The Languages Everyone Understands: Math, Money and DWG™

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Class summary

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.

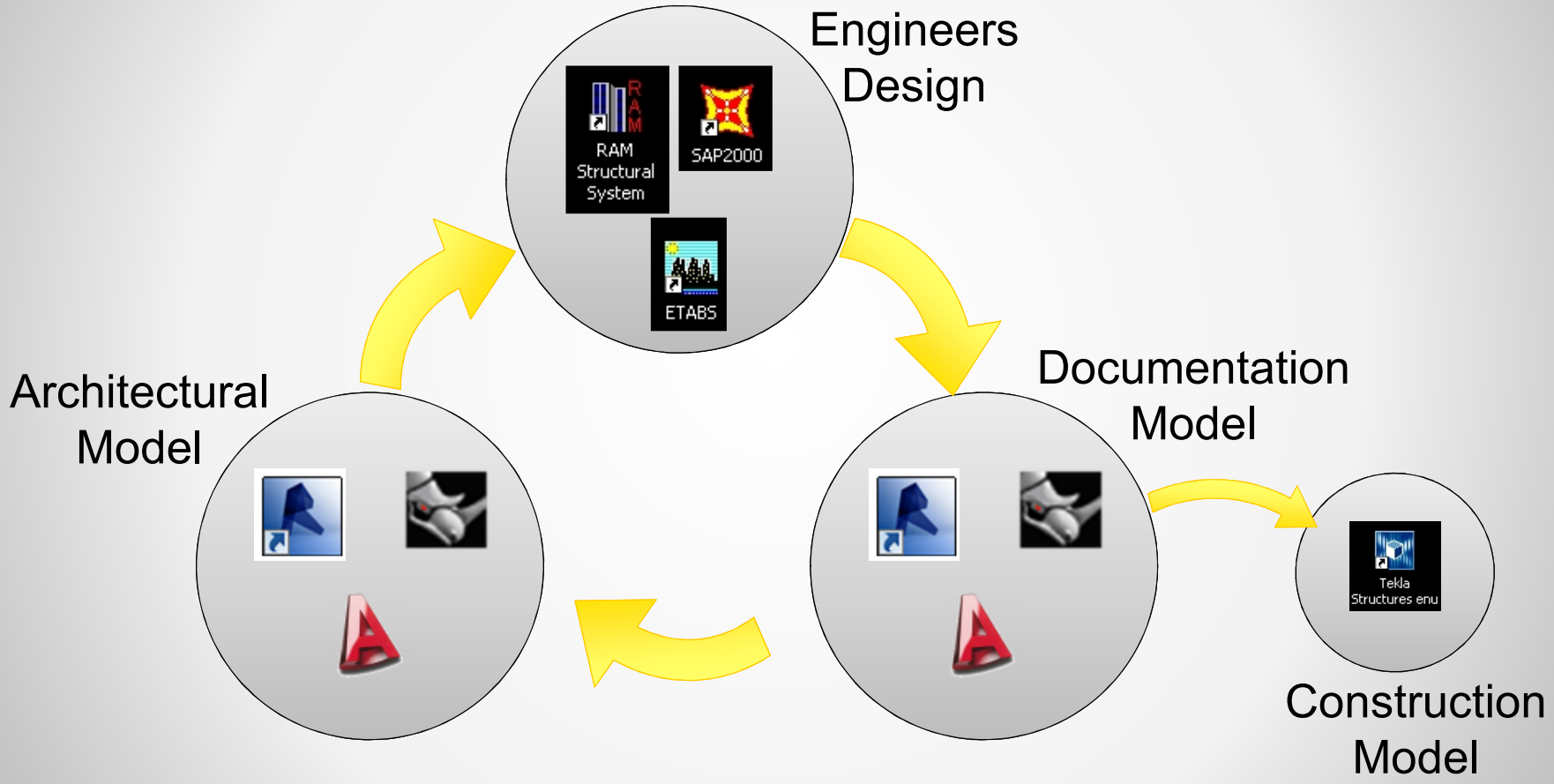
Key learning objectives

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

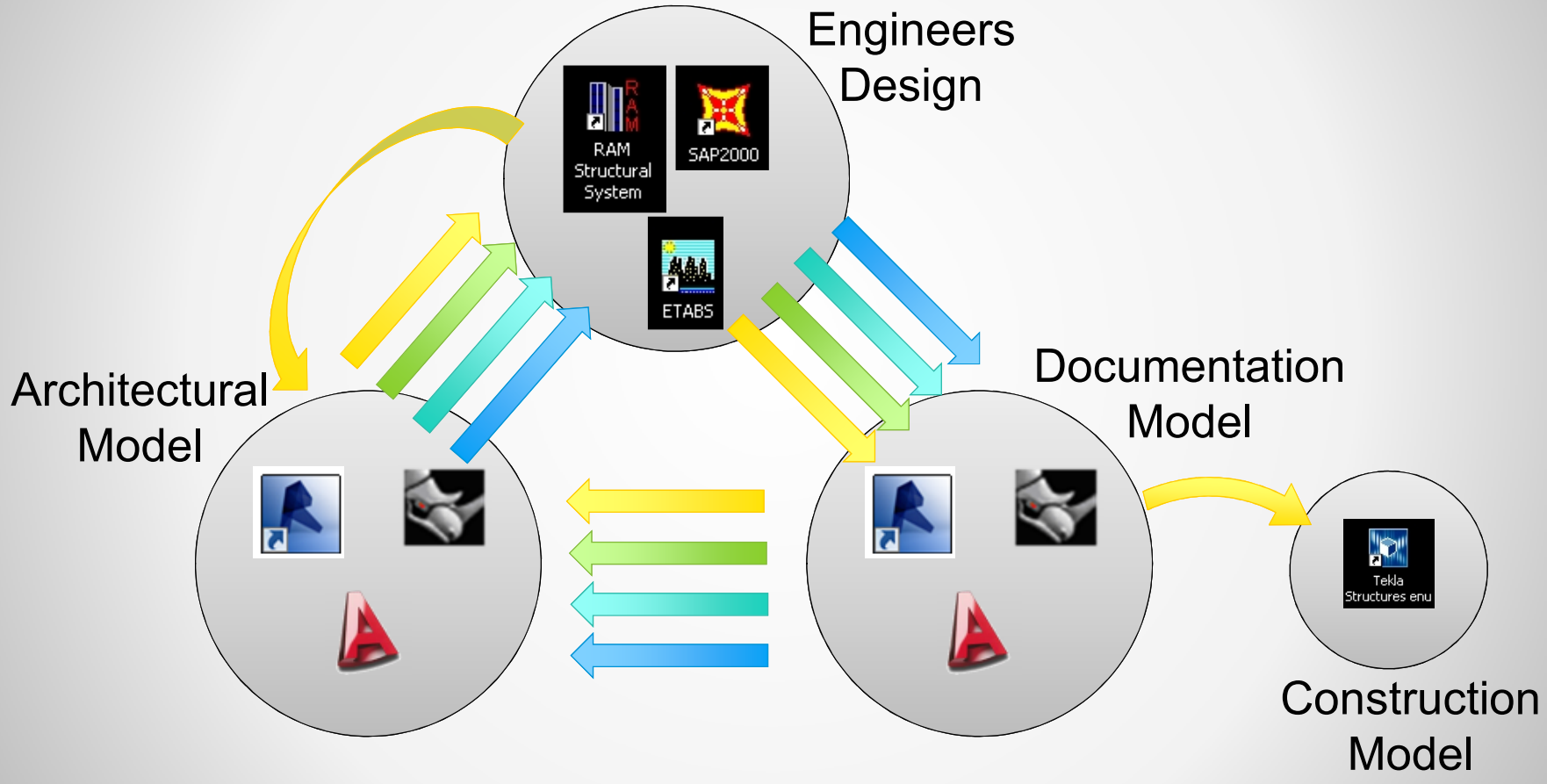
- Set up a BIM workflow using modern tools such as Revit.
- Demonstrate the benefits of establishing a BIM workflow early in the life of the project.
- Demonstrate how modern software can develop communication between analysis and coordination models.
- Demonstrate how program integration can help achieve technical and coordination goals.

THE CURRENT BIM PROCESS

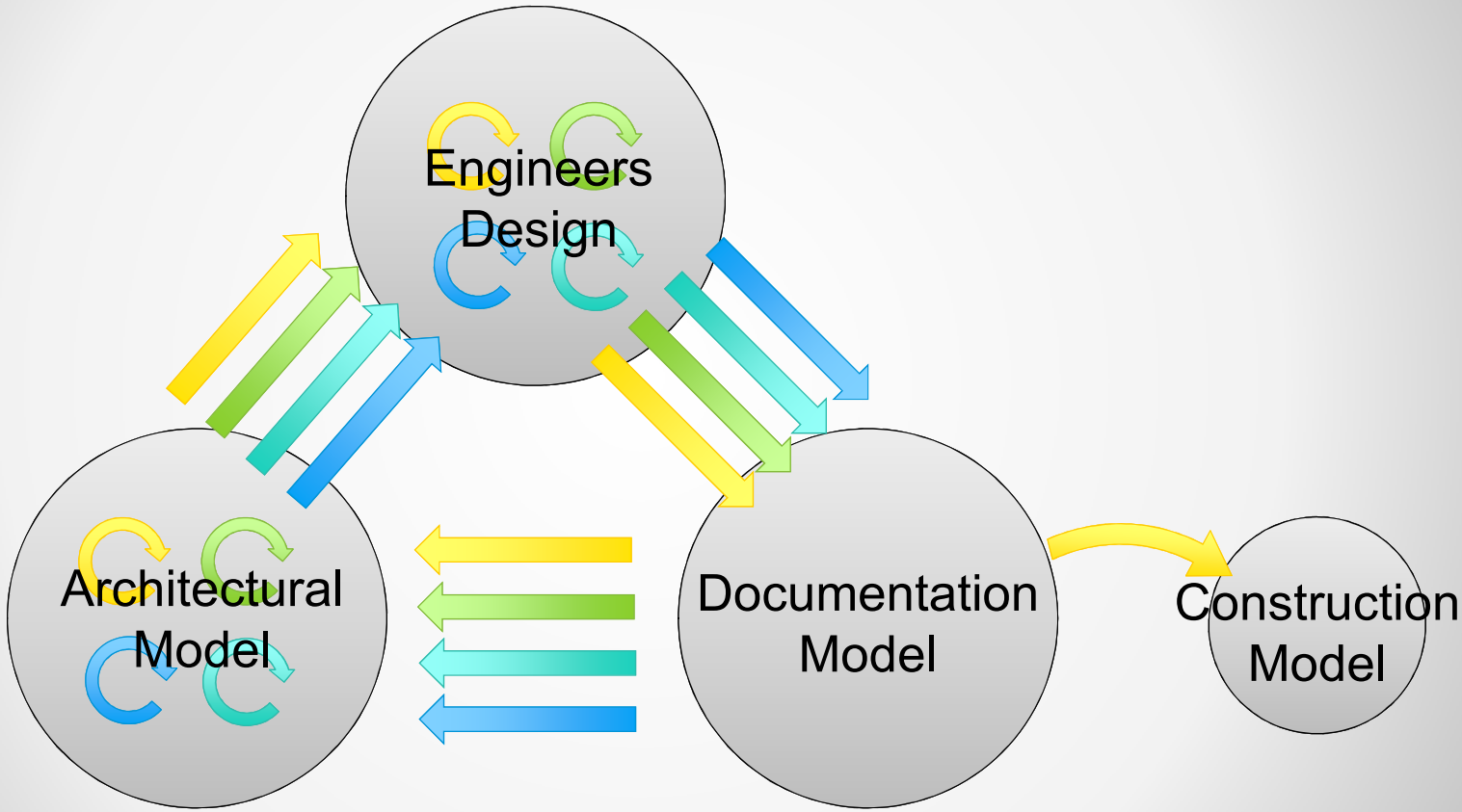
CURRENT BIM PROCESS



CURRENT BIM PROCESS



CURRENT BIM PROCESS



PLAN OF ATTACK

Plan of Attack

- It's all about communication

- What is the most efficient way to share

  ~~as much information as possible?~~

  only the information that needs to be shared?

Plan of Attack

Using follow along case studies we will learn…

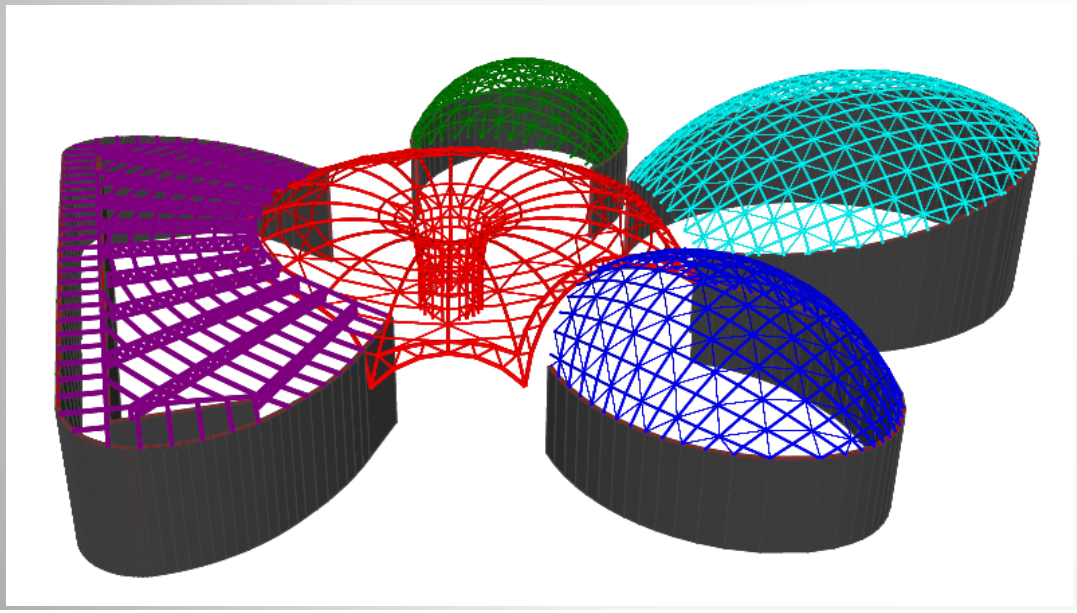
- The steps required to set up a BIM workflow
- What are the Driving questions we need to answer
- What tools are available and how to choose them
- Automation – Pros and Cons
- Evaluate / Lessons Learned

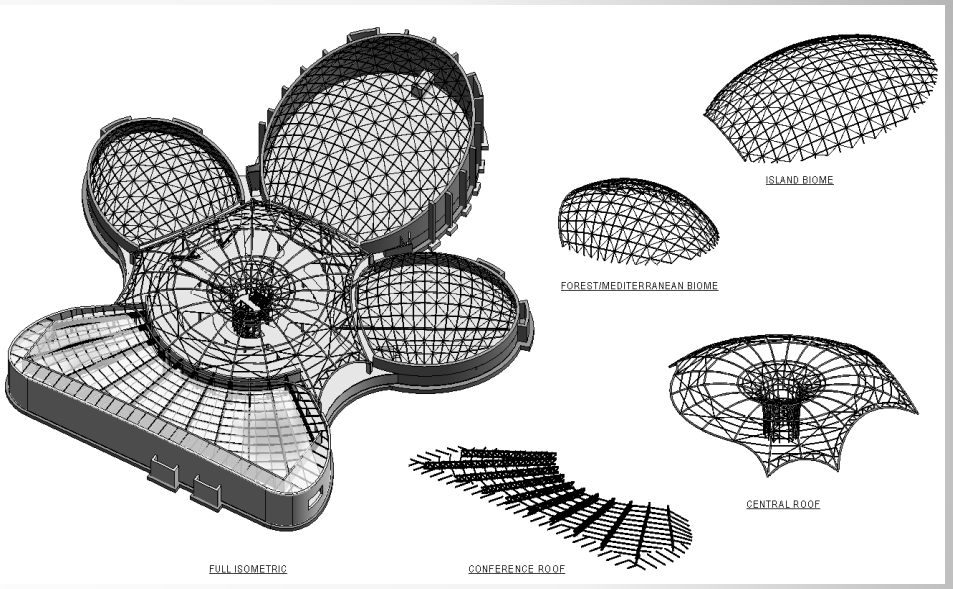
CASE STUDIES BACKGROUND

Case Studies Background

2D Curves

3 Dome Gridshells
Total Footprint of 206,000 ft2

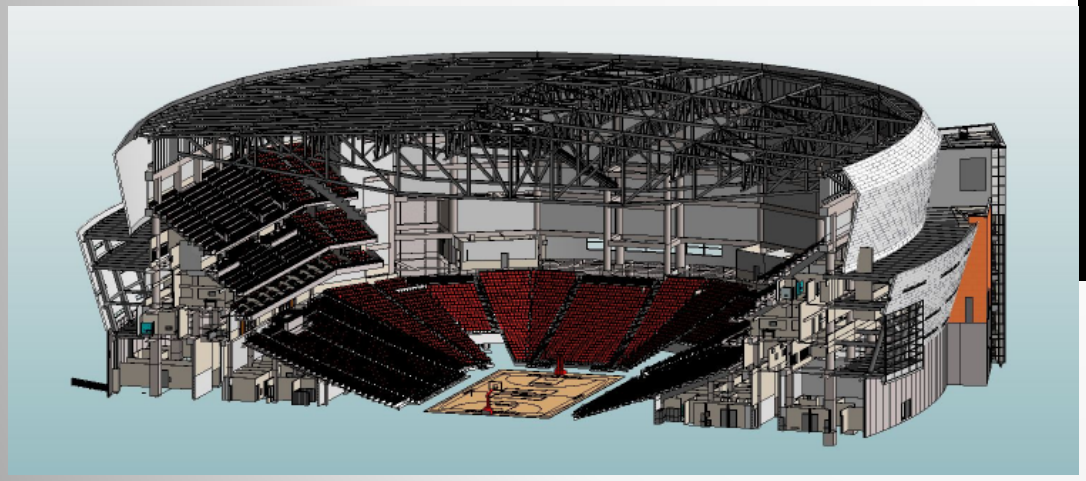


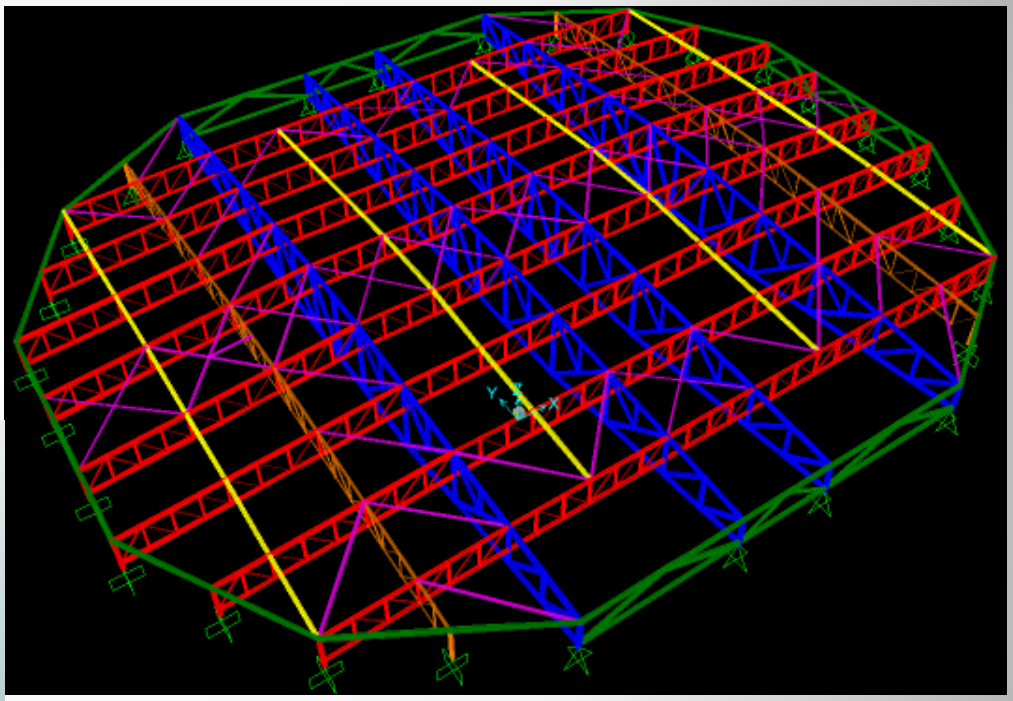


Case Studies Background

Orthogonal Trusses

350ft x 425ft
Total area of 155,000 sqft
2,000 Tons of steel:





SETTING UP A BIM WORKFLOW

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

SETTING UP A BIM WORKFLOW

- Answer the Driving questions
- Determine what tools are available
- Establish a hierarchy of information
- Determine existing links between your tools
- Choose the best BIM workflow available

THE DRIVING QUESTIONS

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

The Driving Questions

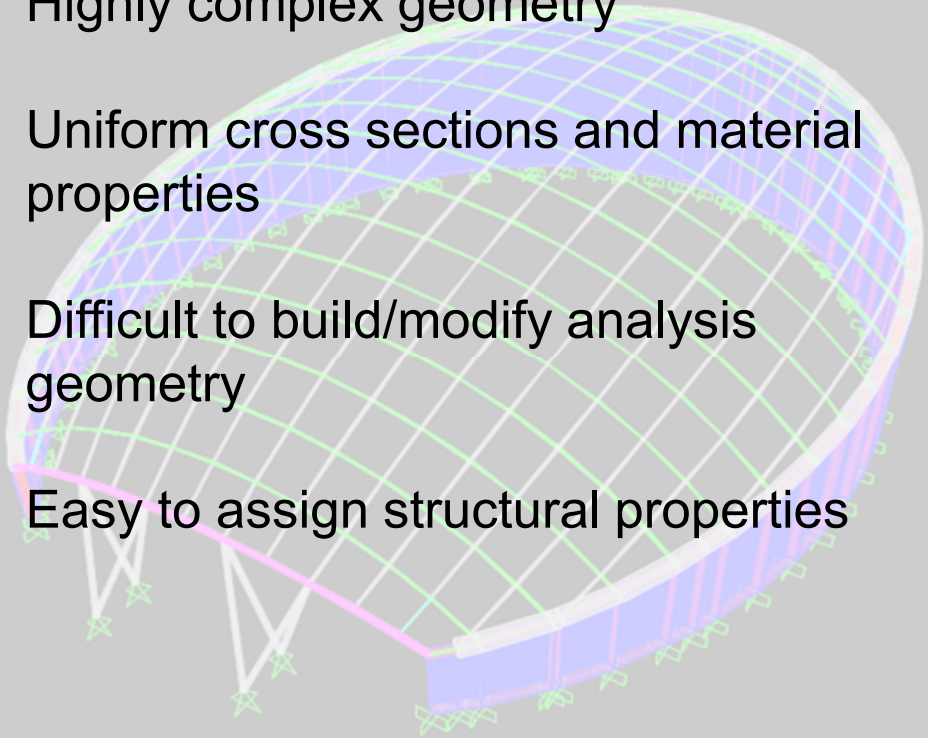
What are the Driving Questions we need to answer?

- 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?

COMPLEXITY

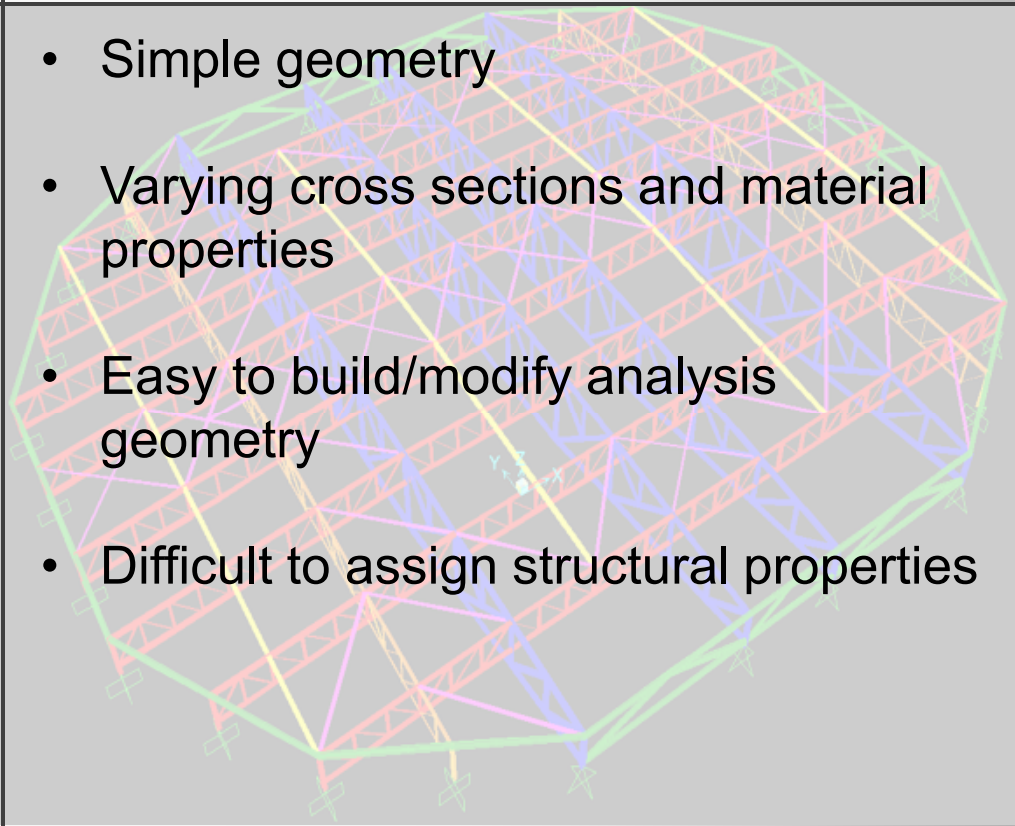
2D CURVES

- Highly complex geometry
- Uniform cross sections and material properties
- Difficult to build/modify analysis geometry
- Easy to assign structural properties



ORTHOGONAL TRUSSES

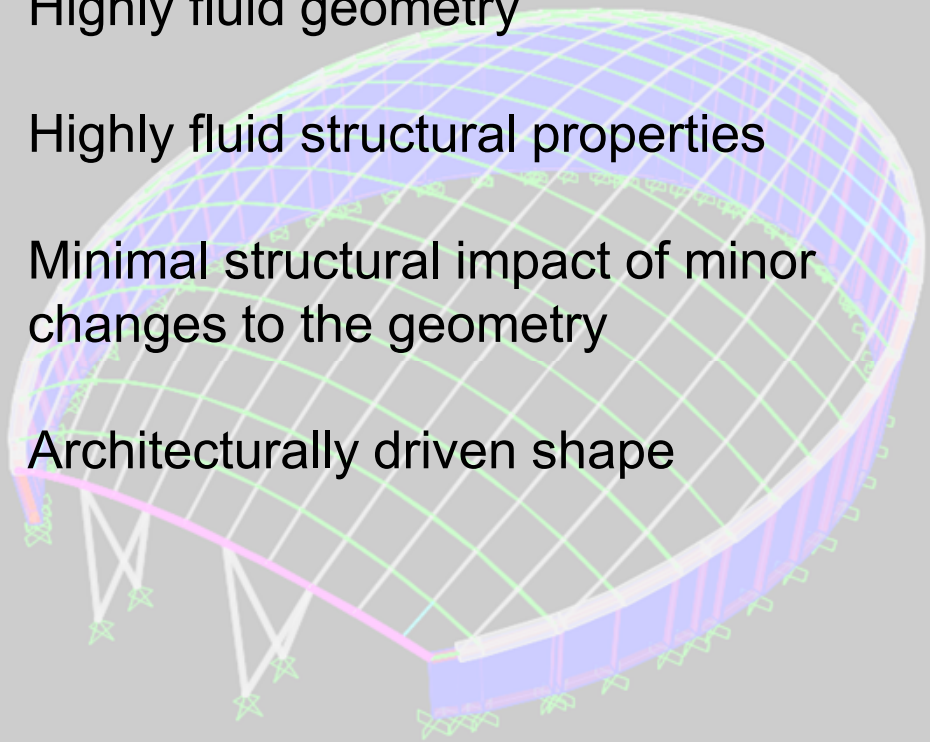
- Simple geometry
- Varying cross sections and material properties
- Easy to build/modify analysis geometry
- Difficult to assign structural properties



FLUIDITY

2D CURVES

- Highly fluid geometry
- Highly fluid structural properties
- Minimal structural impact of minor changes to the geometry
- Architecturally driven shape



ORTHOGONAL TRUSSES

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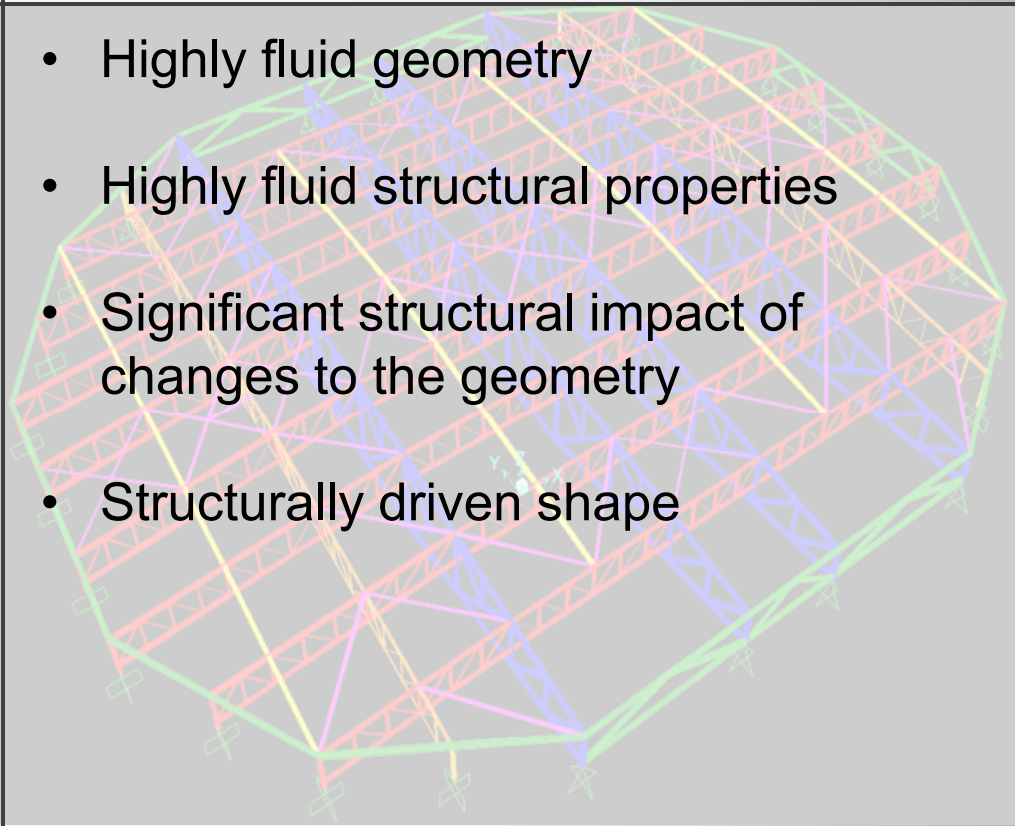
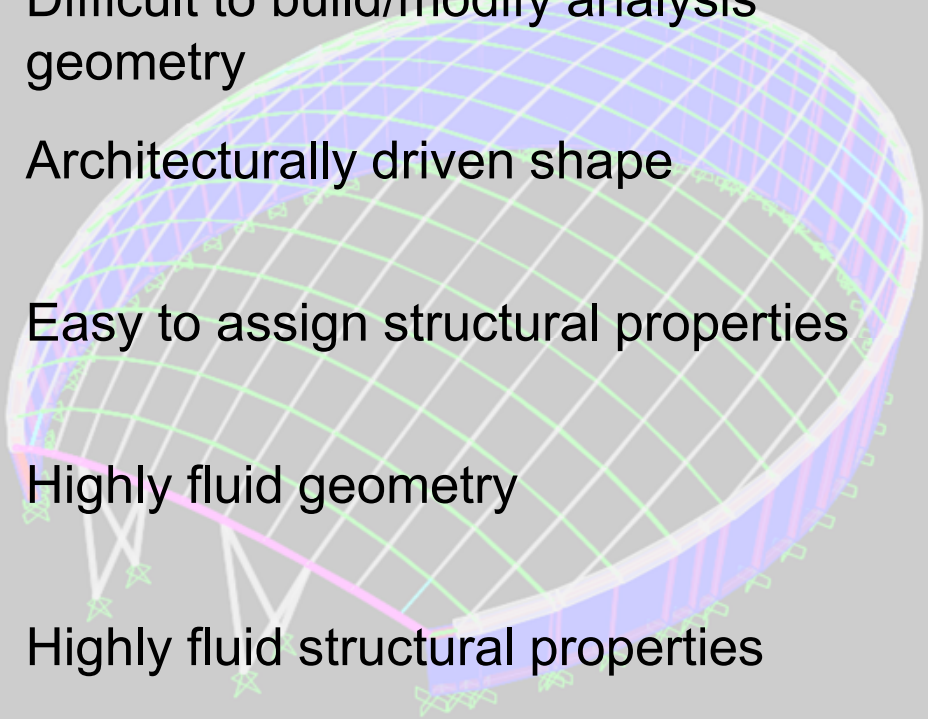


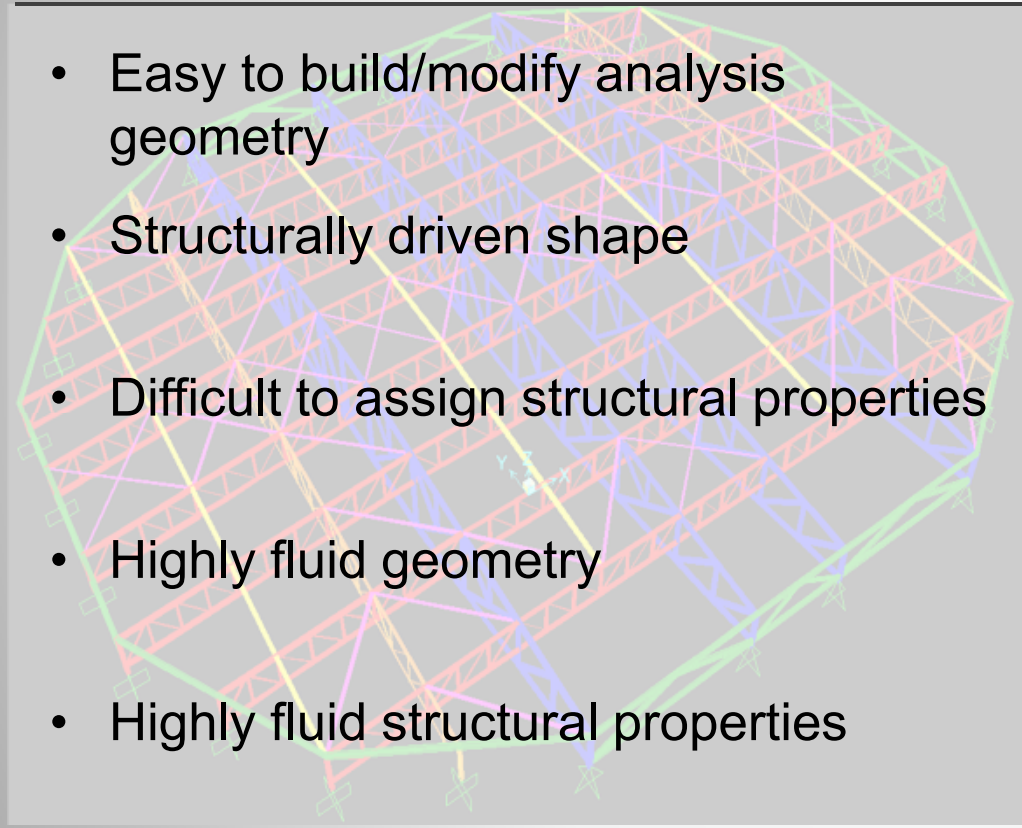
WHAT DOES THIS TELL US?

2D CURVES	WE NEED TO…
• Difficult to build/modify analysis geometry	Transfer the full geometry directly into our software
• Architecturally driven shape	Withdraw information from architects software
• Easy to assign structural properties	DO NOT need to communicate structural properties between software
• Highly fluid geometry	Modify geometry without repeat work
• Highly fluid structural properties	Communicate structural properties between software



WHAT DOES THIS TELL US?

ORTHOGONAL TRUSSES	WE NEED TO…
• Easy to build/modify analysis geometry	Transfer the full geometry directly into our software
• Structurally driven shape	DO NOT need to withdraw information from the architects software.
• Difficult to assign structural properties	Communicate structural properties between software
• Highly fluid geometry	Modified the geometry without requiring repeat work
• Highly fluid structural properties	Communicate structural properties between software



AVAILABLE TOOLS

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

BIM Tools

Geometry







Analysis/Design


Documentation



CHOOSING THE BIM TOOLS

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

BIM Tools – 2D Curves

Geometry







Analysis/Design


Documentation



DXF
LIN
.xlm
STP
3dm
DXF
SDNF
.xlm
IFC
STP
CSiX
Revit

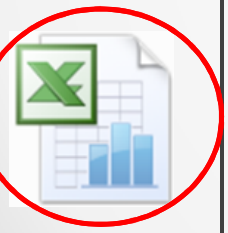
BIM Tools – Orthogonal Trusses

Geometry







Analysis/Design




Documentation



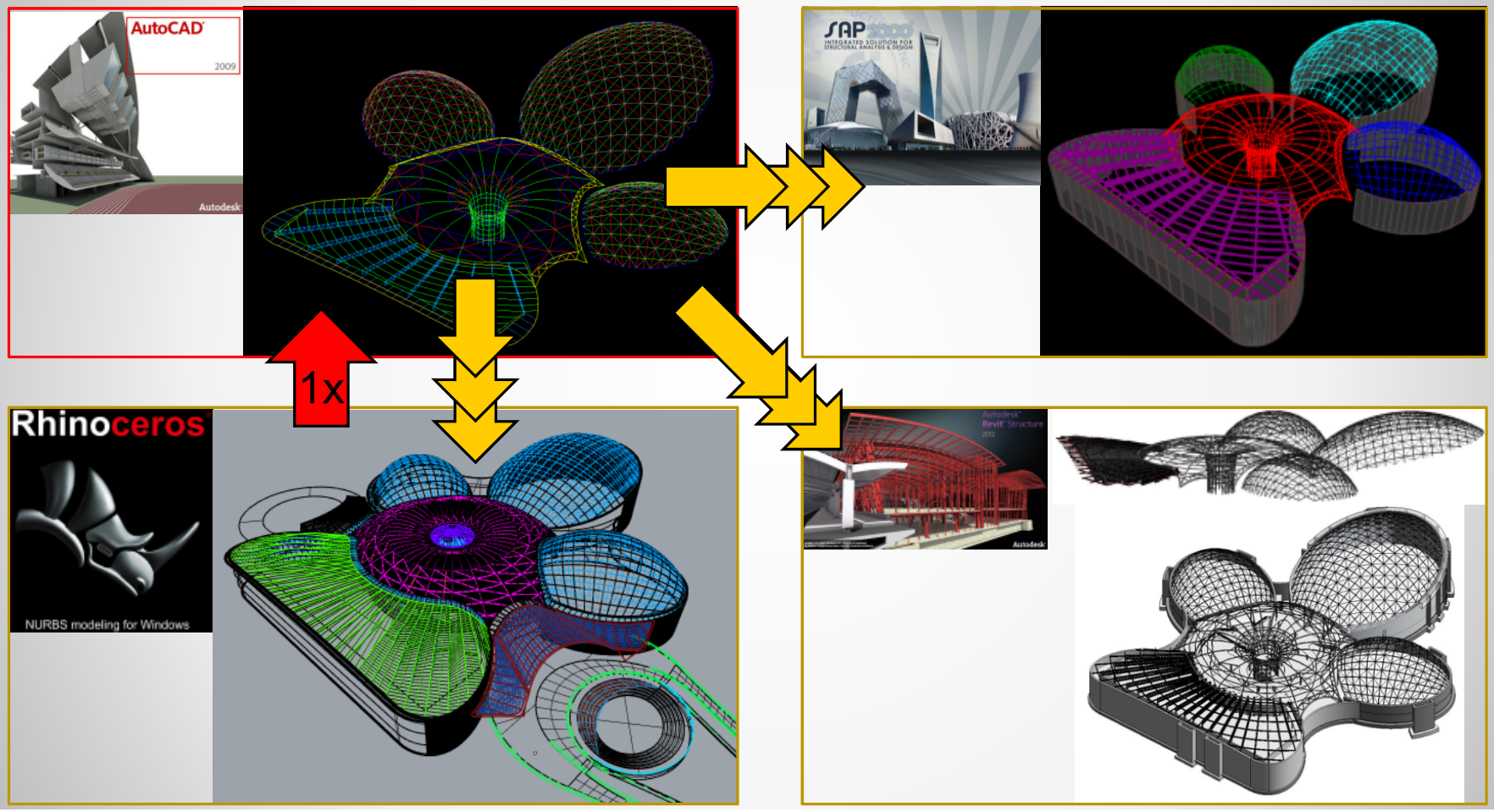

SETTING UP A BIM WORKFLOW

Choosing what BIM tools we are going to use is not the same as setting up a BIM workflow.

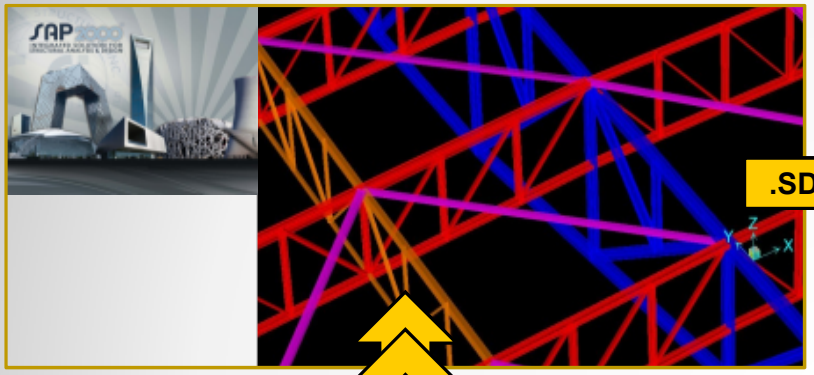
SETTING UP A BIM WORKFLOW

- Answer the Driving questions
- Determine what tools are available
- Establish a hierarchy of information
- Determine existing links between your tools
- Choose the best BIM workflow available

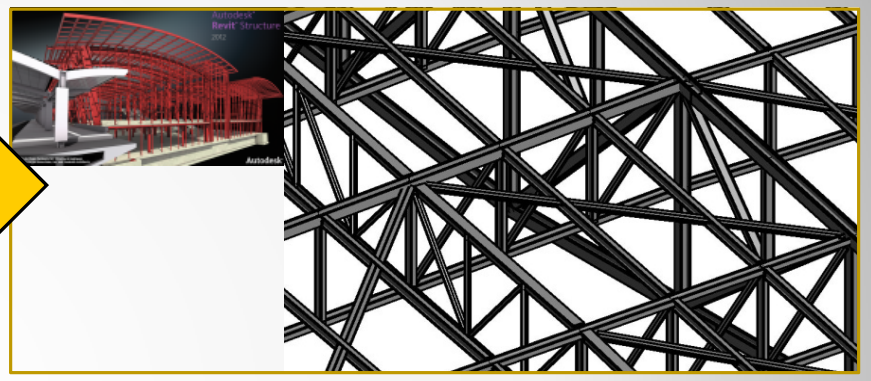
BIM Workflow – 2D Curves

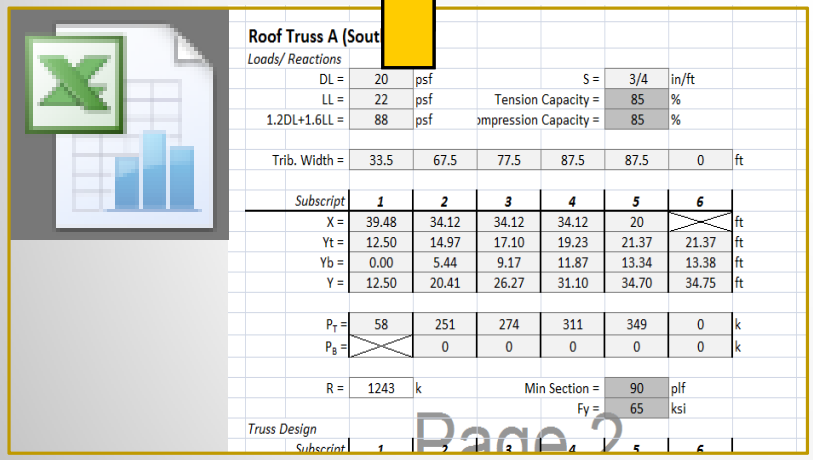


BIM Workflow – Orthogonal Trusses



.SDNF





Roof Truss A (Sout

Loads/ Reactions

DL =	20	psf	S =	3/4	in/ft
LL =	22	psf	Tension Capacity =	85	%
1.2DL+1.6LL =	88	psf	ompression Capacity =	85	%

Trib. Width =	33.5	67.5	77.5	87.5	87.5	0	ft

Subscript	*1*	*2*	*3*	*4*	*5*	*6*	
X =	39.48	34.12	34.12	34.12	20		ft
Yt =	12.50	14.97	17.10	19.23	21.37	21.37	ft
Yb =	0.00	5.44	9.17	11.87	13.34	13.38	ft
Y =	12.50	20.41	26.27	31.10	34.70	34.75	ft
P_T =	58	251	274	311	349	0	k
P_B =		0	0	0	0	0	k

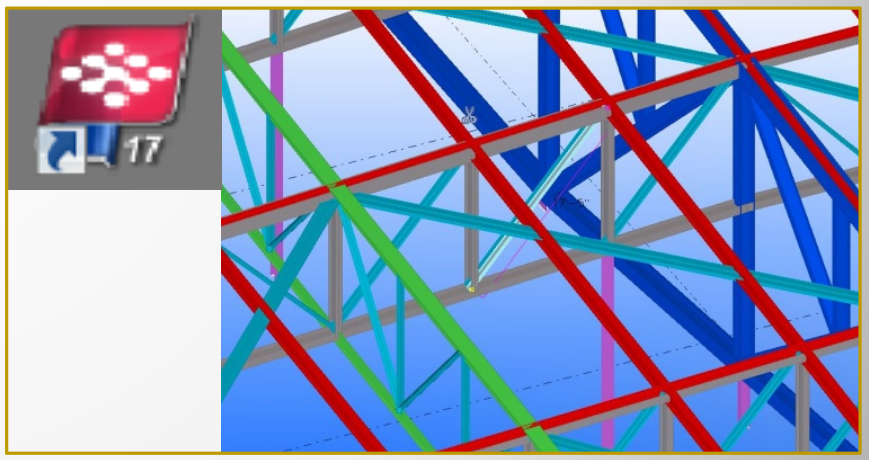
R =	1243	k	Min Section =	90	plf
			Fy =	65	ksi

Truss Design

Subscript 1 2 3 4 5 6

Page 2

.STP

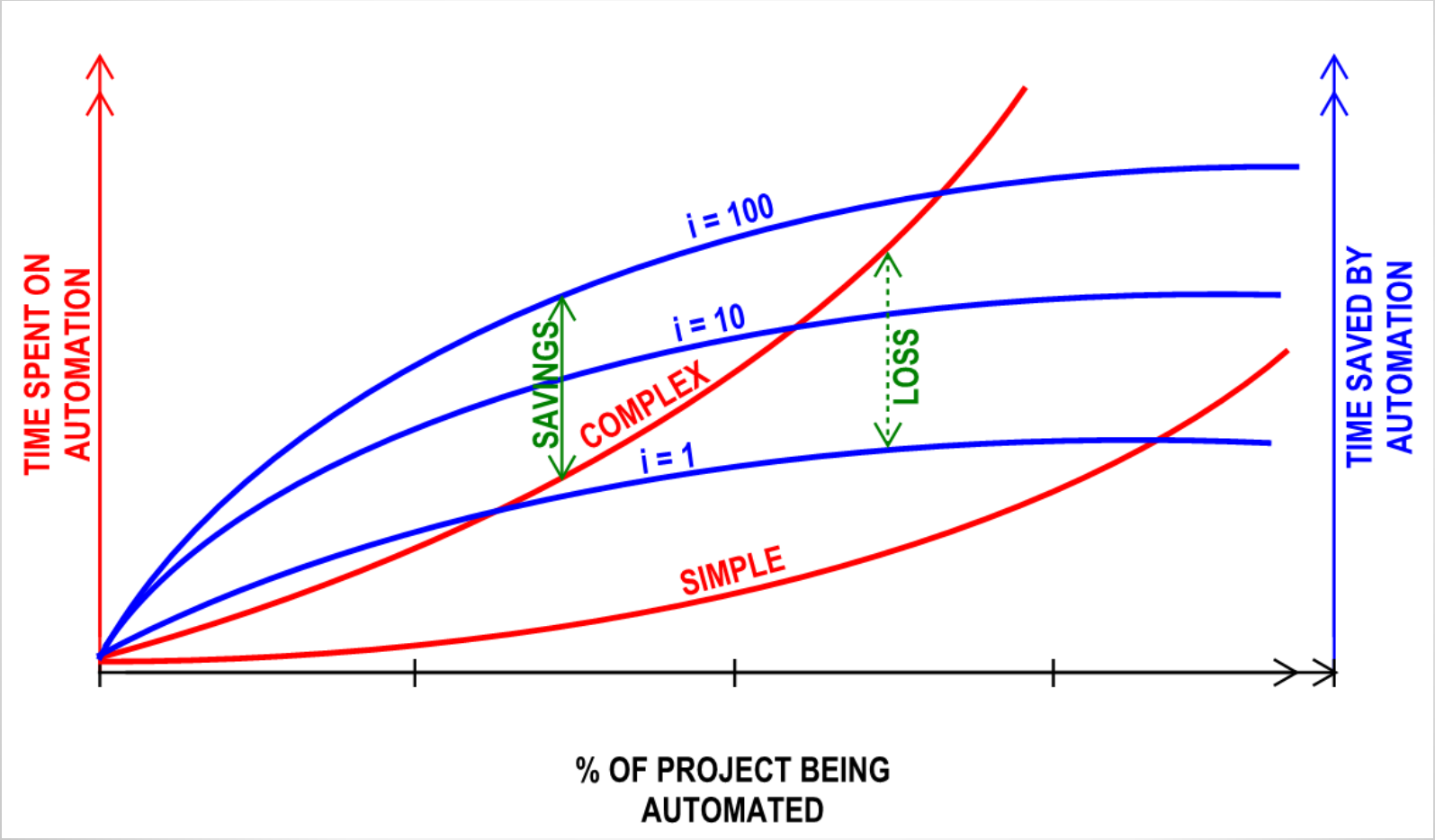


AUTOMATION: HOW MUCH TIME WILL YOU REALLY SAVE?

AUTOMATION

- ESTABLISH HOW MUCH OF THE PROJECT IS WORTH AUTOMATING
- DETERMINE THE AMOUNT OF TIME IT WILL TAKE TO AUTOMATE BASED ON THE COMPLEXITY OF THE PROJECT
- DETERMINE THE SAVINGS DUE TO THE NUMBER OF ITERATIONS THE AUTOMATION WILL HELP WITH
- DETERMINE THE AMOUNT OF AUTOMATION THAT WILL RESULT IN THE GREATEST SAVINGS TO THE PROJECT
- INCORPORATE THE AUTOMATION INTO THE BIM WORKFLOW

AUTOMATION


TIME SPENT ON AUTOMATION
i = 100
i = 10
i = 1
SAVINGS
LOSS
COMPLEX
SIMPLE
TIME SAVED BY AUTOMATION
% OF PROJECT BEING AUTOMATED

AUTOMATION

2D CURVES

- No automation

Because of the ease of applying structural properties to the 2D Curves models there was limited time savings by automating the BIM process.

ORTHOGONAL TRUSSES

- Geometry manipulation of joint coordinates via database editing
- Load manipulation via database editing

Because of the simple geometry and ease of automating the BIM process, as well as the high number of iterations required for the Orthogonal Trusses project there was a significant benefit to automating a portion of the BIM process.

LESSONS LEARNED

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

Lessons Learned

- 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.

Lessons Learned

- It's OK to have a simple workflow
- Hindsight is 20/20

SUMMARY

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

SUMMARY

- 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 enables you able to ensure that the information is consistent between models.

SUMMARY

- 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.

SUMMARY

- 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.