Introduction to Using Autodesk® Simulation Products to Simulate Solar Thermal Loads in Concrete Bridges

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Sr. SQA Engineer

Who -

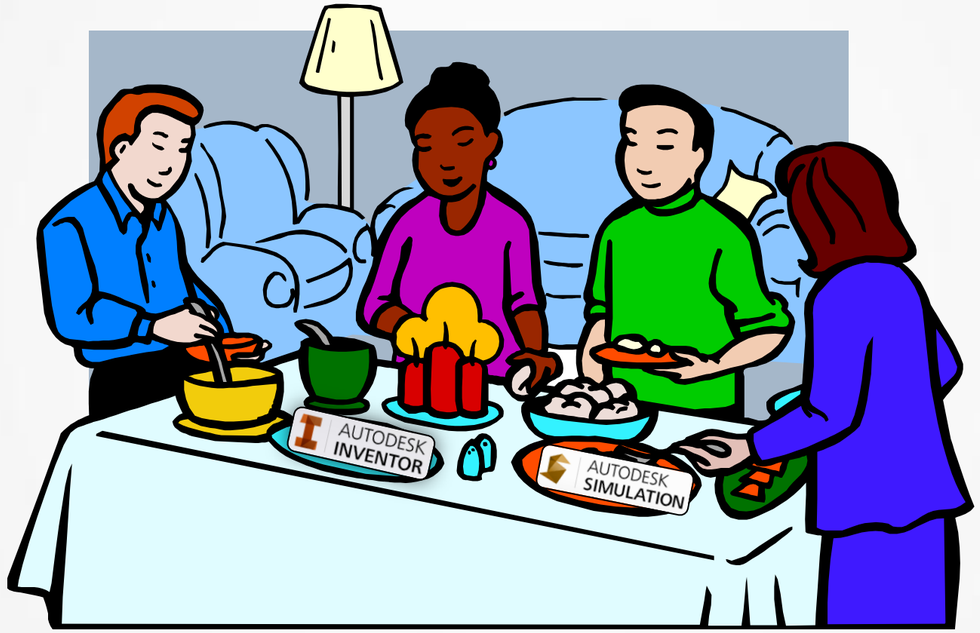
- Your Instructor
  - Peggy Menzies
    - CFD Quality Lead
- Lab Assistants
  - Heath Houghton
    - Product Manager (CFD)
  - Sualp Ozel
    - Product Manager (Mechanical)
  - Dave Graves
    - Solution Engineer

52+ years experience

- Together with YOU

What -

Dine from the smorgasbord of Autodesk tools



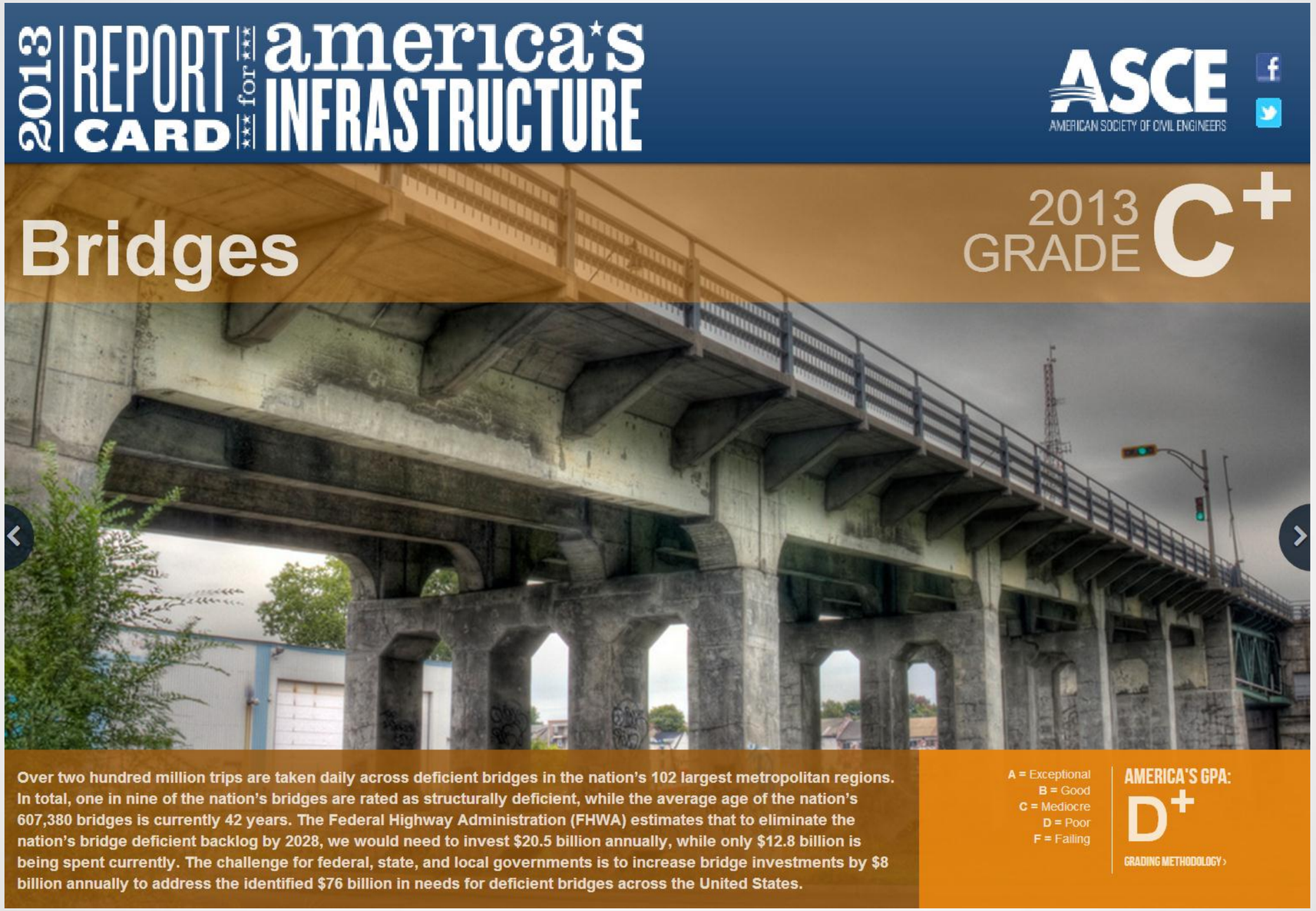
Learn how the combination of tools can help design better structures

Where & When -

- Class Handout Notations

Don’t forget to download your class materials

Why -


2013 REPORT CARD for America's INFRASTRUCTURE
ASCE
AMERICAN SOCIETY OF CIVIL ENGINEERS
Bridges
2013 GRADE C+
Over two hundred million trips are taken daily across deficient bridges in the nation's 102 largest metropolitan regions. In total, one in nine of the nation's bridges are rated as structurally deficient, while the average age of the nation's 607,380 bridges is currently 42 years. The Federal Highway Administration (FHWA) estimates that to eliminate the nation's bridge deficient backlog by 2028, we would need to invest $20.5 billion annually, while only $12.8 billion is being spent currently. The challenge for federal, state, and local governments is to increase bridge investments by $8 billion annually to address the identified $76 billion in needs for deficient bridges across the United States.
A = Exceptional
B = Good
C = Mediocre
D = Poor
F = Failing
AMERICA'S GPA:
D+
GRADING METHODOLOGY ›

Let's get started:
(Key learning objectives)

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

- Create an analysis model in Inventor
- Set up and simulate in CFD
- Process thermal results in CFD
- Evaluate stresses in Mechanical

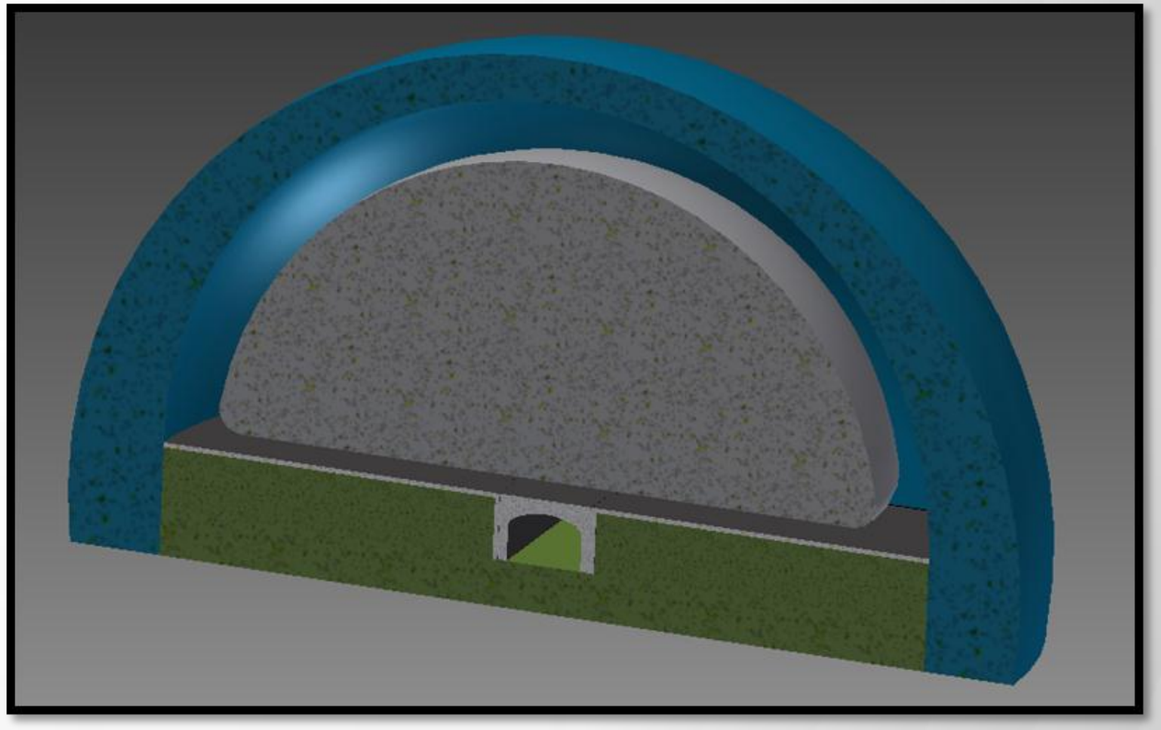
Create an analysis model in Inventor

Double click to get started →

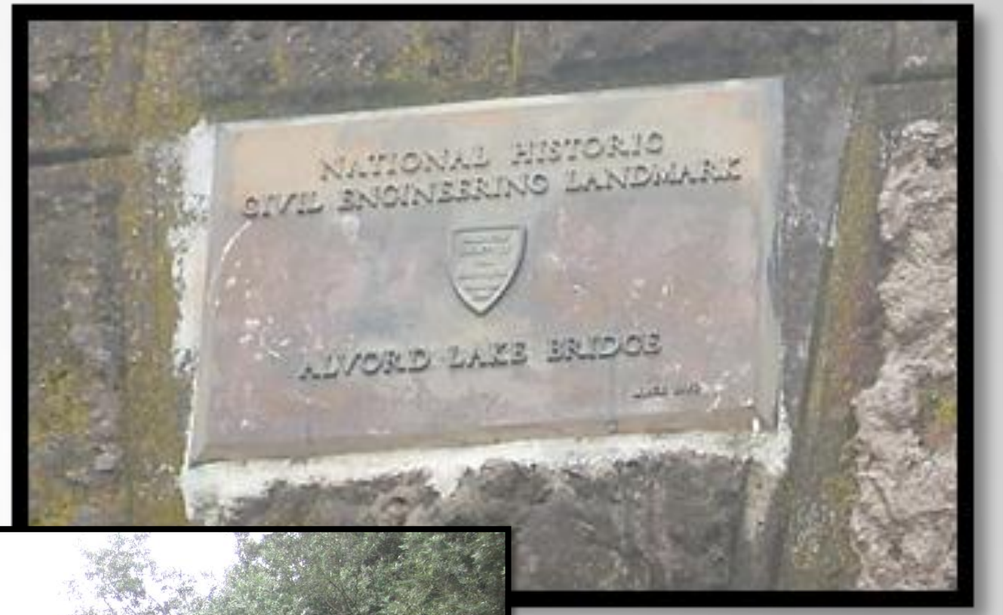
Open the Demo Assembly in Inventor

- Navigate to *\SM1571-L\Demonstration\Inventor Geometry

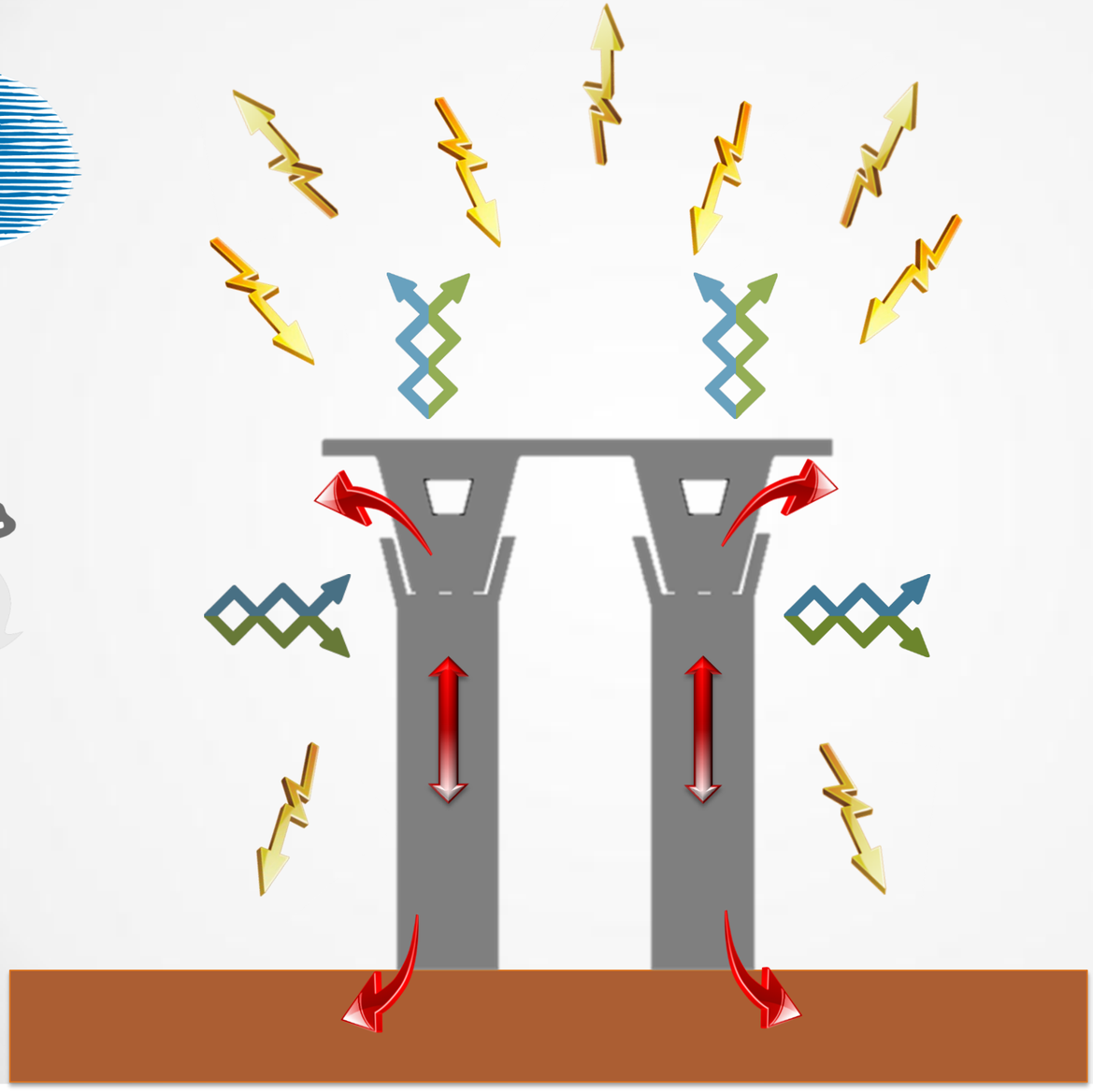
- Open “Solar Assembly.iam”

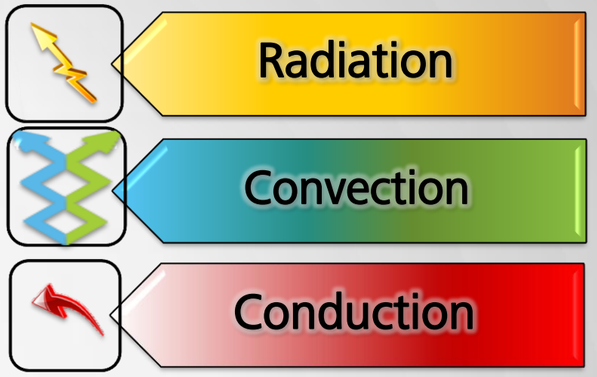


Our Demonstration Model – The Alvord Lake Bridge

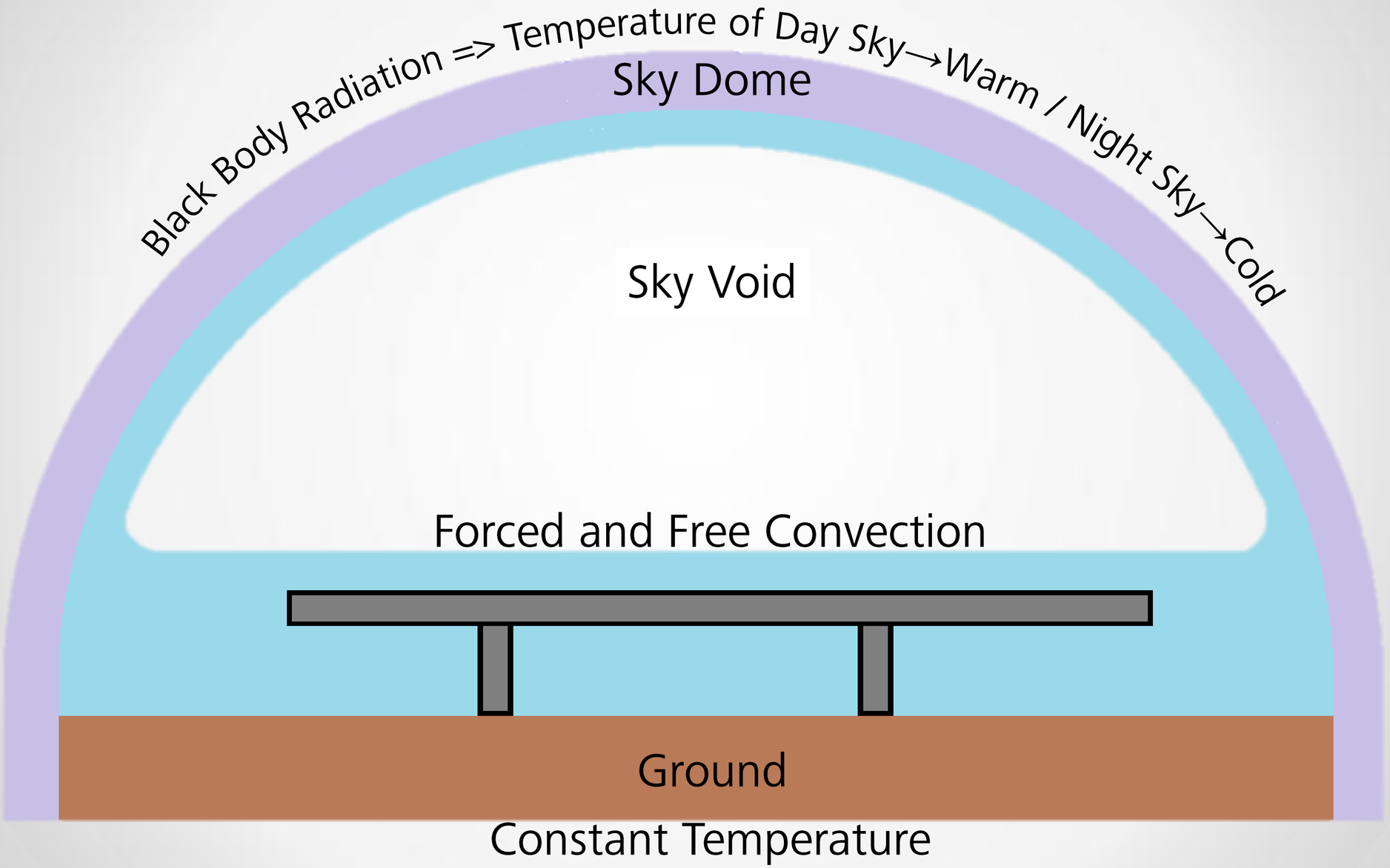


Bridge Heat Transfer 101



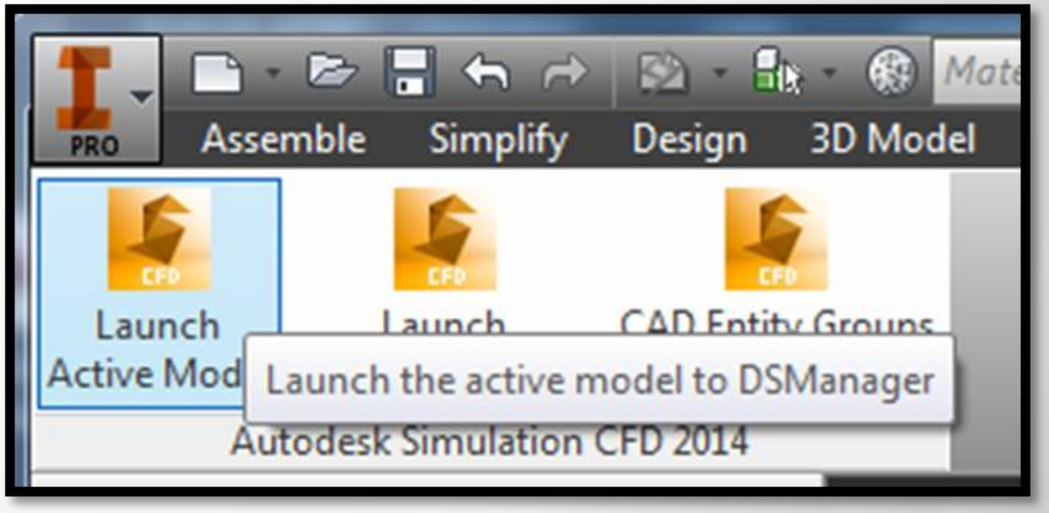


Heat Transfer Schematic



Setup and simulate in CFD

Launch to CFD →

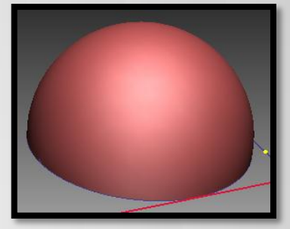


Basics in CFD

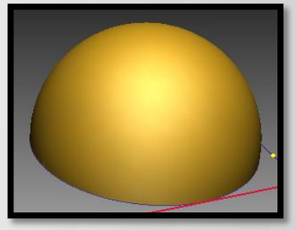
- Complete launch → click OK
- Adjust Geometry → Select Merge
- Practice Navigation and Selection:

Display Action	ADSK CFD Mouse Command
Wheel Zoom	Scroll
Rotate	Shift + MMB
Pan	MMB
Select/deselect	LMB
Rubberband select	LMB drag
Blank/hide	Ctrl + MMB
Show all	Ctrl + MMB off model

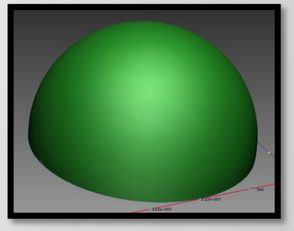
Selected



About to Deselect



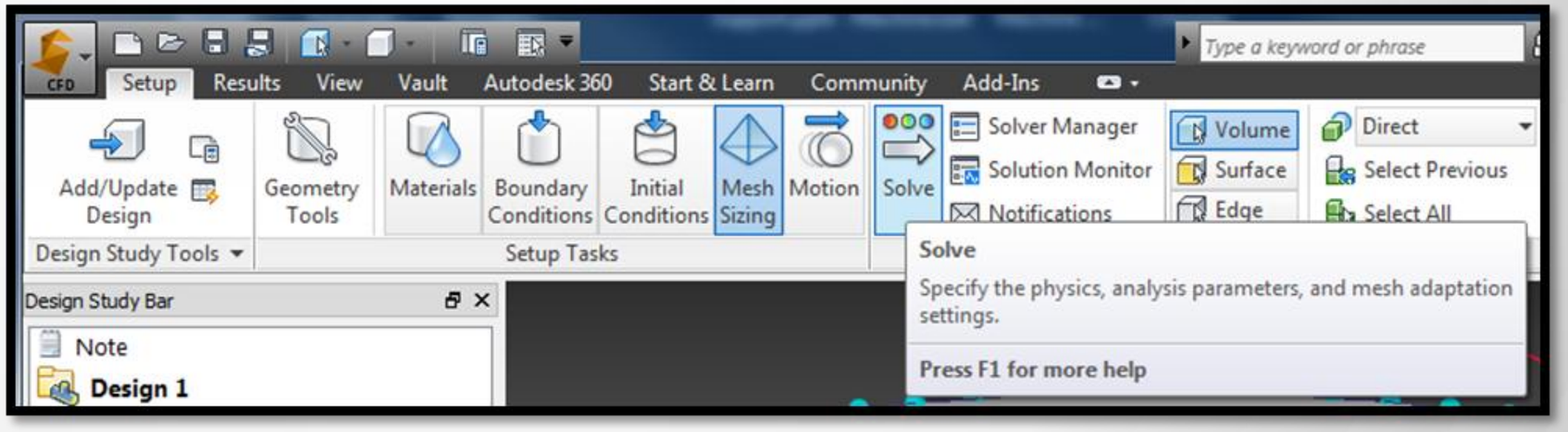
Ready to Select



Steps

- Materials
- Conditions
- Mesh
- Solve

Work left to right ->



Considerations

- Adjust Solar Heat Flux for Date and Location

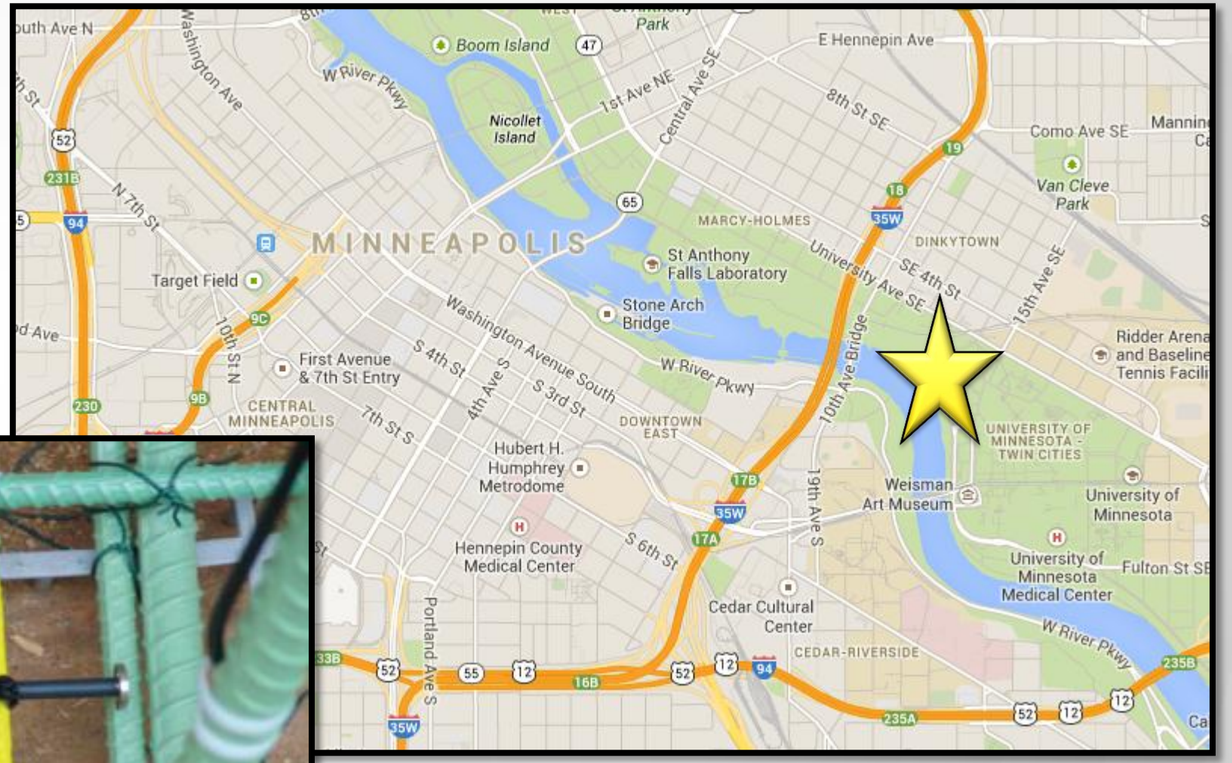
$$\text{Solar Heat Flux} = \frac{4.6\ \text{kWh/m}^2\text{/day} * 1000\ \text{W/kW}}{13.5\ \text{hours of sunlight/day}} = 340\ \text{Watts/m}^2$$

- Material Properties
  - Sky as a Black Body => Emissivity ε = 1.0
  - Natural Convection => Air Conductivity *100
- Environment Conditions
  - Sky => Temperature range 12°C Day / -43° C Night
  - Ground => Temperature 5°C

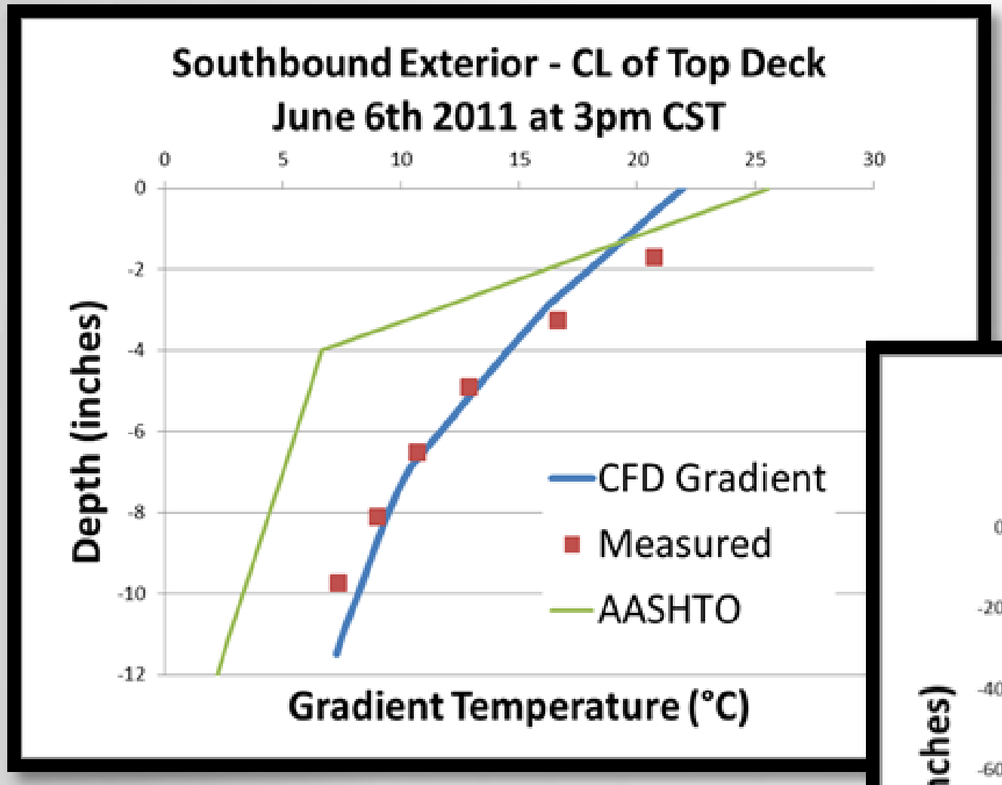
Process thermal results in CFD

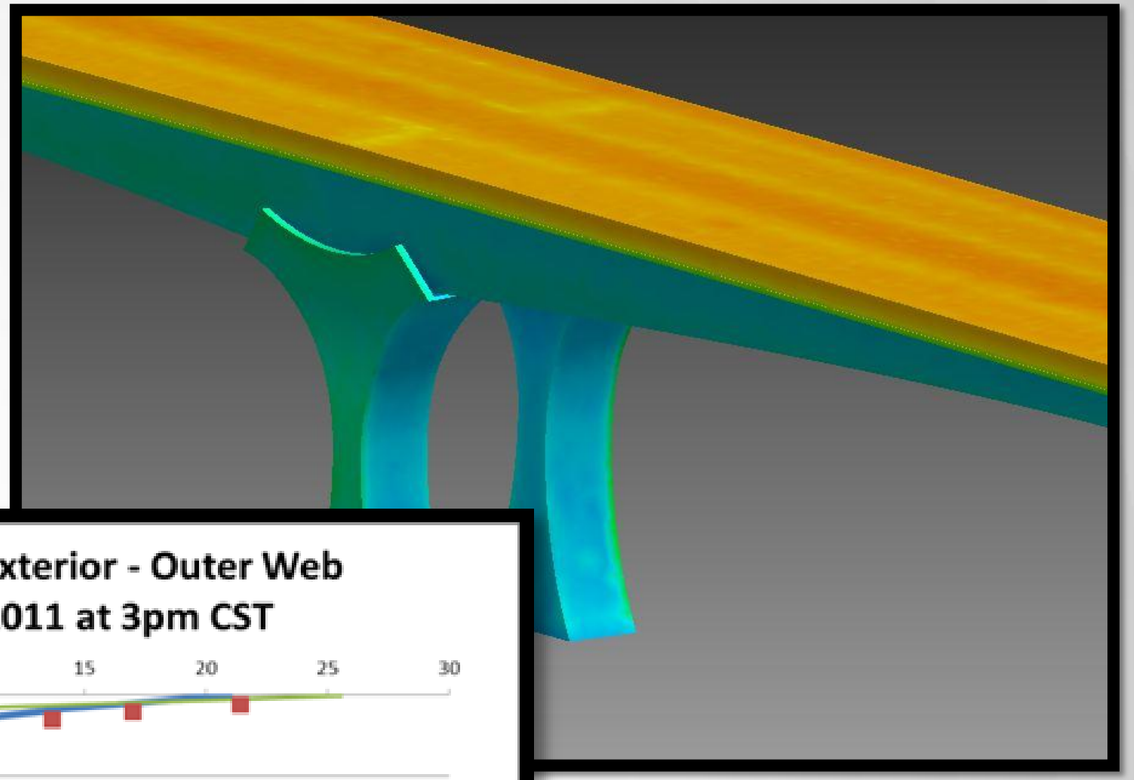
*Open *\SM1571-L\Demonstration\CFD with Results\Solar Assembly\Solar Assembly.cfdst*

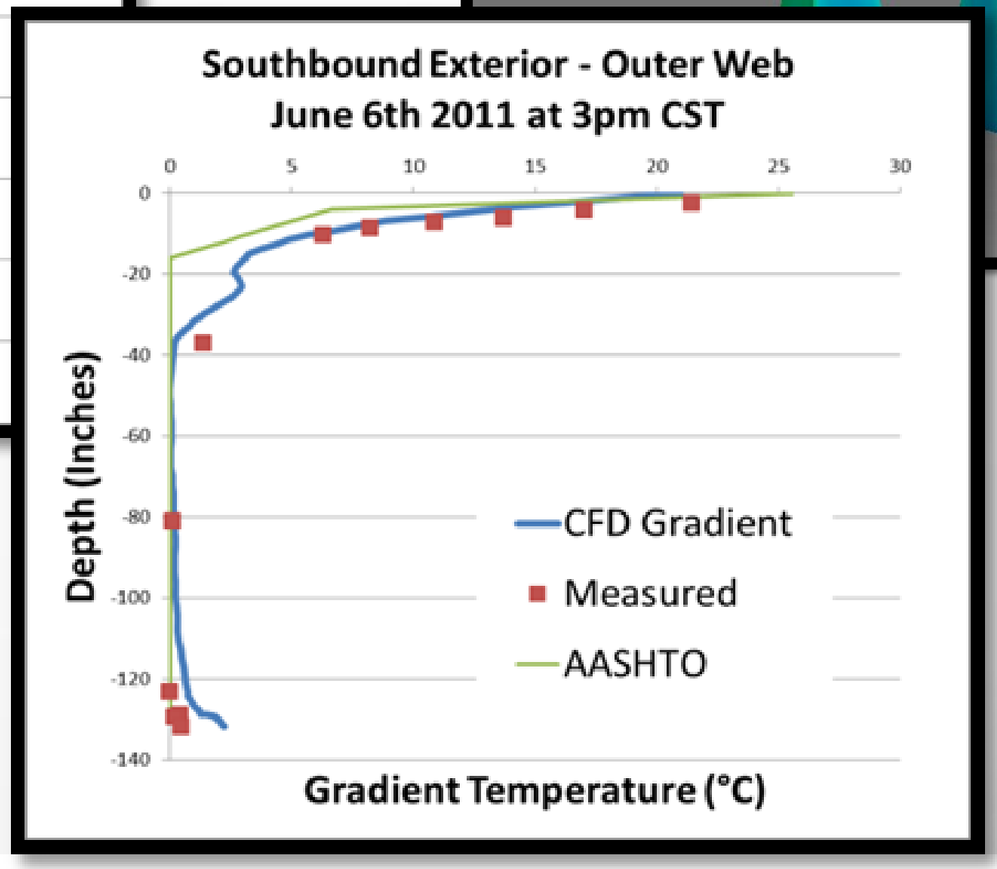
I-35 West “St. Anthony Falls Bridge”



Validation


Southbound Exterior - CL of Top Deck
June 6th 2011 at 3pm CST
0
5
10
15
20
25
30
0
-2
-4
-6
-8
-10
-12
Depth (inches)
CFD Gradient
Measured
AASHTO
Gradient Temperature (°C)

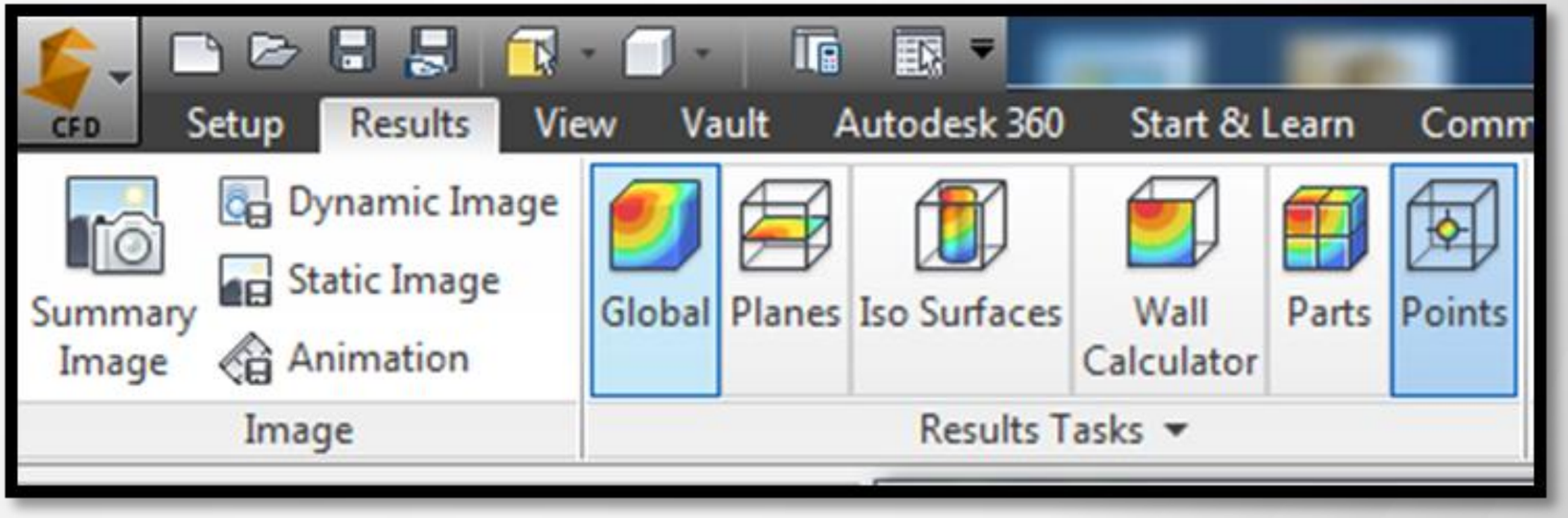



Southbound Exterior - Outer Web
June 6th 2011 at 3pm CST
0
5
10
15
20
25
30
0
-20
-40
-60
-80
-100
-120
-140
Depth (Inches)
CFD Gradient
Measured
AASHTO
Gradient Temperature (°C)

Steps

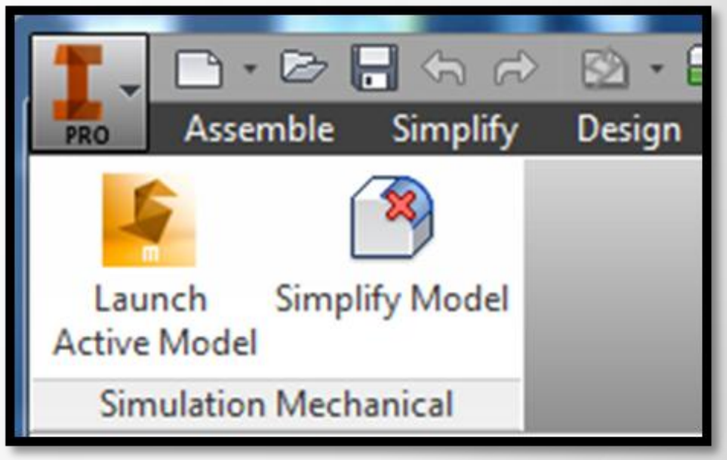
- Global
- Planes
- Points

Work left to right ->



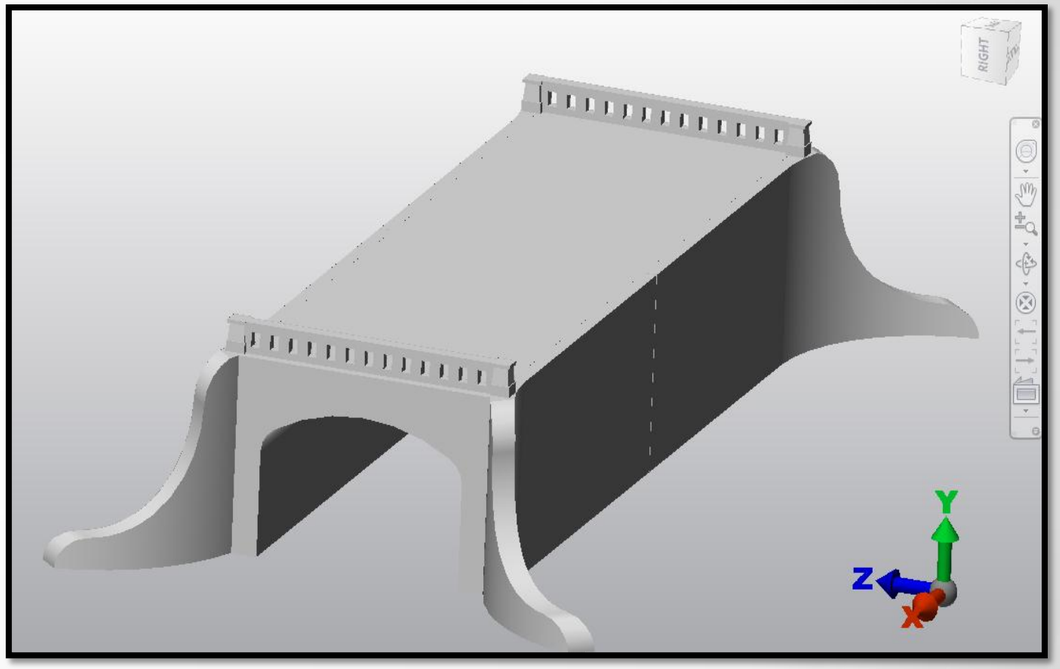
Evaluate CFD thermal stresses in Mechanical

Use the “Bridge only” level of detail->



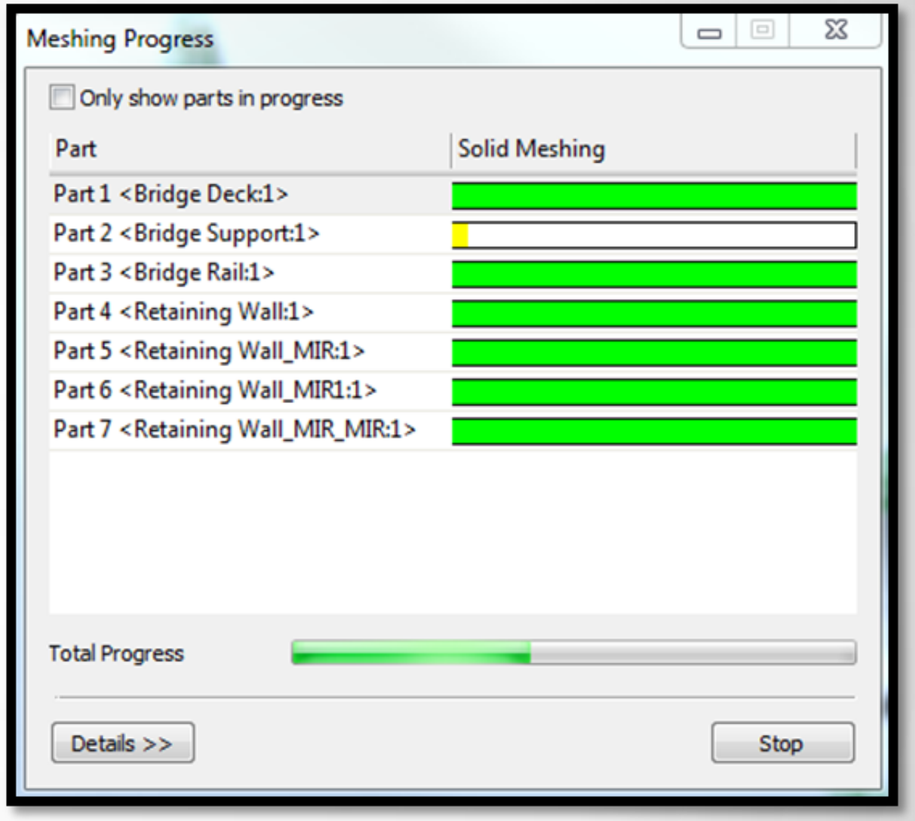
Steps

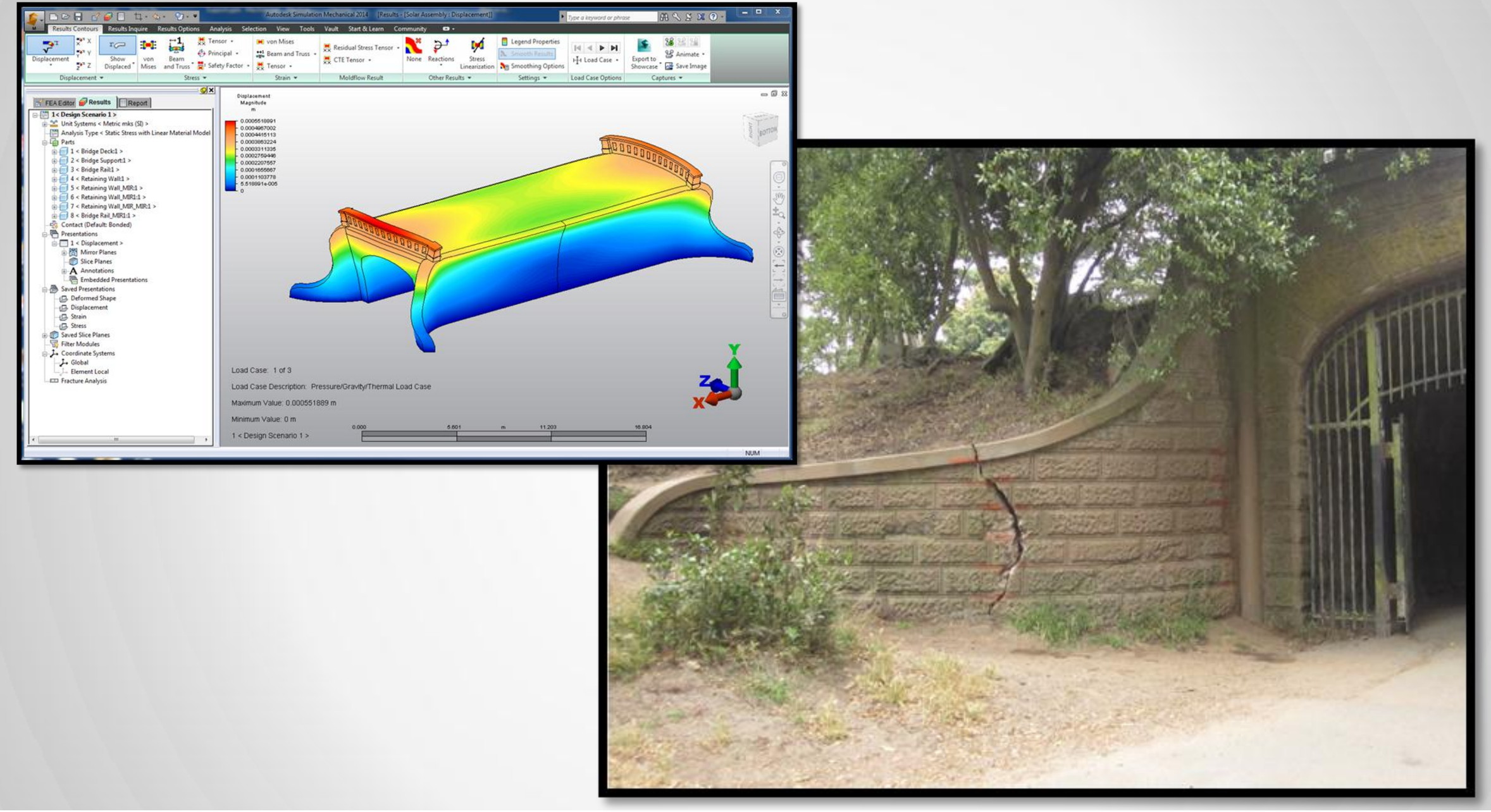
- Mesh to enable editing
- Transfer CFD results
- Analyze
- Visualize



Importing CFD Results

- Element Definition
- Parameters Thermal
- Parameters Multipliers
- Run Simulation




Autodesk Simulation Mechanical 2014
[Results - [Solar Assembly : Displacement]]
Results Contours
Results Inquire
Results Options
Analysis
Selection
View
Tools
Vault
Start & Learn
Community
Displacement
Show Displaced
von Mises
Beam and Truss
Tensor
Principal
Safety Factor
Residual Stress Tensor
CTE Tensor
None
Reactions
Stress Linearization
Legend Properties
Smooth Results
Smoothing Options
Load Case
Export to Showcase
Animate
Save Image
FEA Editor
Results
Report
1 < Design Scenario 1 >
Unit Systems < Metric mks (SI) >
Analysis Type < Static Stress with Linear Material Model
Parts
1 < Bridge Deck:1 >
2 < Bridge Support:1 >
3 < Bridge Rail:1 >
4 < Retaining Wall:1 >
5 < Retaining Wall_MIR:1 >
6 < Retaining Wall_MIR1:1 >
7 < Retaining Wall_MIR_MIR:1 >
8 < Bridge Rail_MIR1:1 >
Contact (Default: Bonded)
Presentations
1 < Displacement >
Mirror Planes
Slice Planes
Annotations
Embedded Presentations
Saved Presentations
Deformed Shape
Displacement
Strain
Stress
Saved Slice Planes
Filter Modules
Coordinate Systems
Global
Element Local
Fracture Analysis
Displacement Magnitude
m
0.000551889
0.0004967002
0.0004415113
0.0003863224
0.0003311335
0.0002759446
0.0002207557
0.0001655667
0.0001103778
5.518891e-005
0
Load Case: 1 of 3
Load Case Description: Pressure/Gravity/Thermal Load Case
Maximum Value: 0.000551889 m
Minimum Value: 0 m
1 < Design Scenario 1 >
0.000
5.601
m
11.203
16.804
Y
Z
X
NUM

Thank you!

Questions?