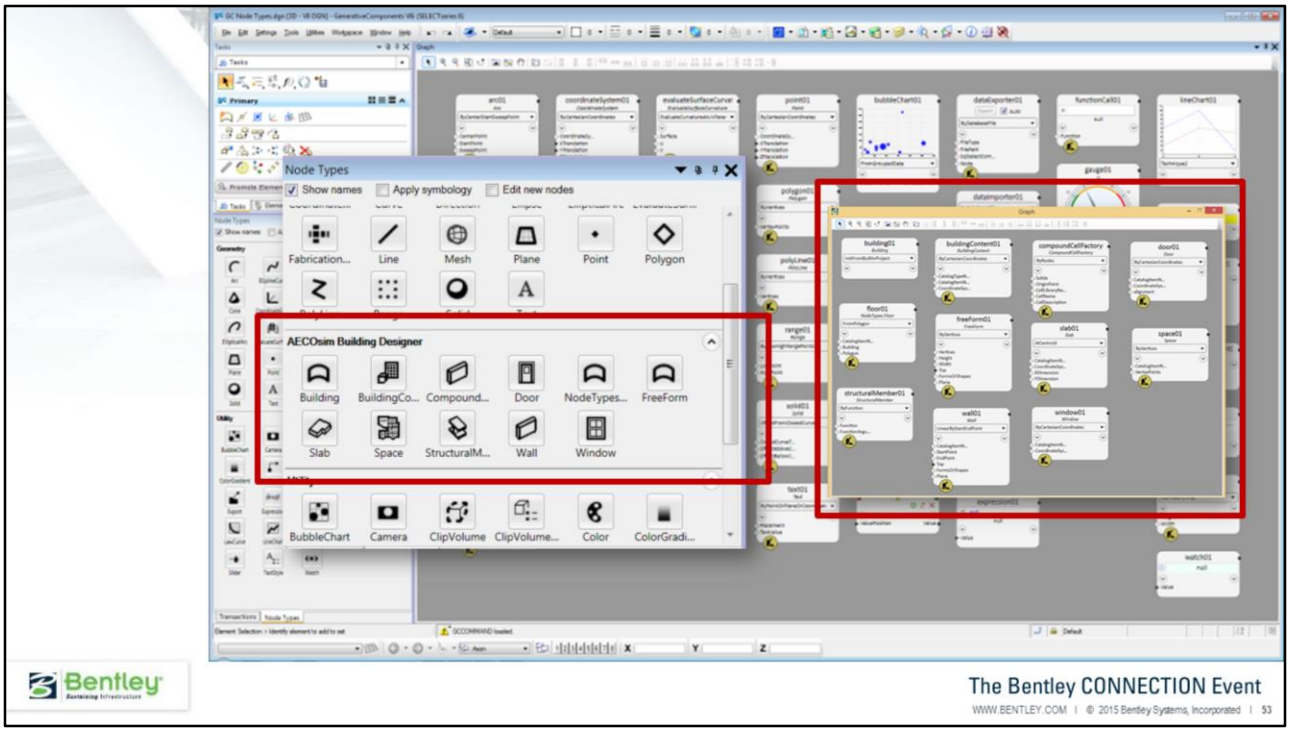
And begin to assemble them together

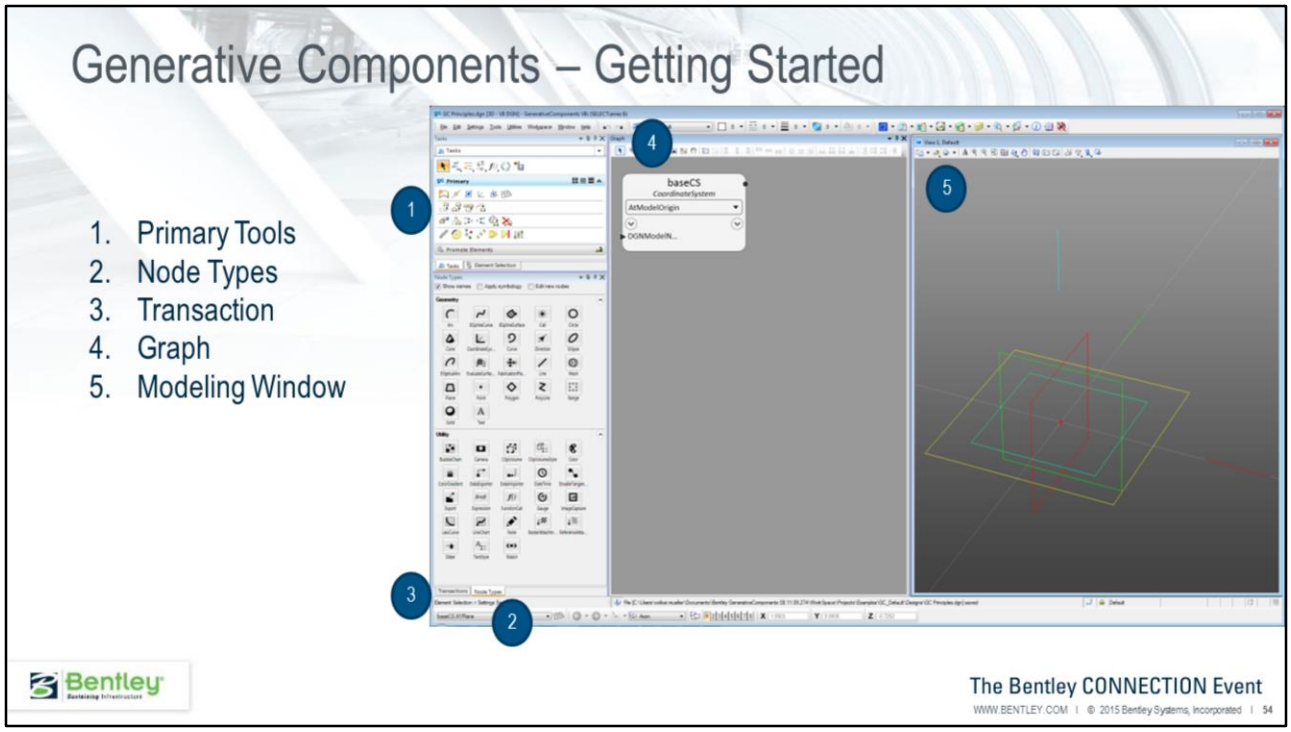


And begin to assemble them together



To generate an overview of the project for design coordination and project delivery purposes


Node Types
Show names
Apply symbology
Edit new nodes
Fabrication...
Line
Mesh
Plane
Point
Polygon
AECOsim Building Designer
Building
BuildingCo...
Compound...
Door
NodeTypes...
FreeForm
Slab
Space
StructuralM...
Wall
Window
BubbleChart
Camera
ClipVolume
ClipVolume...
Color
ColorGradi...



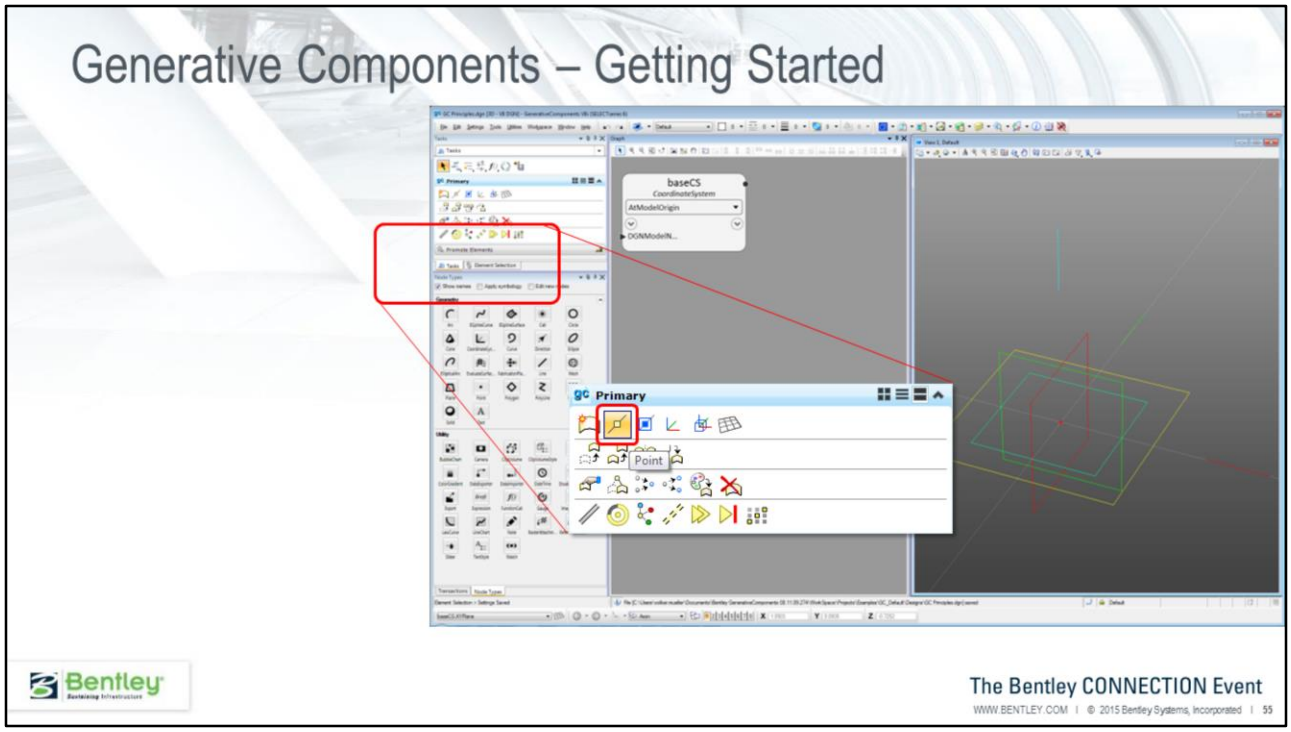
Primary Tools - Placing basic geometry and performing basic functions such as copy

Node – A node is the method of placing an object or performing a function on an object

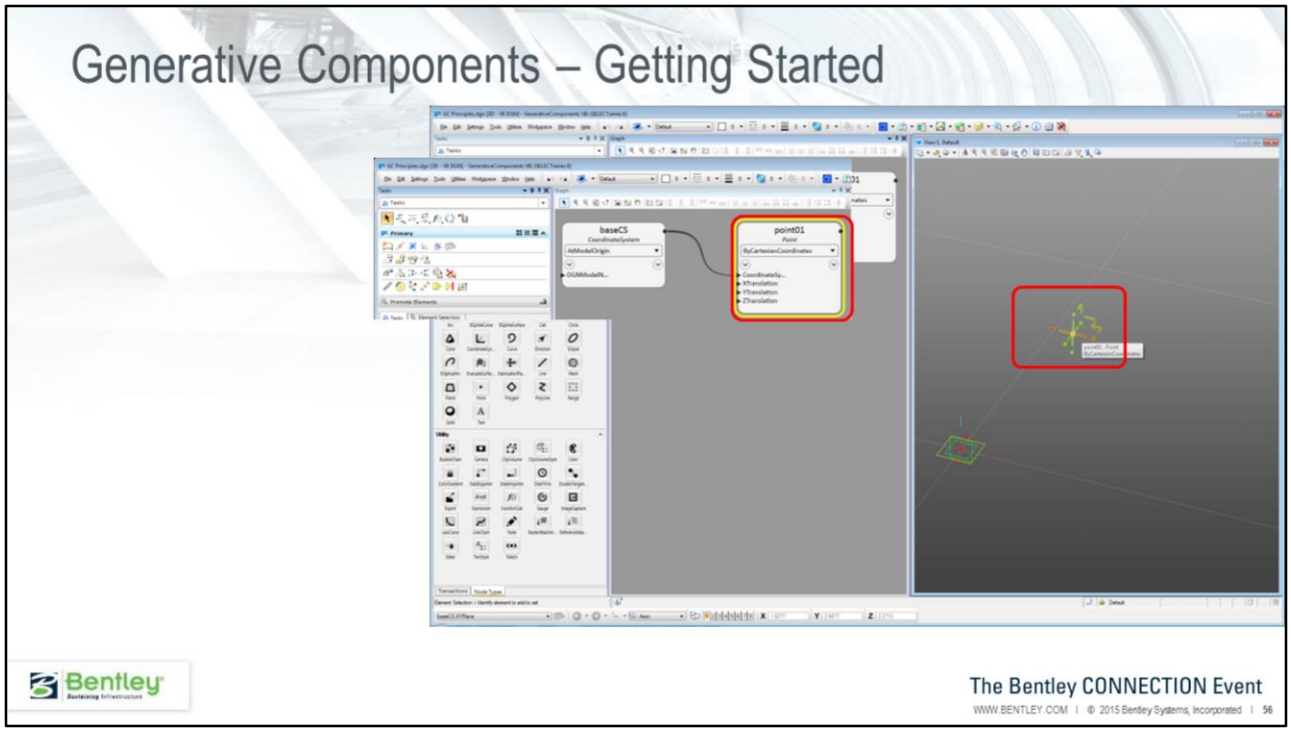
Transactions – provide a history of actions

Graph allow viewing of the geometry and relationships. Actions can be performed from the graph

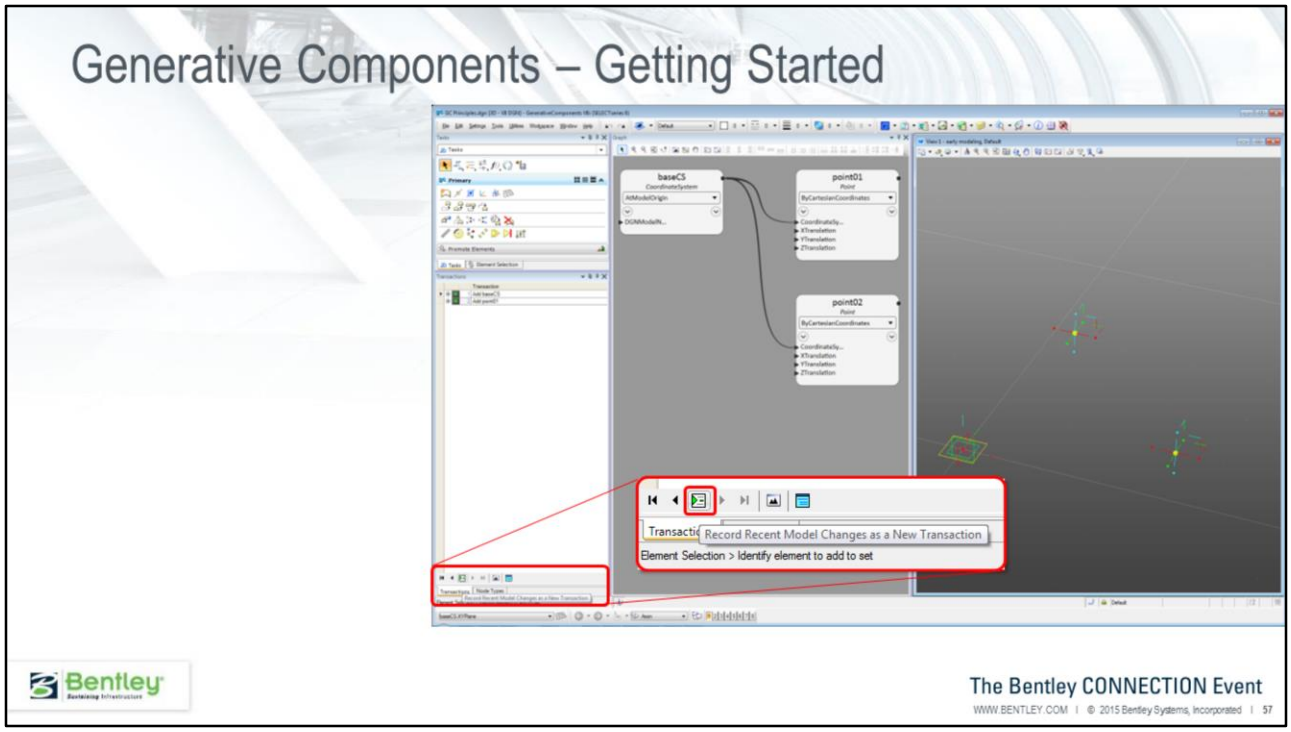
The Modelling window is where the model is displayed



The primary tools allow quick access to basic functions. We often start here, placing our first point or using existing geometry we have modelled elsewhere to promote to a GC element

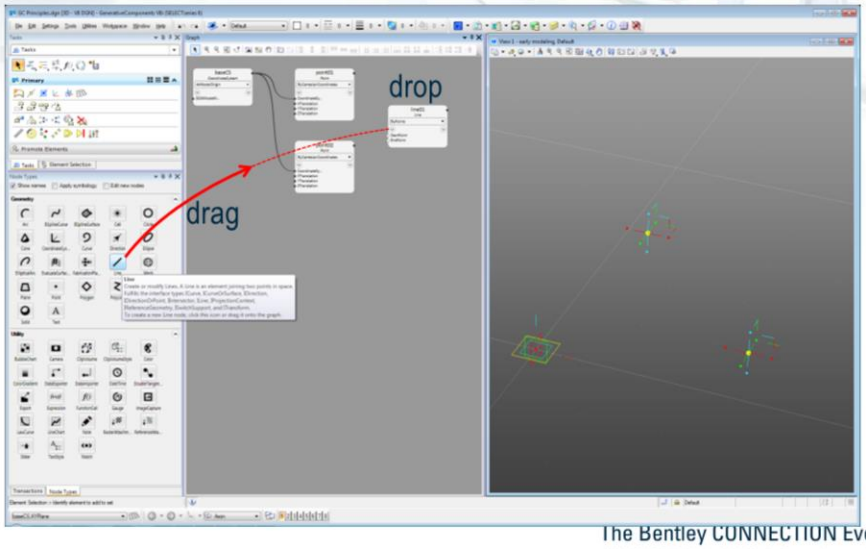


Lets say we place a point. That point appears in our graph and in our model view. We can edit the point in both the model view and the graph



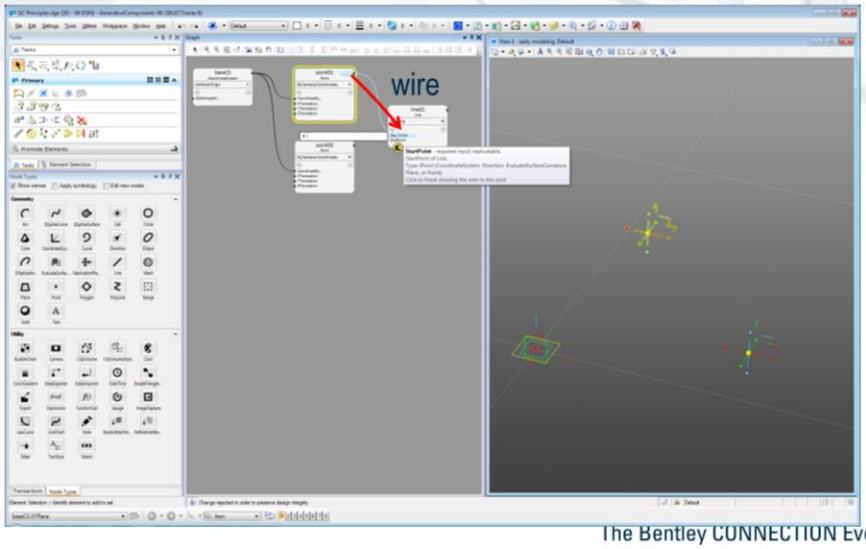
Transactions preserve history of model construction…or construct/edit model narrative

Generative Components – Getting Started



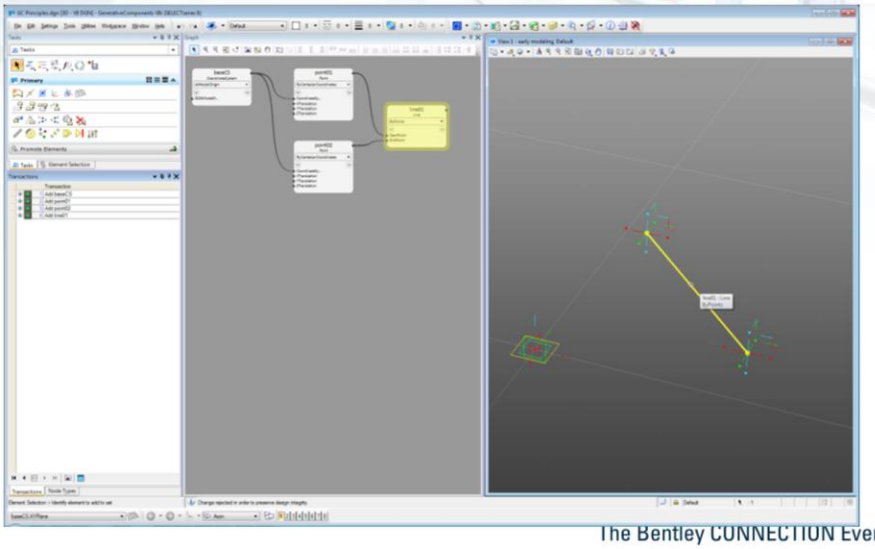
"drag and drop" from Node Types palette into Graph.

Generative Components – Getting Started

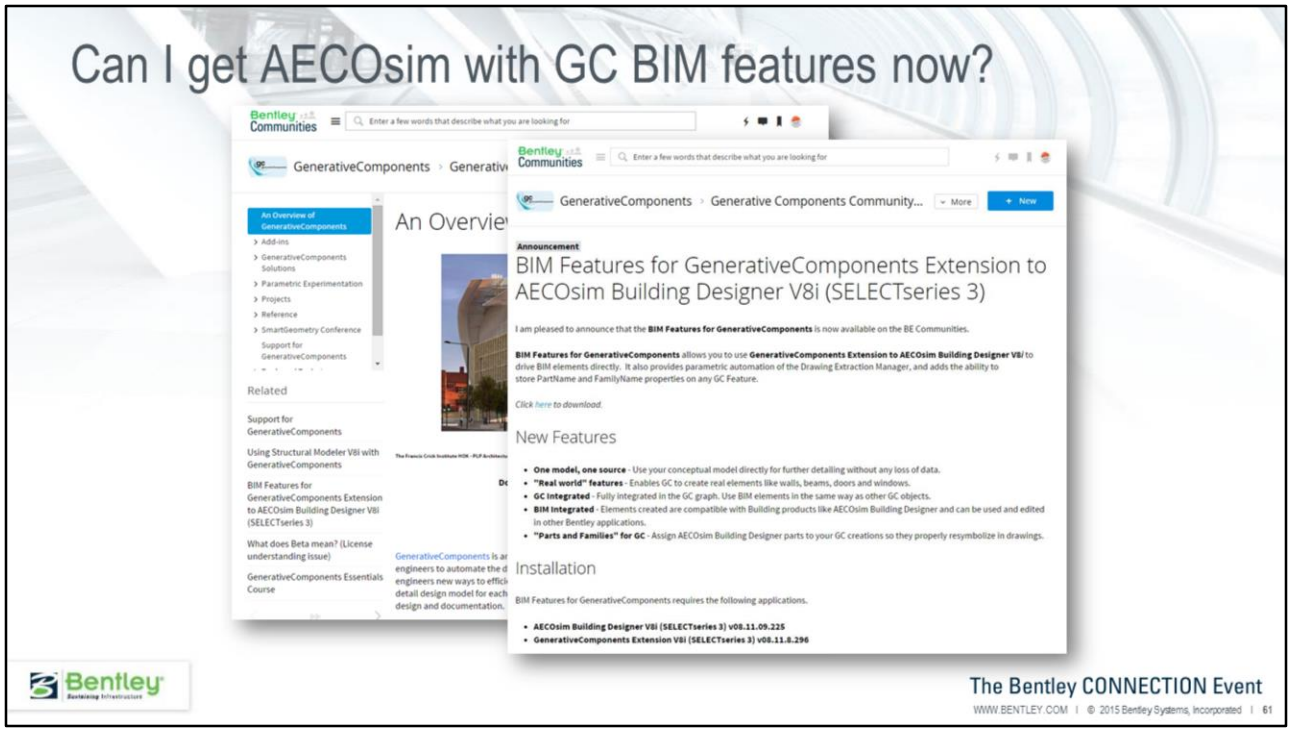


We can wire outputs from “upstream” nodes or wire inputs to “downstream nodes”

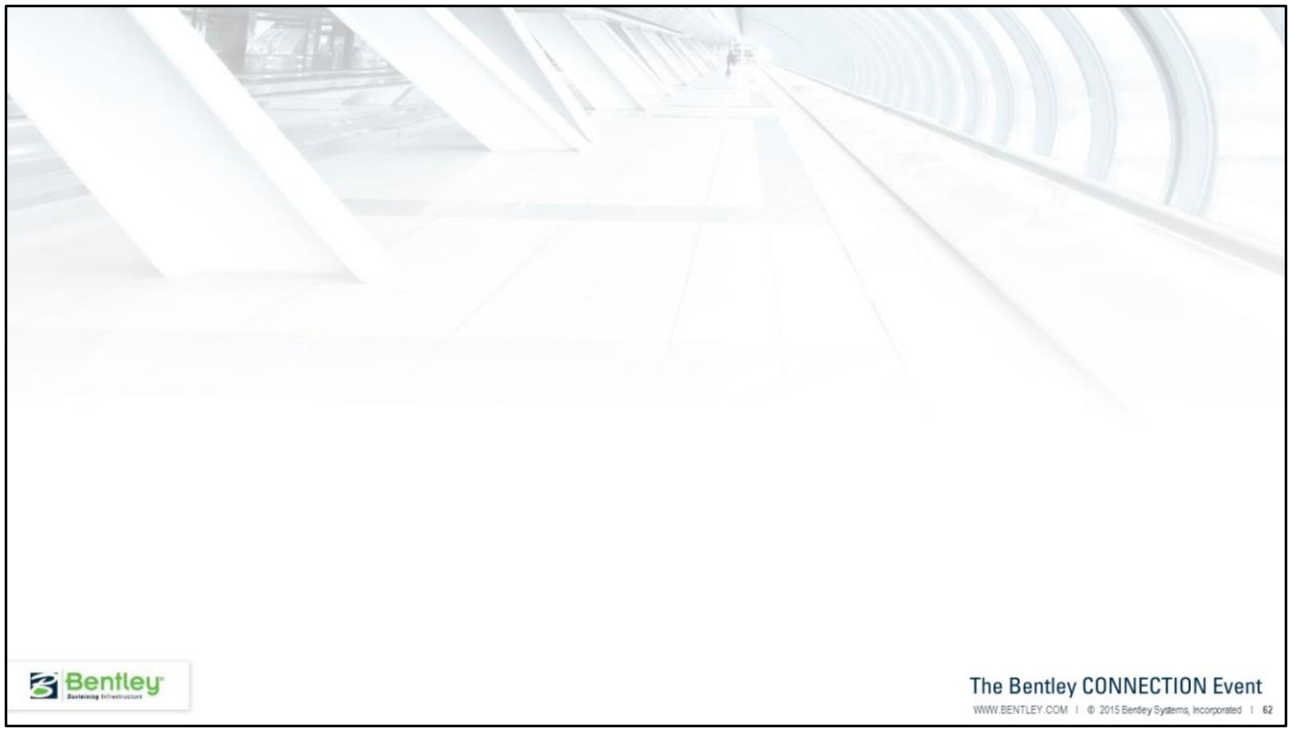
Generative Components – Getting Started

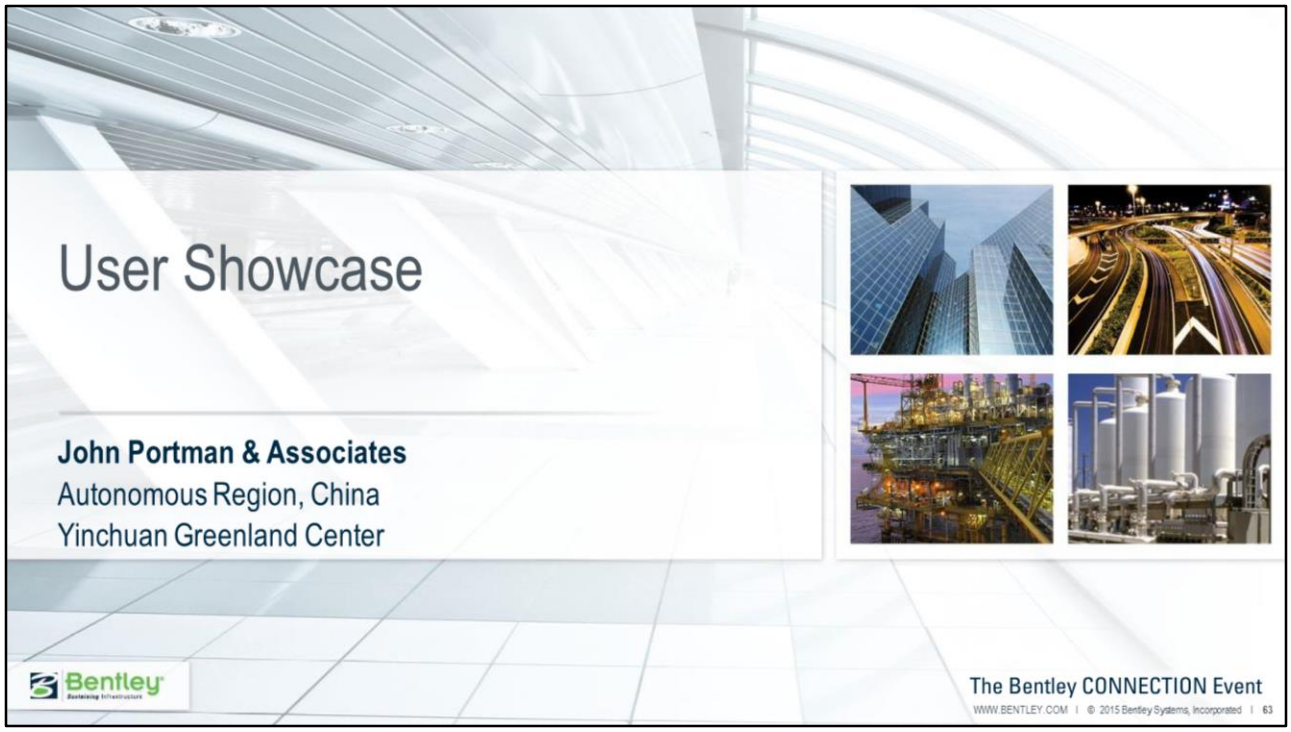


node becomes valid when all required inputs have been provided.
record transactions!



We can wire outputs from “upstream” nodes or wire inputs to “downstream nodes”





Let’s take a closer look at some users and how they’vee used AECOsim Building Designer and GenerativeComponents together.
You’ll notice that both large and small firms are represented showing the breadth and depth of our products.

We’re going to take a look at John Portman & Associates and their project, Yinchuan Greenland Center, located in Yinchuan, Ningxia Hui in China.

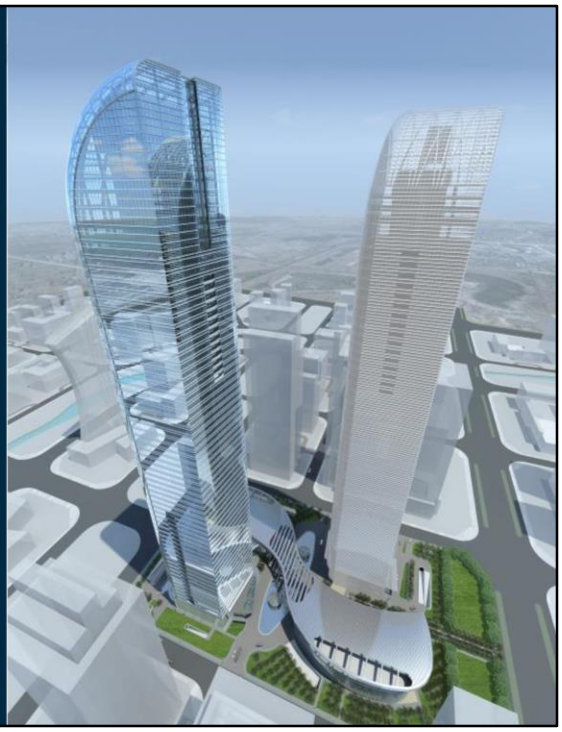
AECOsim Building Designer + Generative Components

Completion Date: July 2016

Size: Approximately 3,293,757 sf (306,000 sm)

Building Height: 984 ft (301 m)

Scope: Combined above-ground office, hotel, boutique retail space

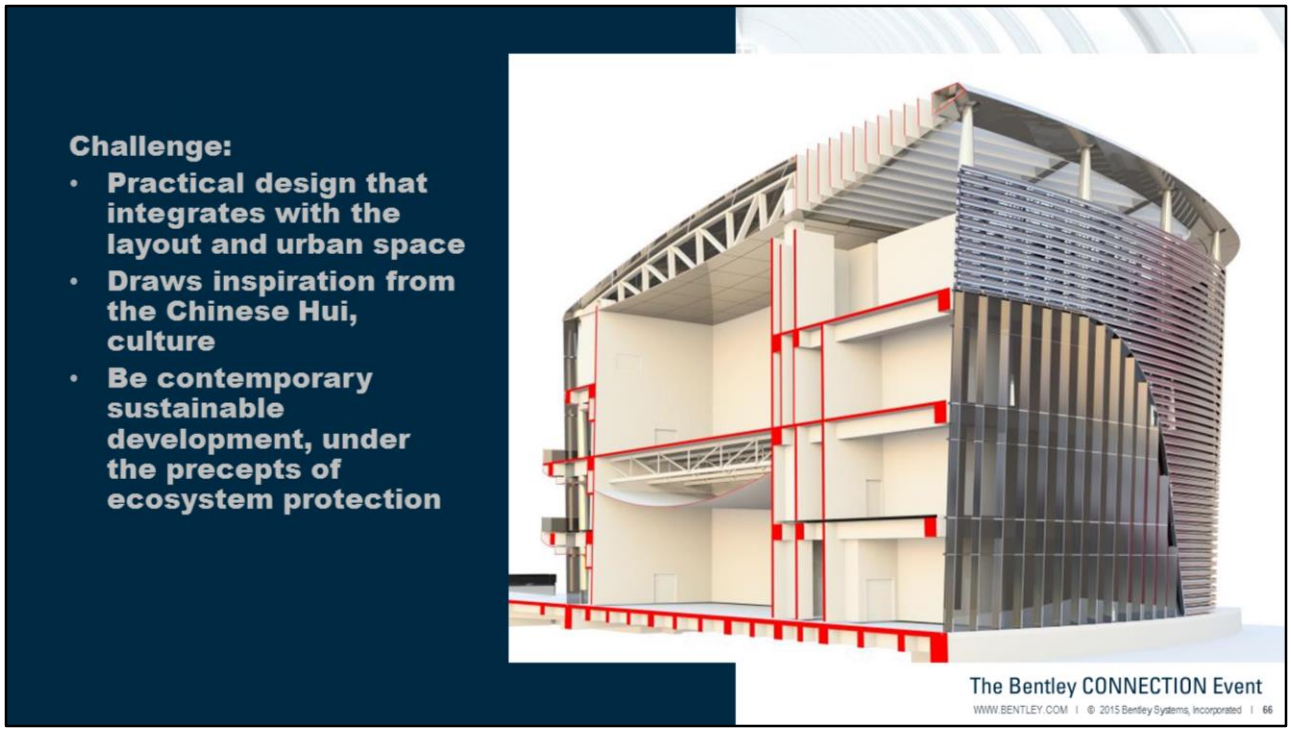


Scope: This project is a mixed-use project. John Portman & Associates combined above-ground office, hotel and boutique retail spaces, with ample auto and bicycle parking below ground.

- The literal meaning of Yinchuan means “silver river.” So the towers are linked by a “silver river”- a podium building with a sinuous (curvy) form. The tower forms take inspiration from shapes found in the unique calligraphy of the Chinese Hui – a script that fuses Chinese and Arabic.
- When completed, expected in 2016, the towers will be the tallest in the Ningxia Hui region of China.

Products: The 3D BIM model created in GenerativeComponents and AECOsim Building Designer enabled the firm to meet the demanding design schedule by facilitating better design

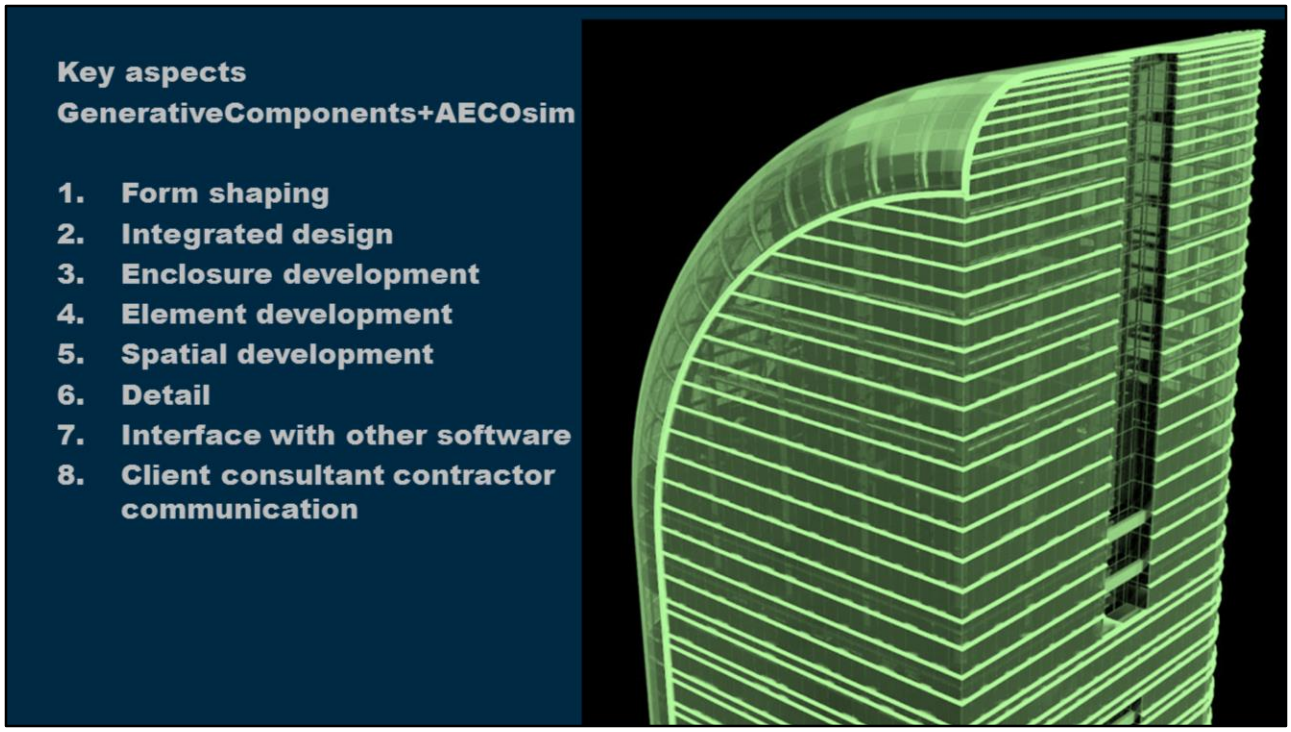
decisions and fostering communication among teams.



Design Challenge

There were the unique design challenges that John Portman & Associates had to meet…and did so successfully.

- This specific design was chosen for its practicality as well as its skillful integration of the layout and urban space.
- As Yinchuan is the capital of the Ningxia Hui Autonomous Region, the project's design draws inspiration from the Chinese Hui, whose culture offers a unique blend of Islamic and Chinese influences.



GC and ABD were used for the following aspects of the project – from form shaping to client communication.

Success

Keep in mind these are all the benefits realized without GC and ABD being fully integrated. Now imagine the greater benefits now that they are. John Portman has seen the following by using GC and ABD:

Increased Project Collaboration: Collaboration, both internally and externally, was improved. People were able to see and share information as it was developed. The GC model and the 3D model were used to prepare architectural plans, elevations, sections, details and schedules. Because sections could be cut early in the design process, interferences between architecture and structure, or problems of clearances were detected early,

allowing the design to be refined at an early stage.

Increased ROI: John Portman & Associates brought their entire design team together early in the design process to coordinate efforts and to establish strategies for efficiency in construction, function, materials, water, energy, daylight and site usage to achieve the project goals. The result is what they consider to be a constructed aesthetic – an integration of design, structure and energy comfort systems as a complete system. First, the team was able to optimize the design of the enclosure and structural system with the use of GenerativeComponents. Secondly, the team was able to easily integrate complex geometry generated in GC with the data created in ABD.

Reduced Time of Project Delivery: GenerativeComponents made creating complex geometry relatively quick and easy thus allowing for more iterative design. What would have taken a considerable amount of time to build and modify in base 3D was quickly executed in GC. With the 3D model created in both GC and AECOsim, the architects were able to swiftly extract any 3D condition needed. Revisions requested were also quickly implemented. The architectural team was able to rapidly explore options, make revisions and come up with the optimal solution, all while staying on schedule.

Reduced Cost of Project Delivery: The 3D BIM model created with GC and in AECOsim ensured a fully coordinated design and enabled John Portman & Associates to meet the highly demanding and sensitive design schedule.

Reduced Operation Costs: The firm often must contract out for animations and renderings. On this project, the architects were able to do them in-house with AECOsim. The firm also typically contracts out for sun studies. Again, for this project, the architects were able to generate them internally and use them

to optimize the performance of the systems. Eliminating these outside expenses saved the firm out-of-pocket project costs.
Reduced and Managed Risks: The GC and BIM model facilitated better design decisions and fostered better communication between team members.

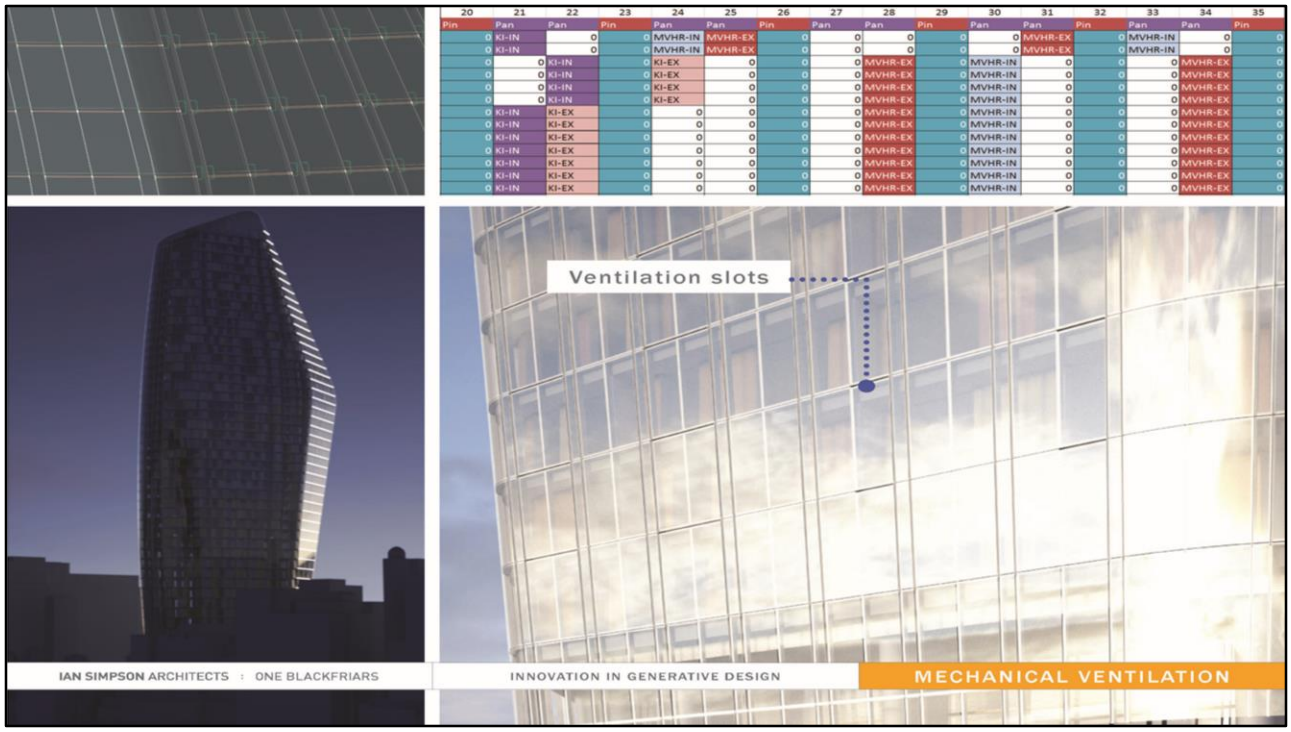
Now let's take a look at One Blackfriars Road by SimpsonHaugh, which was formerly known as Ian Simpson Architects.

- Simpson Haugh designed the GBP 250 million signature skyscraper One Blackfriars
- They used GenerativeComponents, Bentley's parametric modeling software, to set out the curved geometry of the building form, and define the relationships between internal and external facades.

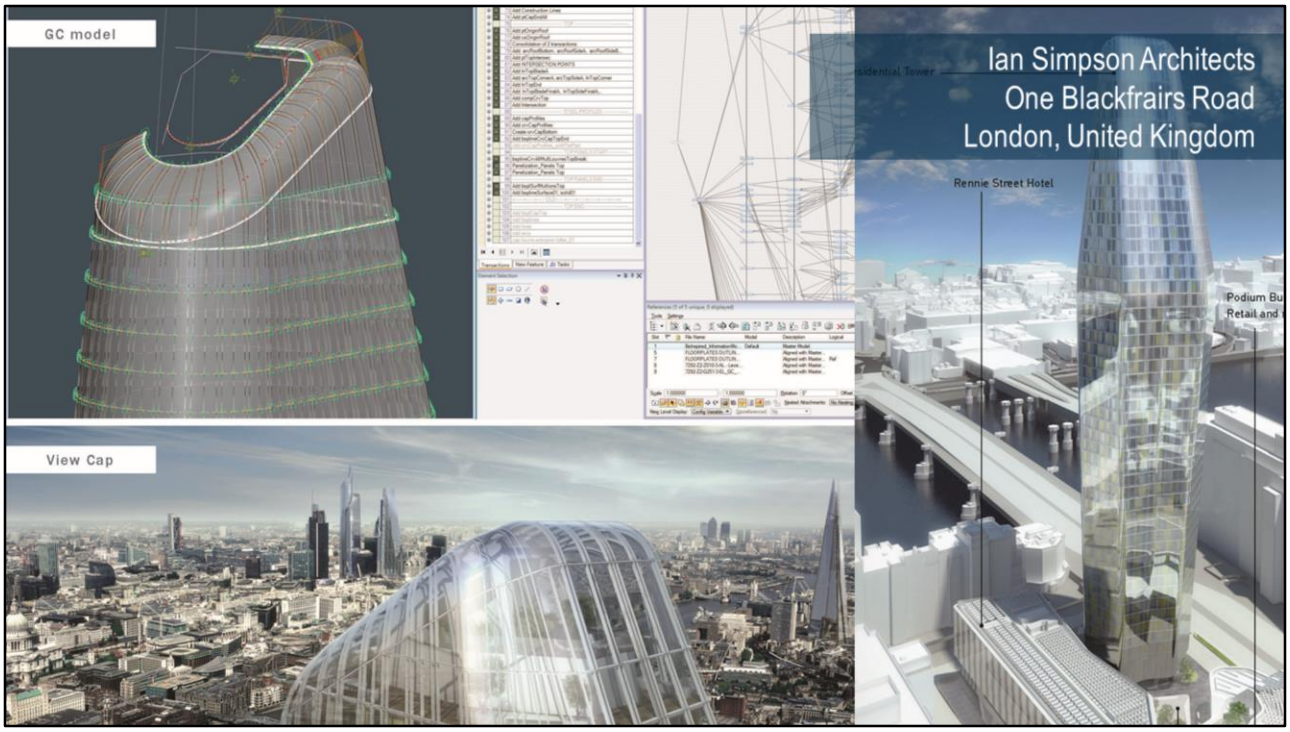
This image is the view of the residential lobby illustrating the intimate space at the base of the slender tower.

The Project Objective for Blackfriars is as follows:

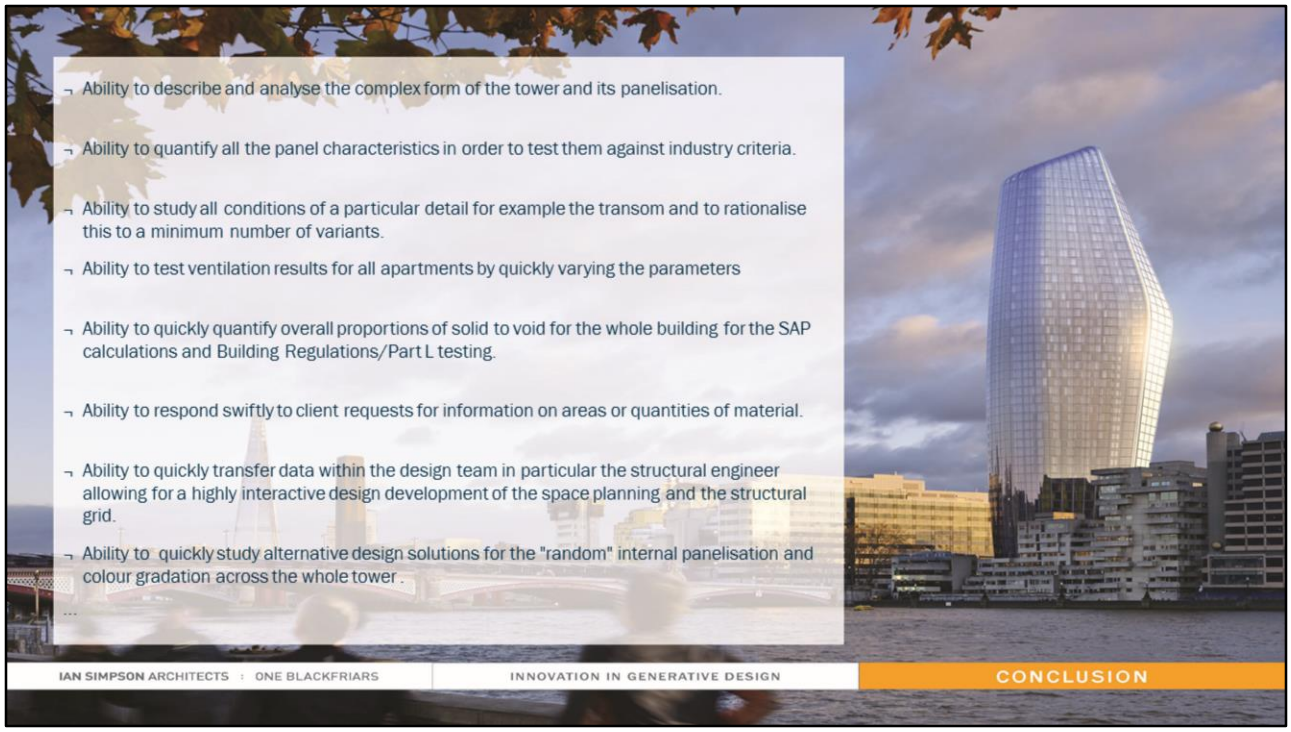
- Design a mixed-use complex to anchor Blackfriars Bridge and grace the Southwark skyline.
- Maximize daylight and minimize solar reflection for neighboring properties. (so it had to be slender)
- Balance the tower's beautiful form with the program's contextual function.



- One of the many challenges on the tower was the mechanical ventilation through the external envelope
- It was crucial to keep it's visual impact to a minimum
- The location and size went through many iterations so they needed to a design tool that is able to quickly respond to client requests and performance changes
- **First they used an Excel spread sheet as an INPUT to** GC. Everybody in the team could use it – even people on their team with less advanced scripting skills – to change the position of the ventilation slots.
- This enabled the team to quickly respond to client requests and performance



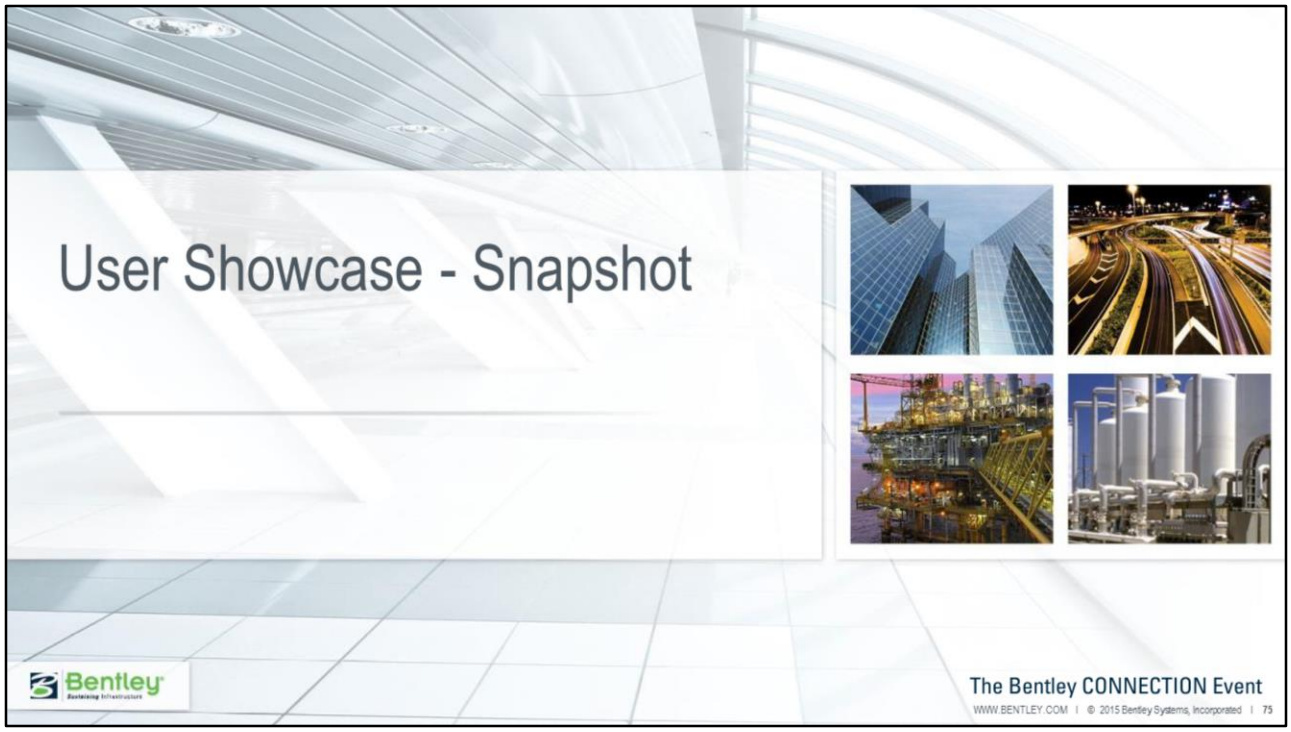
- Simspon Haugh said that GenerativeComponents proved to be beneficial in several ways: One is the way in which you can build the geometry -- making the design process very flexible and helping to describe very precisely the complexity of the building
- And the models where all coordinated in Bentley Architecture, **NOW AECOSIM BUILDING DESIGNER**, and exported to SCHEDULES and DRAWINGS



ROI

- GenerativeComponents allowed SimsponHaugh to fine tune the façade, reducing the number of panels and minimizing the number of double-curved panels.
- It took just two days instead of weeks to produce visuals for viewing angles from the apartments.

- Though some were skeptical that One Blackfriars would be built, the ground-breaking ceremony in October 2013 marked the start of construction, which is expected to be completed by 2017.
- With a mix of residential, commercial, and retail properties, One Blackfriars represents a significant investment by the developer. The 50-storey tower is now being marketed worldwide.



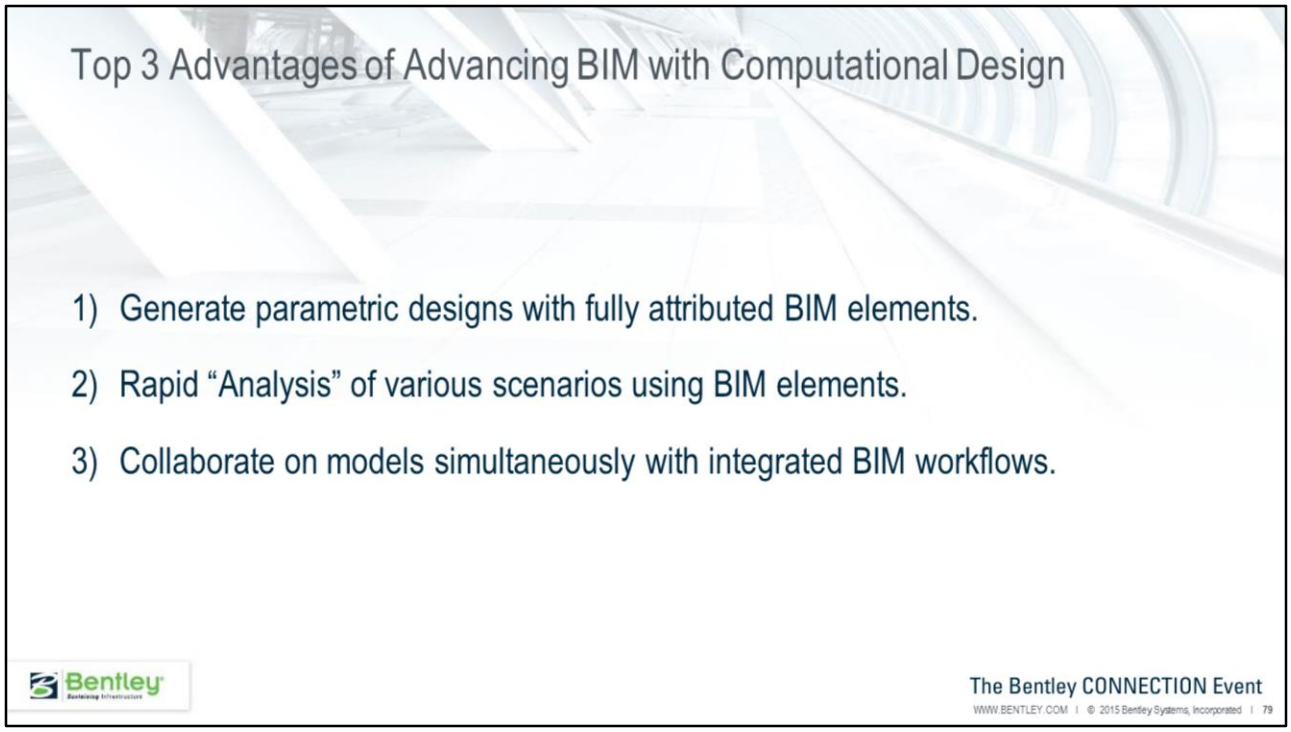
Now here are just a few snapshots of projects.

2014 Winner – Innovation in Building

- This mixed-use facility establishes Boston-based Emerson's identity in Los Angeles, California. Designed by Morphosis Architects to be a magnet for activity, it provides an iconic setting for premieres, events, and student showcases that draw the general public, students, and industry professionals.
- The new USD 85 million facility will also host workshops, lectures, and other events that engage the broader community.
- Bringing student housing, instructional facilities, and administrative offices to one location, ELA condenses the diversity of a college campus into an urban site. Fundamental to the ELA experience, student housing gives structure to the overall building. Housing up to 220 students,

the domestic zones frame a dynamic core dedicated to creativity, learning and social interaction. Composed of two slender towers bridges by a mutli-use platform the 10 story square frames an outdoor “room”.


Wujin Council OfficesLAB Architecture
Changzhou, Jiangsu, China
Studio with SIADR



When integrating ABD and GC, here are the top advantages:

1) Generate parametric designs with fully attributed BIM elements.
2) Rapid "Analysis" of various scenarios using BIM elements.
3) Collaborate on models simultaneously with integrated BIM workflows.

Thank you for your time. If you want additional information on the projects covered here…you can find the Simpsonhaugh and John Portman projects on Bentley.com on our Be Inspired Project Portfolio. The Arup ferris wheel can be found with our other case studies on Bentley.com/abd (Bentley dot com back slash a-b-d)

<PLAY VIDEO that was produced by John Portman - Has audio but just music. >

This video was produced by John Portman that provides a great overview of the project.