AUTODESK UNIVERSITY 2013

The Languages Everyone Understands: Math, Money, and DWG™

Michael David – Buro Happold

CM3026 A carefully planned BIM workflow enabled the design team to create both coordination and structural analysis models for a structure with highly complex geometry extremely fast and efficiently. Using Autodesk® AutoCAD® as a central hub of geometric definitions, the design team was able to communicate seamlessly between Rhinoceros®, Autodesk® Revit®-based software, and SAP2000®. This resulted in the architecture, coordination, and analysis models all matching each other perfectly while also making it easy to track changes and update the models as the design progressed.

Learning Objectives

At the end of this class, you will be able to:

- Learning Objective 1: Set up a BIM workflow process using modern design tools such as Revit-based software and AutoCAD
- Learning Objective 2: Explain the benefits of establishing an efficient BIM workflow early in the life of a project
- Learning Objective 3: Describe how modern technologies can be used to develop communication between structural analysis and coordination models
- Learning Objective 4: Explain how the integration of various programs can be used to achieve multiple technical and coordination goals

About the Speaker

Michael David is a structural engineer in Buro Happold's New York office. With a background in high performance structures, he specializes in utilizing software interoperability for the design and construction of complex steel structures.

Michael has experience in long span construction projects such as the Pinnacle Bank Arena in Lincoln, NE and is currently working on the Atlanta Falcon's New Stadium Project in Atlanta, GA. He also has experience in specialty structures such as WTown Biomes, which is a gridshell structure located in Beijing, China.

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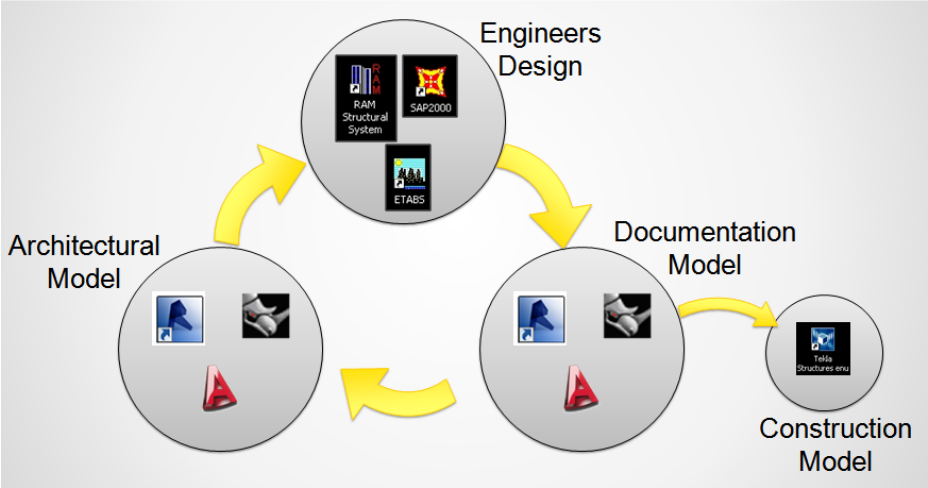
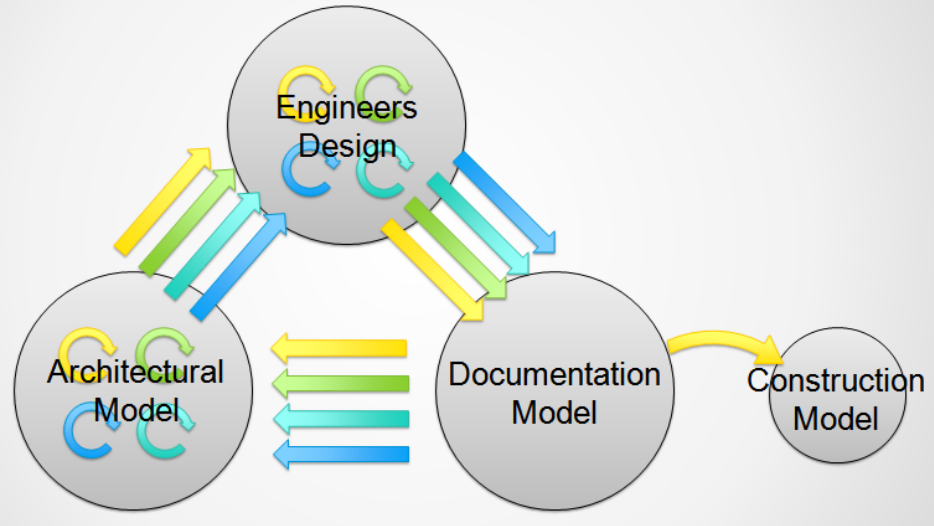
The Current BIM Process

Why do we need to set up a BIM workflow?

Typically the BIM lifecycle of a project begins with the architects providing a model with enough information for the structural engineers to perform their analysis and to layout the structural system of the building. The engineers take this model and produce a structural analysis model for them to analyze. The engineers take their analysis model and produce a model that they are going to use for documentation and drawing production. Some form of this documentation model gets sent back to the architects for coordination. The architects coordinate with the engineer's model and the whole process is iterated for the life of the project.



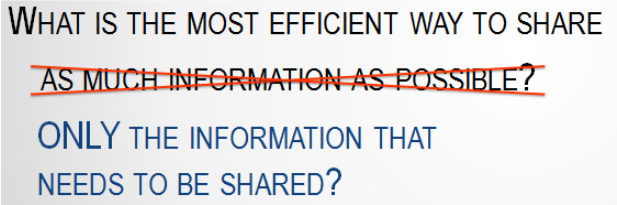
There are also iterations within each firm. These iterations may be running in parallel and may need to be incorporated into the documentation model at different times and at different frequencies.



Plan of Attack

How do we go about determining the most efficient way for us to communicate the information we need to communicate?

Remember to ask yourself…

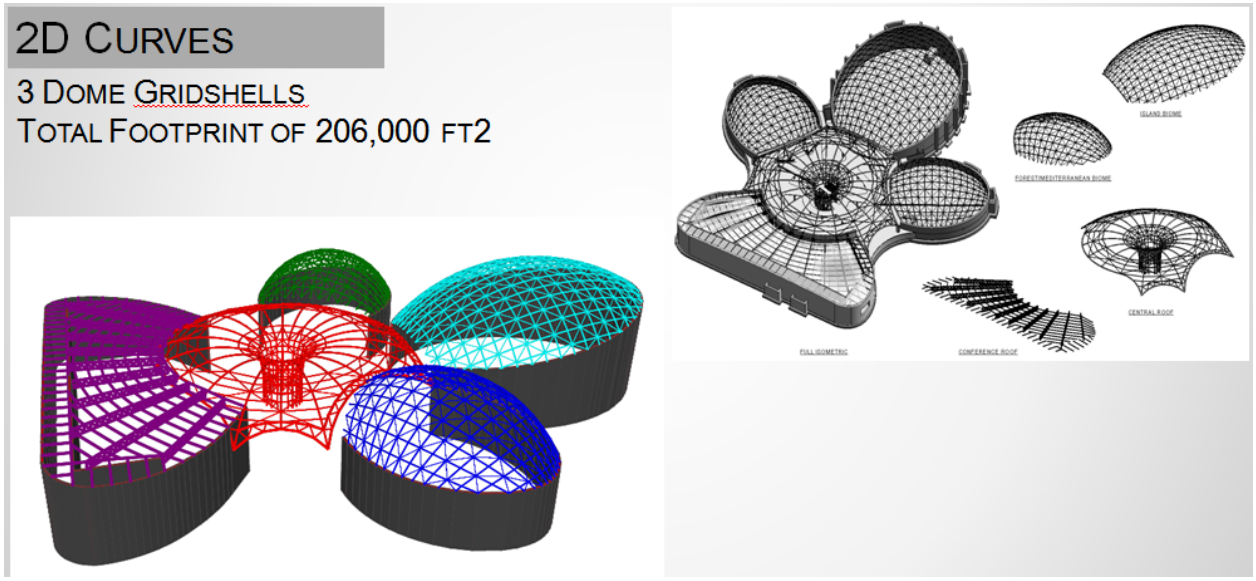


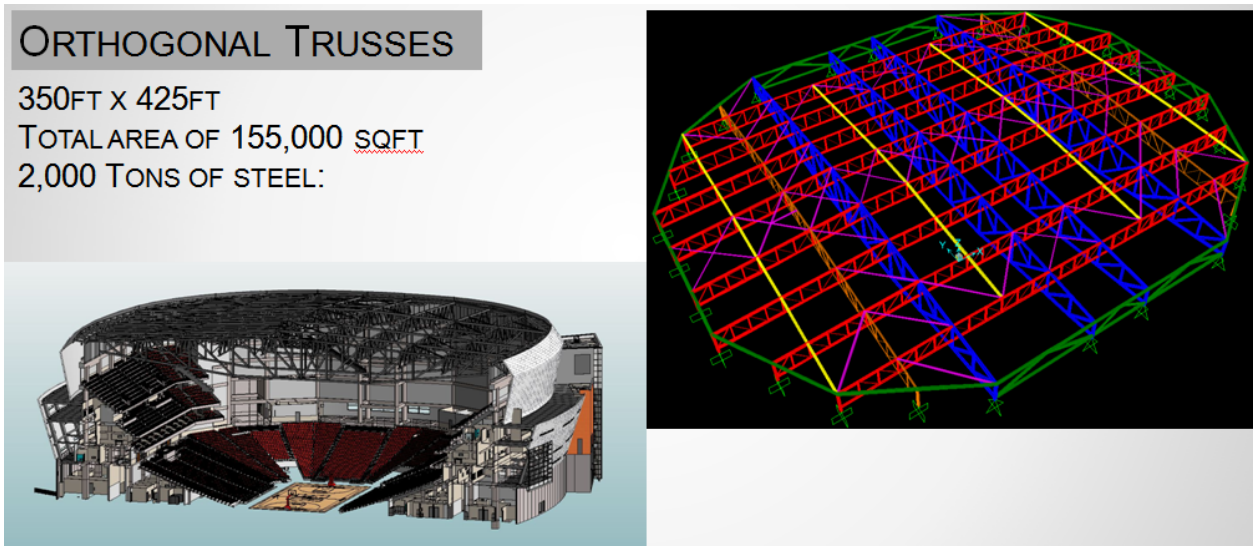
Using follow along case studies (2D Curves and Orthogonal Trusses) we will learn…

- How to set up a BIM workflow?
- What are the Driving questions we need to answer?
- What tools are available to us?
- Evaluate / Lessons Learned

Case Study Background

Below is some background info on the case studies that will be studied in parallel in order to demonstrate how to develop an efficient BIM workflow.





Setting up a BIM Workflow

Learning Objective: Set up a BIM workflow process using modern design tools such as Revit-based software and AutoCAD

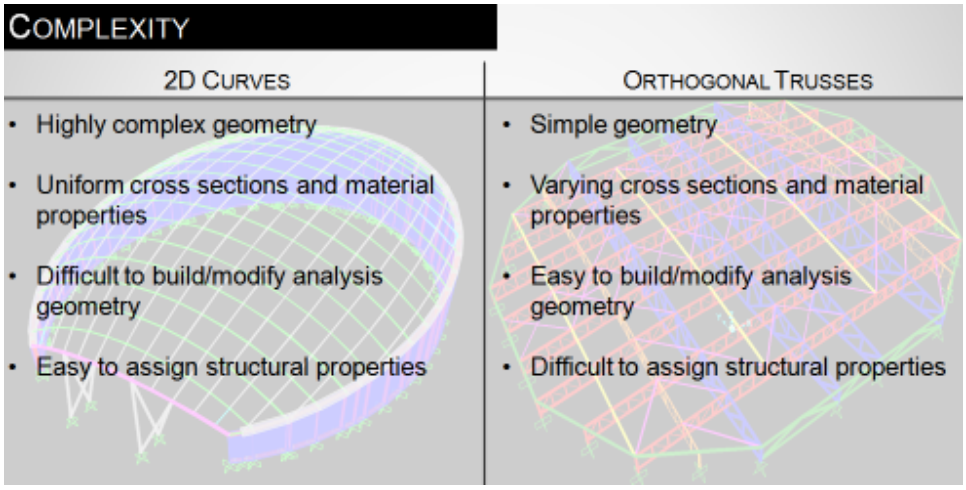
- Answer the Driving questions
- Determine what tools are available
- Establish a hierarchy of information
    - Determine where the information is coming from and use that as a start point
- Determine existing links between your tools
- Connect the dots
- Choose the best path available

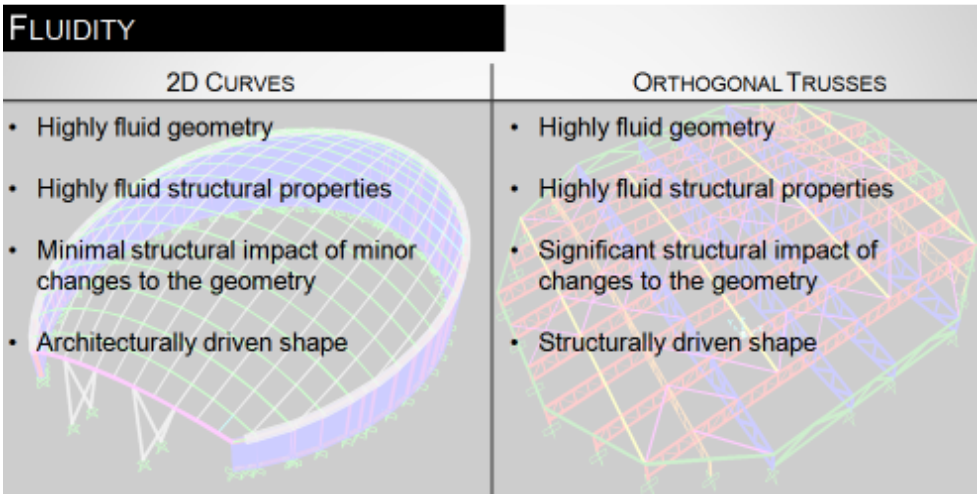
The Driving Questions

What are the Driving Questions we need to answer?

- How Complex is the Structure?
  - How simple is it to build/maintain the structural analysis and production models?
  - This needs to be answered from both a geometric information standpoint and a structural information standpoint

- How fluid is the design?
  - How often is the design going to change and who is going to be making the changes?
  - How difficult/necessary will it be to incorporate the design changes into both the coordination and analysis models?
  - How many times will structural analysis have to be run?





What do the answers to the Driving questions tell us?

2D Curves

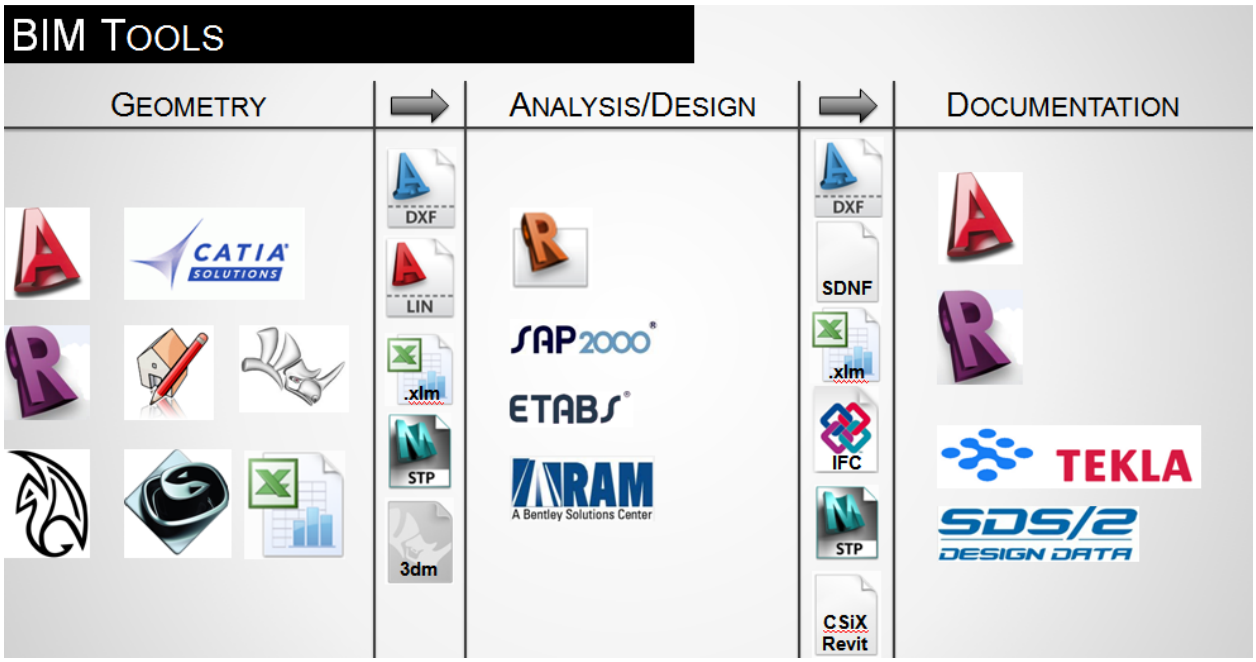
1. Difficult to build/modify analysis geometry
   It is important to be able to transfer the full geometry directly into the structural analysis and documentation software.
2. Architecturally driven shape
   It is important to be able to withdraw information directly from the information provided by the architect.
3. Easy to assign structural properties
   It is not critical that structural properties be communicated between analysis and documentation software.
4. Highly fluid geometry
   It is important that the geometry is able to be modified without requiring repeat work. However, because of the ease to assign structural properties the importance of this item is minimized.
5. Highly fluid structural properties
   It is important that the structural properties are able to be communicated between analysis and documentation software.
   However, because of the ease to assign structural properties the importance of this item is minimized.

Orthogonal Trusses

1. Easy to build/modify analysis geometry
   It is not critical to be able to transfer the full geometry directly into the structural analysis and documentation software.
2. Structurally driven shape
   It is not critical to be able to withdraw information directly from the information provided by the architect.
3. Difficult to assign structural properties
   It is important that structural properties be communicated between analysis and documentation software.
4. Highly fluid geometry
   It is important that the geometry is able to be modified without requiring repeat work.
5. Highly fluid structural properties
   It is important that the structural properties are able to be communicated between analysis and documentation software.

Available Tools

Learning Objective: Describe how modern technologies can be used to develop communication between structural analysis and coordination models



Now that we've answered the questions we need to answer and understand the different tools that we have available we need to chose the tools that are going to be most effective for us and we also need to establish a BIM workflow. In order to do this well you need to understand what information is transferred between software by each translation tool. Some tools transfer geometry only, while others transfer structural information as well.

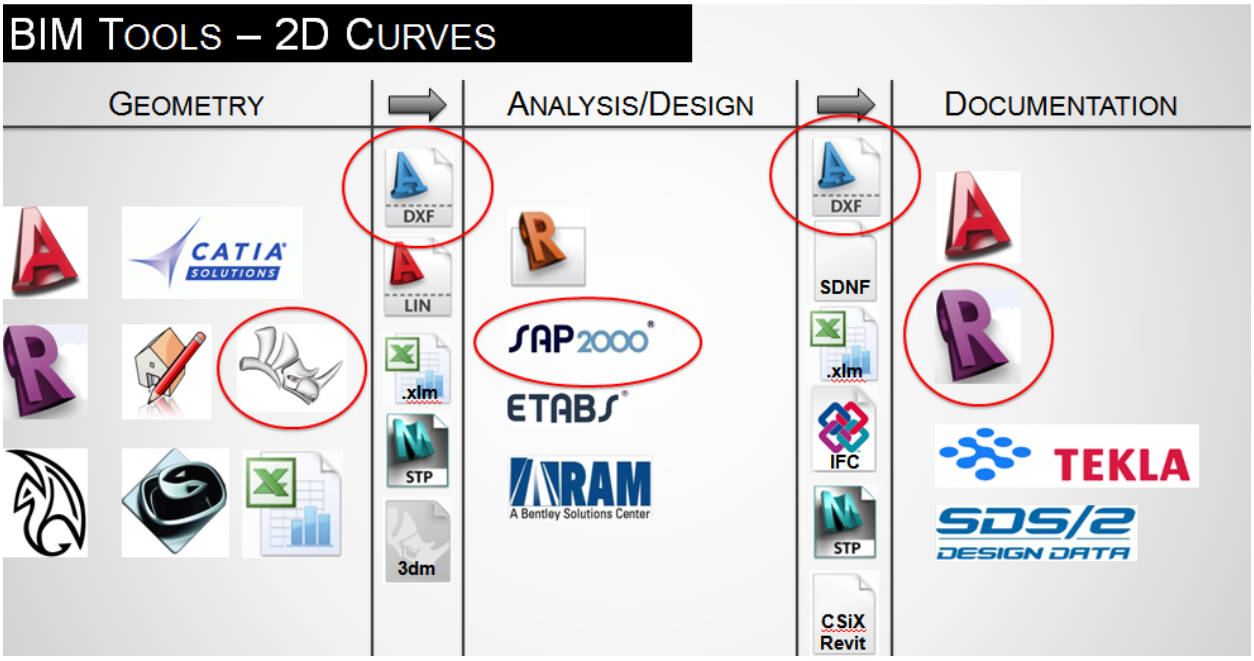
Remember, choosing what BIM tools we are going to use is not the same as setting up a BIM workflow. You need to establish the flow of information for all aspects of the project.

Choosing the BIM tools

Learning Objective: Explain how the integration of various programs can be used to achieve multiple technical and coordination goals

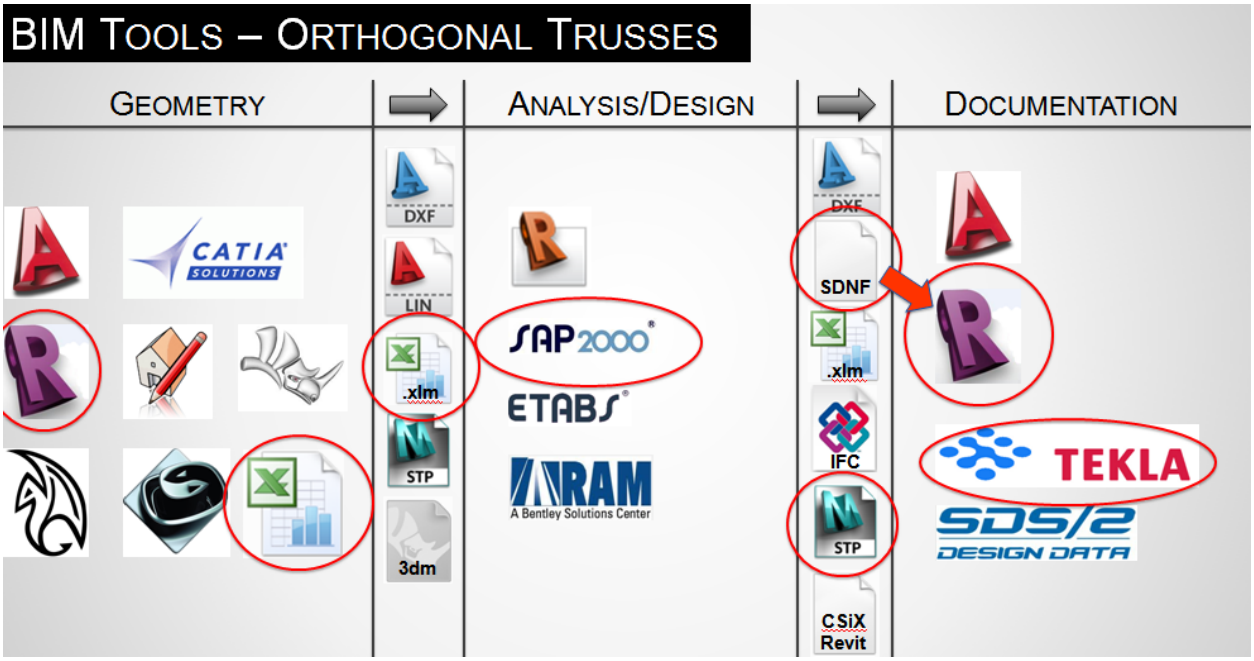
2D Curves

1. Geometry to Analysis
    1. A DXF file allowed us to import the architectural geometry directly into SAP2000.
    2. This does not transfer structural properties, but that wasn't a critical factor because of the simplicity to apply structural properties such as loads and member sizes.
2. Analysis to Documentation
    1. A DXF file allowed us to import the geometry directly into Revit.
    2. This does not transfer structural properties, but that wasn't a critical factor because of the simplicity to apply structural properties such as loads and member sizes.

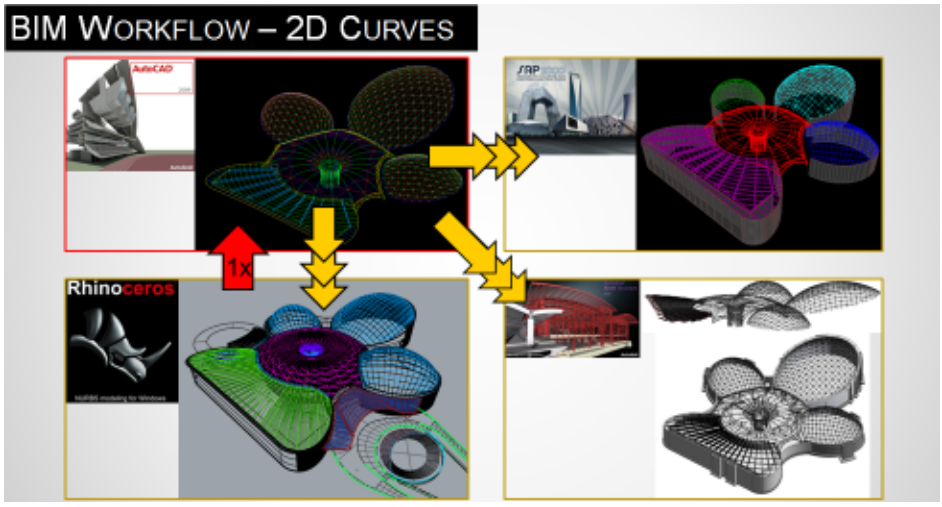


Orthogonal Trusses

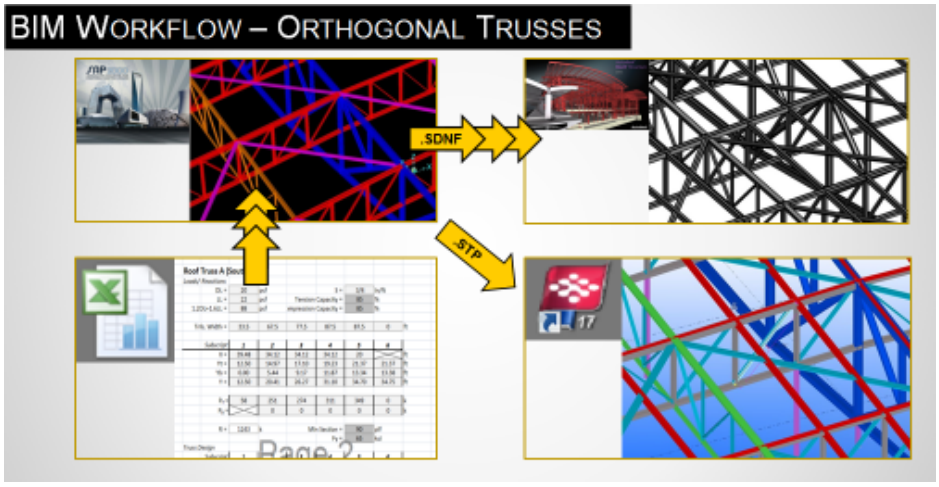
1. Geometry to Analysis
    1. Using an excel file to define the geometry allowed us to easily modify the analysis model. This includes the models geometry and structural information.
    2. This makes it difficult to import architectural geometry, but because the geometry was primarily structurally driven that wasn't a critical factor.
2. Analysis to Documentation
    1. An SDNF file allowed us to import the analysis model geometry directly into Revit.
    2. An STP file allowed us to import the analysis model geometry directly into Tekla.



Connecting the Dots



What we were trying to achieve for the 2D Curves project was to have a model that could easily receive architectural changes and could quickly and easily send that information to the analysis model. We chose to maintain a central model that sent only geometric information (no structural information) to both the structural analysis, coordination and the documentation models. This was possible because of how simple it was to assign structural properties to both the analysis and documentation models.



What we were trying to achieve for the Orthogonal Trusses project was to be able to easily update the geometry and structural load properties within the analysis model. We chose to modify the joint coordinates and the loading criteria of the structural analysis model via the interactive database of SAP2000. We were able to export the SAP model to SDNF and import that into Revit. This transferred the geometry and the structural section properties to the documentation model.

Lessons Learned

- When should you set up a BIM workflow?

  A BIM Work flow should be established as soon as iterations of similar information start to get shared

- Determine which stage of the project you are setting up a BIM workflow for

  You can have different BIM workflows for different stages of a project.

- Iterate the process of developing a workflow as much as you need

  The project will constantly be changing and the factors that defined the answers to the Driving questions can change.

- Who should be involved in the process?

  Internally – You should consult BIM technicians, engineers, and managers. They all should provide input into how you answer the Driving questions and determine the tools you have available for the project.

  Externally – You should consult the architects and any other parties that will be sending or receiving information from.

Summary

Learning Objective: Explain the benefits of establishing an efficient BIM workflow early in the life of a project

- Setting up a BIM workflow allows the entire design team to be as efficient as possible in transferring the right information between different models and you are able to ensure that the information is consistent between models.
- While almost all software can understand DWG it is not always the best options because of the limited information.
- Real BIM software such as Revit allows you to communicate important building information with other software.
- Today's industry is developing independent software links and is also developing common software languages.
- As designers we need to have a process to create BIM workflows that can grow and develop with the fast developing technology within our industry.