Flow Dynamics:
A CFD Implementation Case Study

Leonardo Chonkan

BIM Coordinator / Circuito - JCI

AUTODESK.
UNIVERSITY

Learning Objectives

After this class, you will be able to:

- Make a compelling business case in order to get approval for implementation
- Access learning materials, documentation and other valuable resources available
- Gather the necessary information for successful validation of your results
- Pick an appropriate project to solve and take CFD for a test drive

What this class is NOT about

This class ***will not*** cover the following subjects:

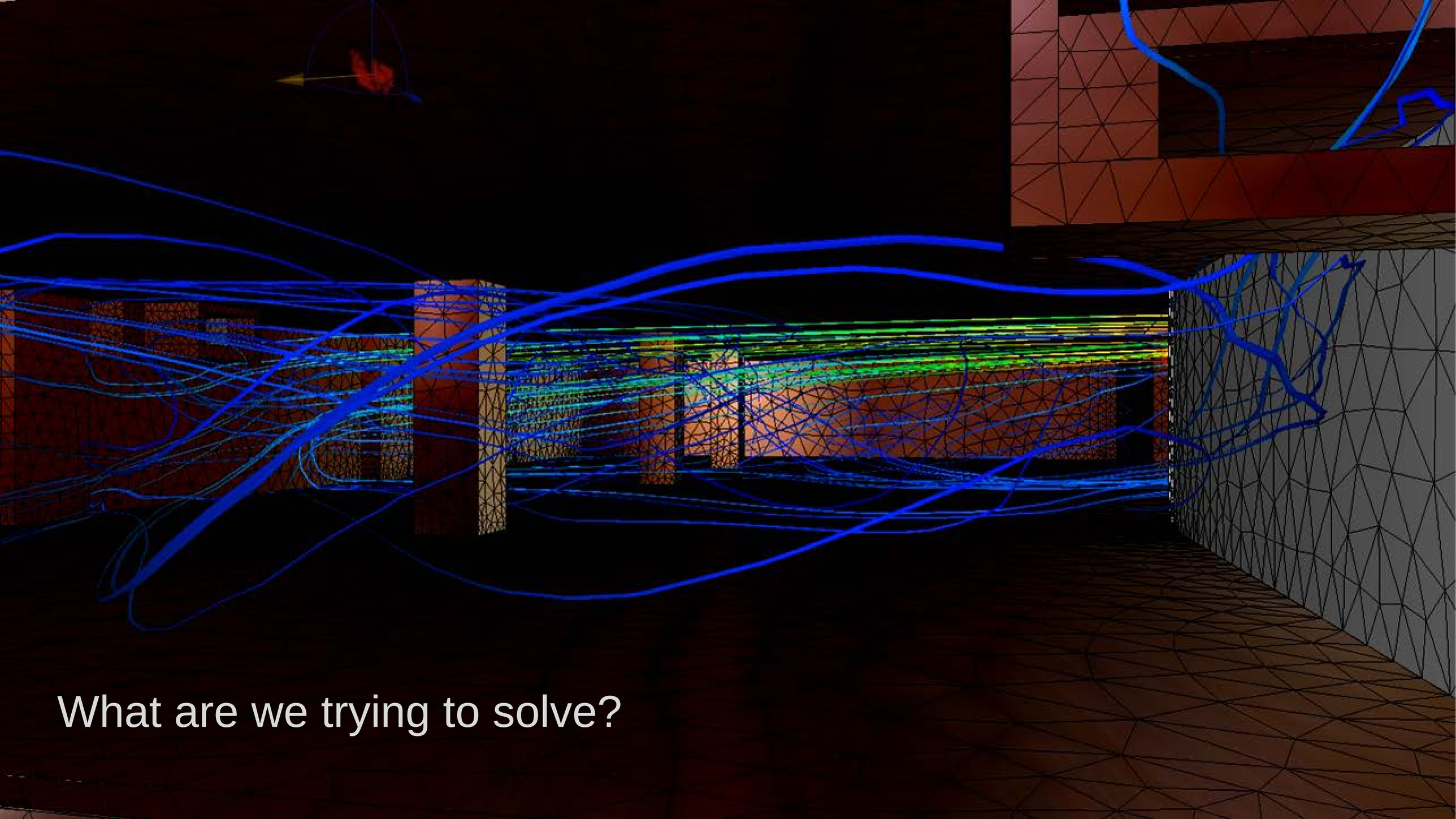
- Software specifics
- Costs / Pricing
- Physical Models / CFD’s equations

About the speaker

Leonardo Chonkan

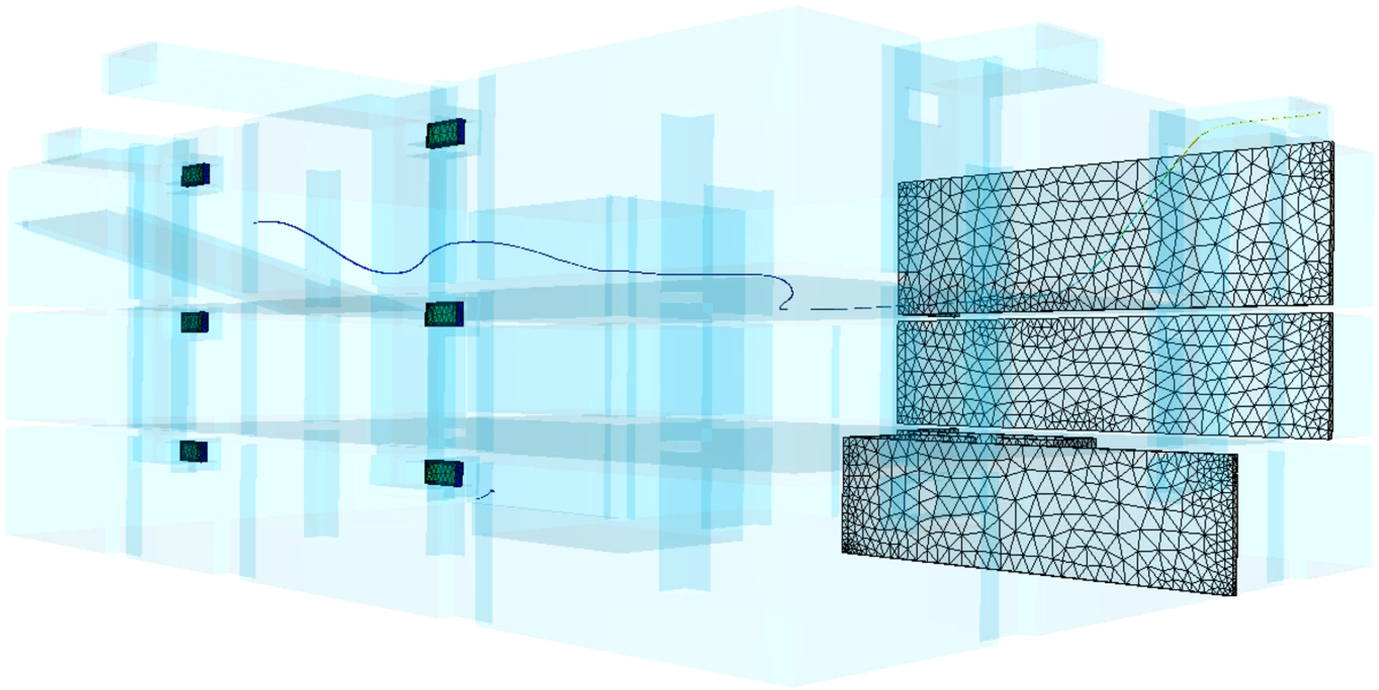
- Civil Engineer
- BIM Coordinator
- Loves programming
- Made in Costa Rica

Introduction



What are we trying to solve?

What is CFD?



Continuity Equation:

$$\frac{\partial \rho}{\partial t} + \frac{\partial \rho u}{\partial x} + \frac{\partial \rho v}{\partial y} + \frac{\partial \rho w}{\partial z} = 0$$

X-Momentum Equation:

$$\rho\frac{\partial u}{\partial t} + \rho u\frac{\partial u}{\partial x} + \rho v\frac{\partial u}{\partial y} + \rho w\frac{\partial u}{\partial z} = \rho g_x - \frac{\partial p}{\partial x} + \frac{\partial}{\partial x}\left[2\mu\frac{\partial u}{\partial x}\right] + \frac{\partial}{\partial y}\left[\mu\left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}\right)\right] + \frac{\partial}{\partial z}\left[\mu\left(\frac{\partial u}{\partial z} + \frac{\partial w}{\partial x}\right)\right] + S_\omega + S_{DR}$$

Y-Momentum Equation:

$$\rho\frac{\partial v}{\partial t} + \rho u\frac{\partial v}{\partial x} + \rho v\frac{\partial v}{\partial y} + \rho w\frac{\partial v}{\partial z} = \rho g_y - \frac{\partial p}{\partial y} + \frac{\partial}{\partial x}\left[\mu\left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}\right)\right] + \frac{\partial}{\partial y}\left[2\mu\frac{\partial v}{\partial y}\right] + \frac{\partial}{\partial z}\left[\mu\left(\frac{\partial v}{\partial z} + \frac{\partial w}{\partial y}\right)\right] + S_\omega + S_{DR}$$

Z-Momentum Equation:

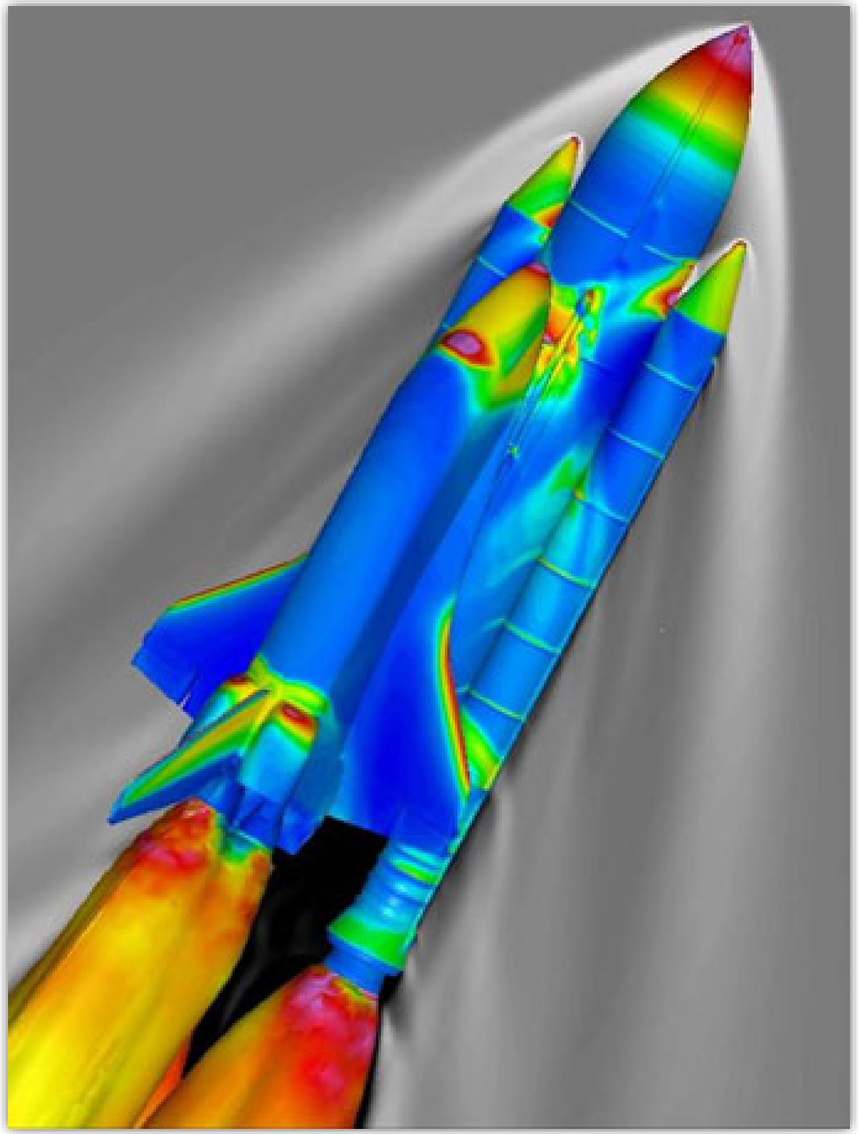
$$\rho\frac{\partial w}{\partial t} + \rho u\frac{\partial w}{\partial x} + \rho v\frac{\partial w}{\partial y} + \rho w\frac{\partial w}{\partial z} = \rho g_z - \frac{\partial p}{\partial z} + \frac{\partial}{\partial x}\left[\mu\left(\frac{\partial u}{\partial z} + \frac{\partial w}{\partial x}\right)\right] + \frac{\partial}{\partial y}\left[\mu\left(\frac{\partial v}{\partial z} + \frac{\partial w}{\partial y}\right)\right] + \frac{\partial}{\partial z}\left[2\mu\frac{\partial w}{\partial z}\right] + S_\omega + S_{DR}$$

The Business Case for CFD

Who uses CFD?

Some examples include:

- **Aircraft Engineers**
- Structural Engineers
- MEP Engineers
- Product Designers
- Maybe you?



Ray Gomez. http://www.nas.nasa.gov/Resources/Applications/applications.html

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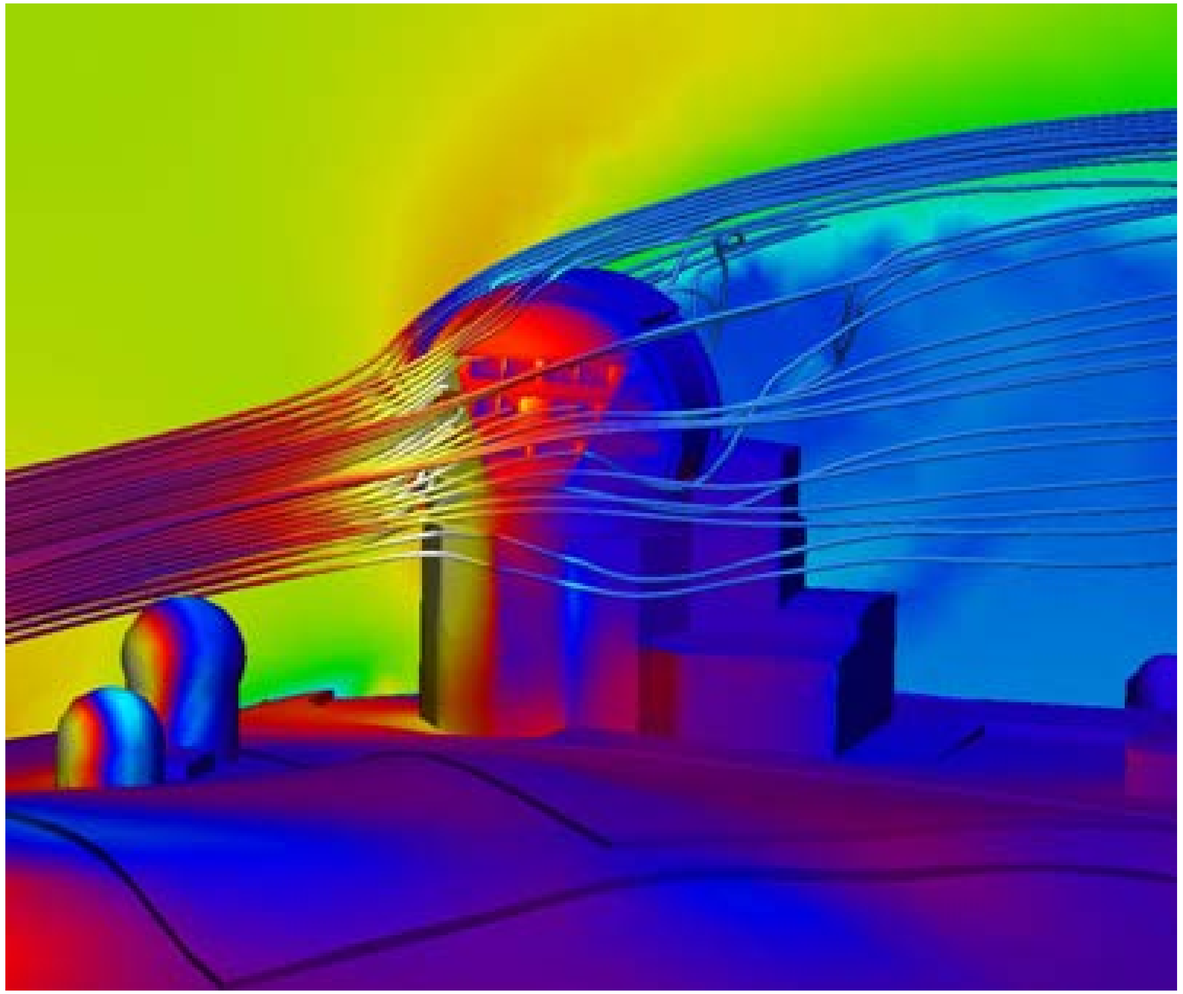

http://help.autodesk.com/view/SCDSE/2019/ENU/?guid=GUID-C7CCFA3C-63C4-44DF-9698-B0220A8A3CF8

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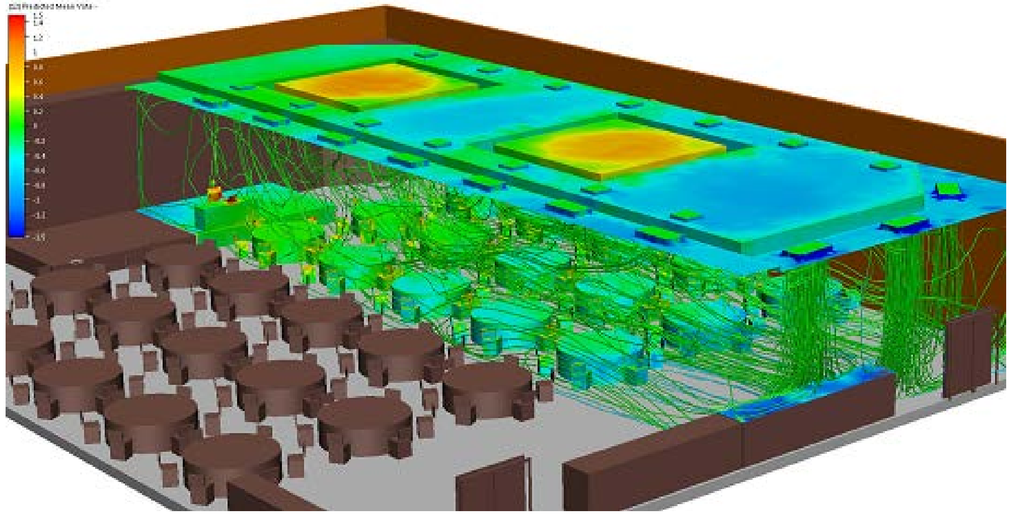

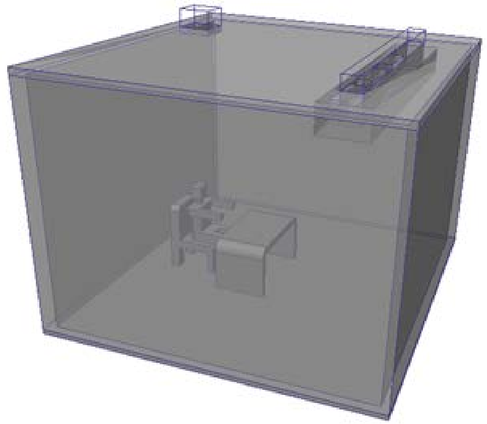

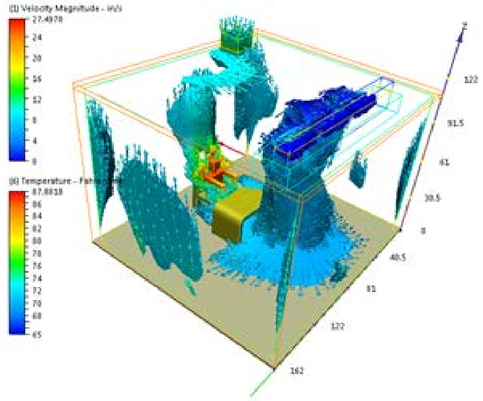

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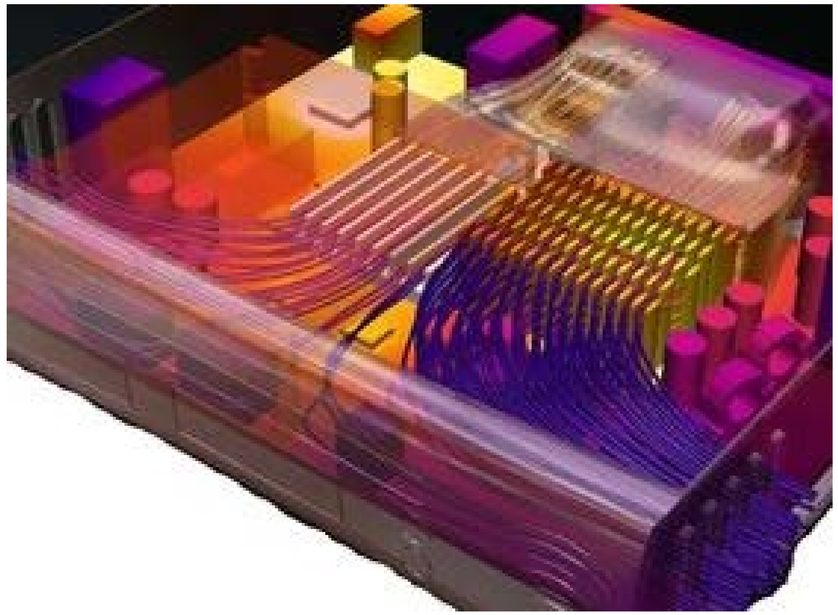

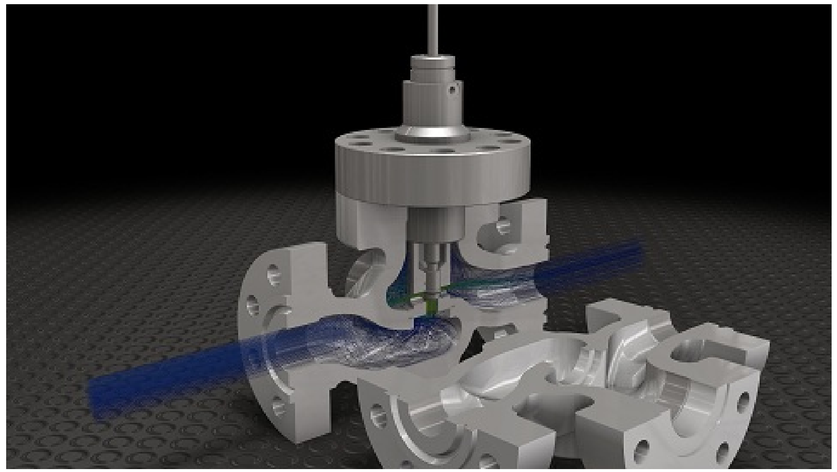

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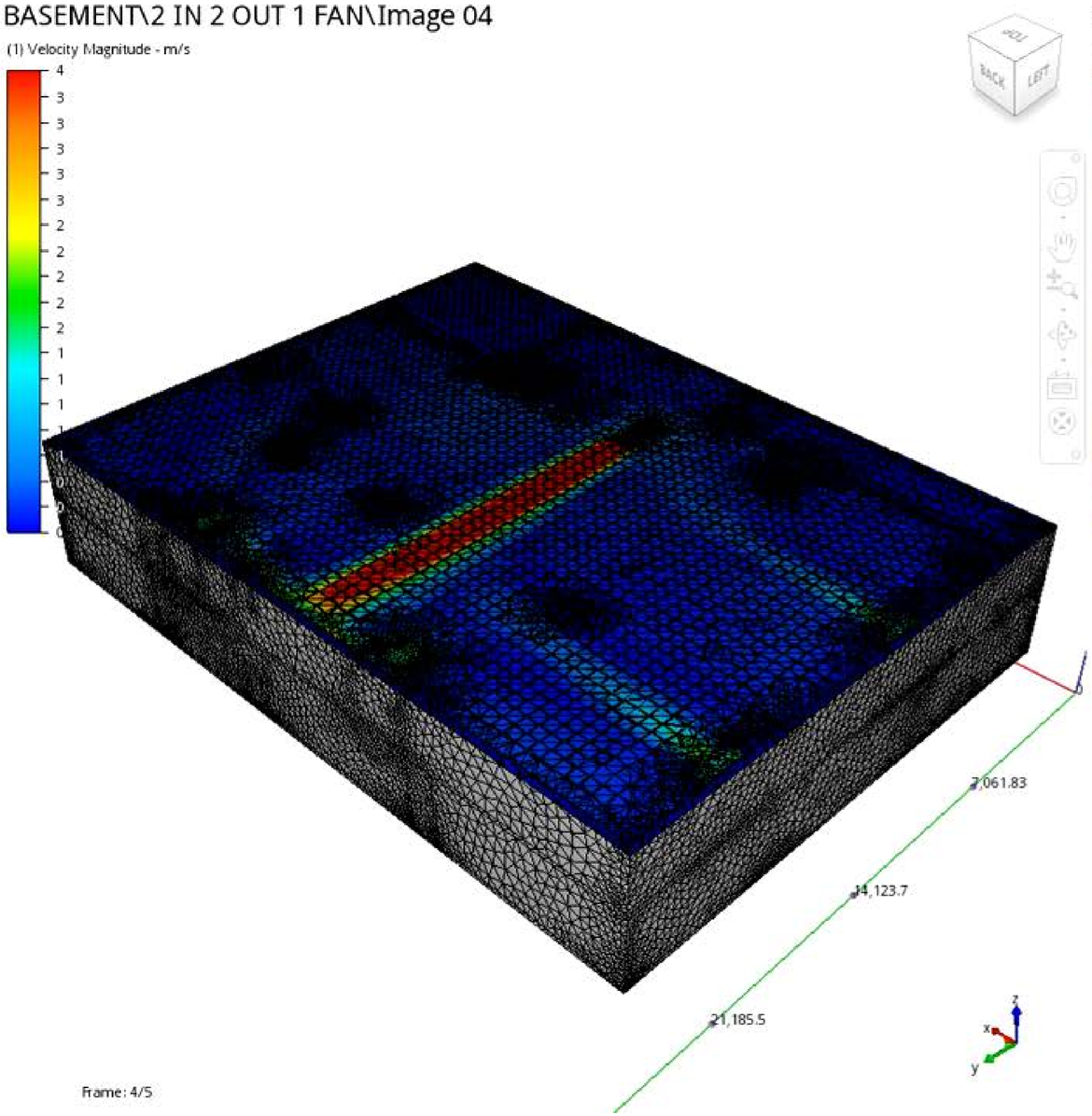
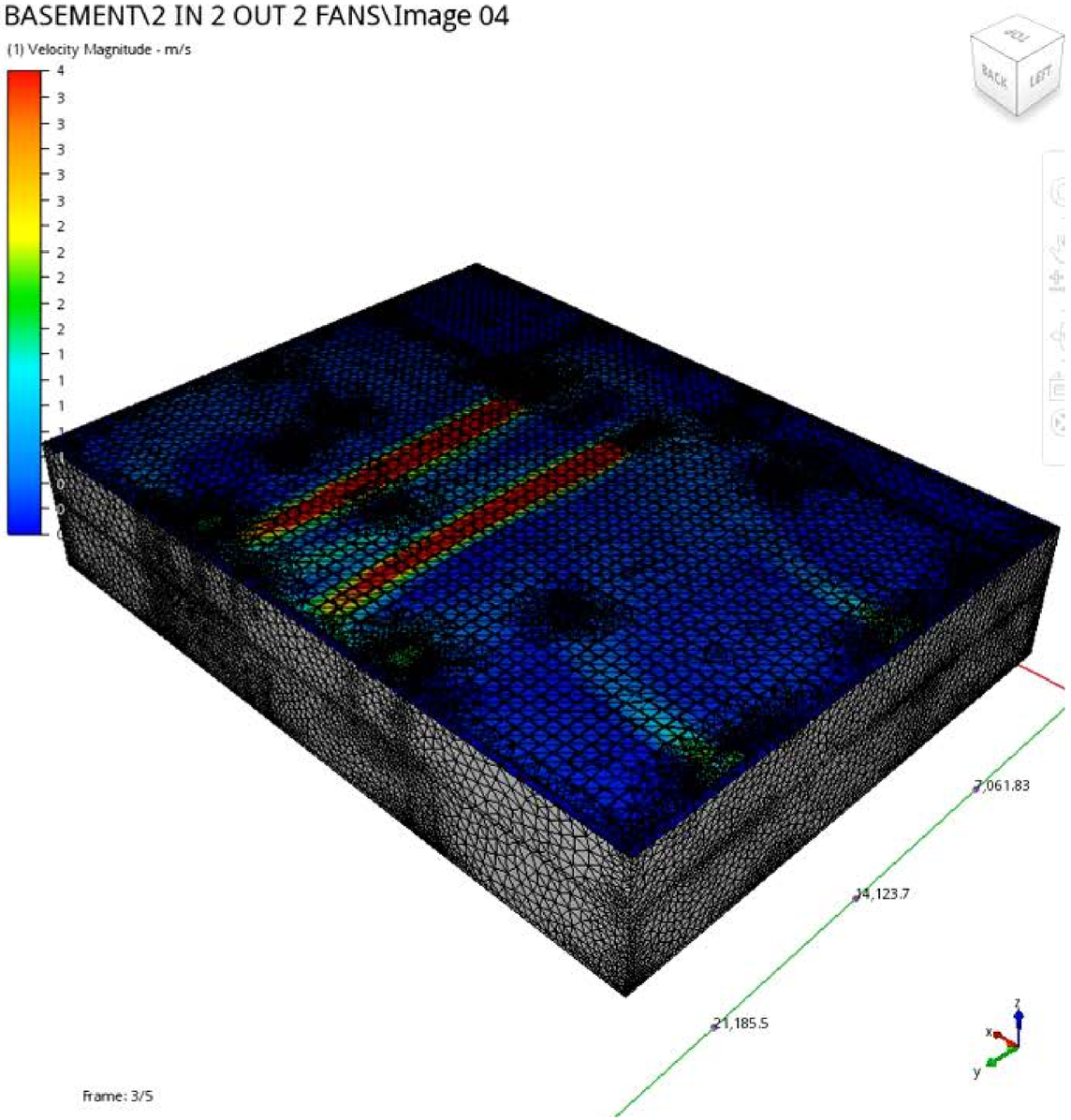
Why would you?

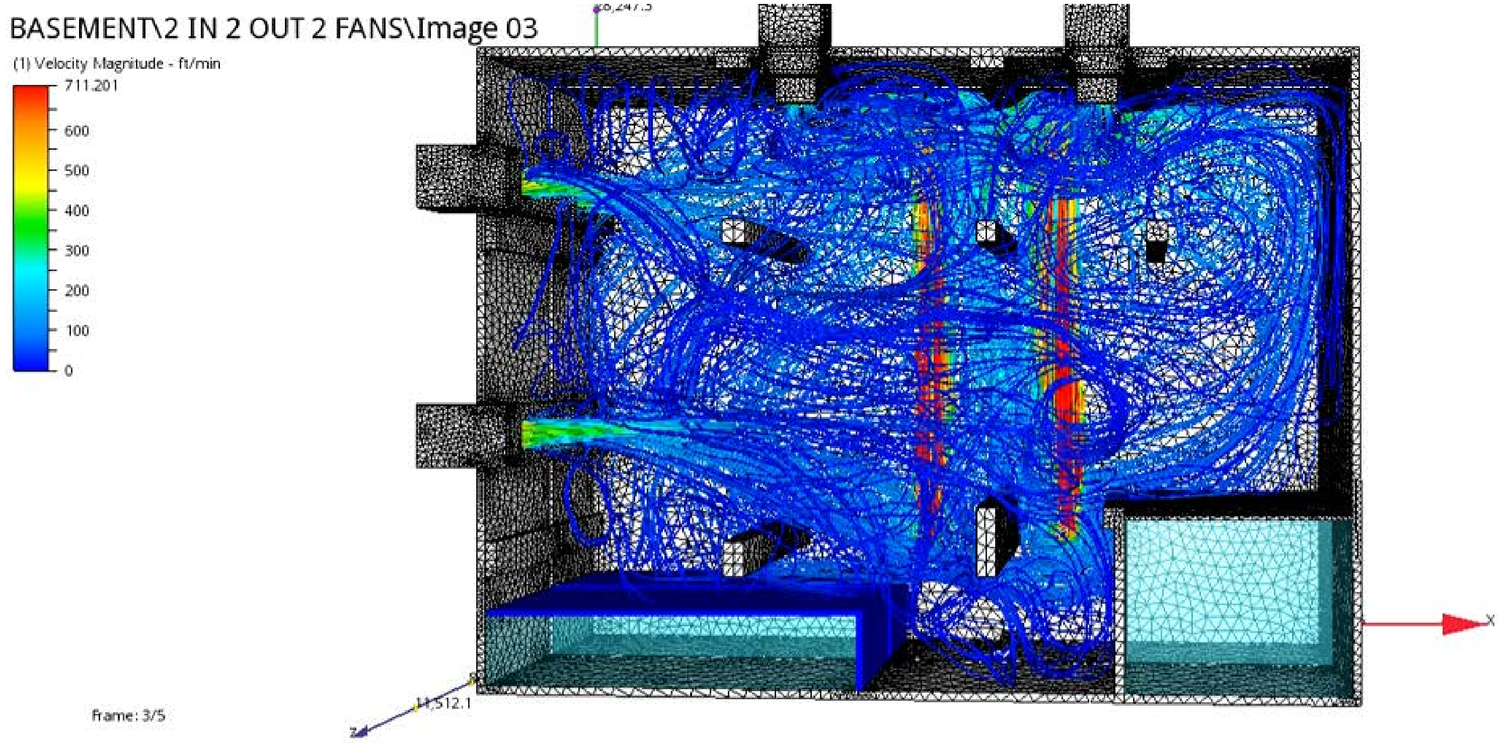
- Improved Decision Making
- Responding to Design Changes
- Beautiful Results

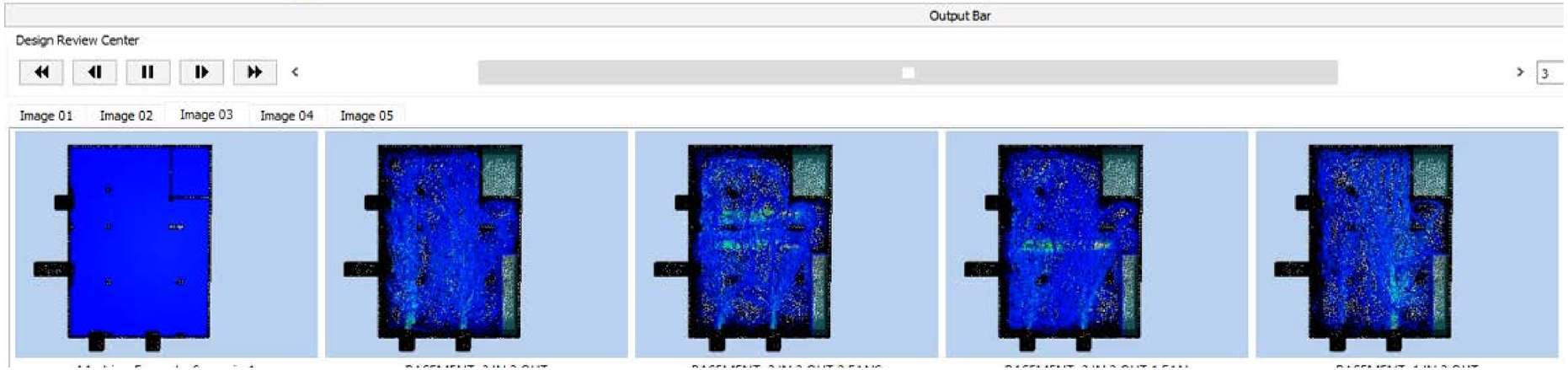
Improved Decision Making



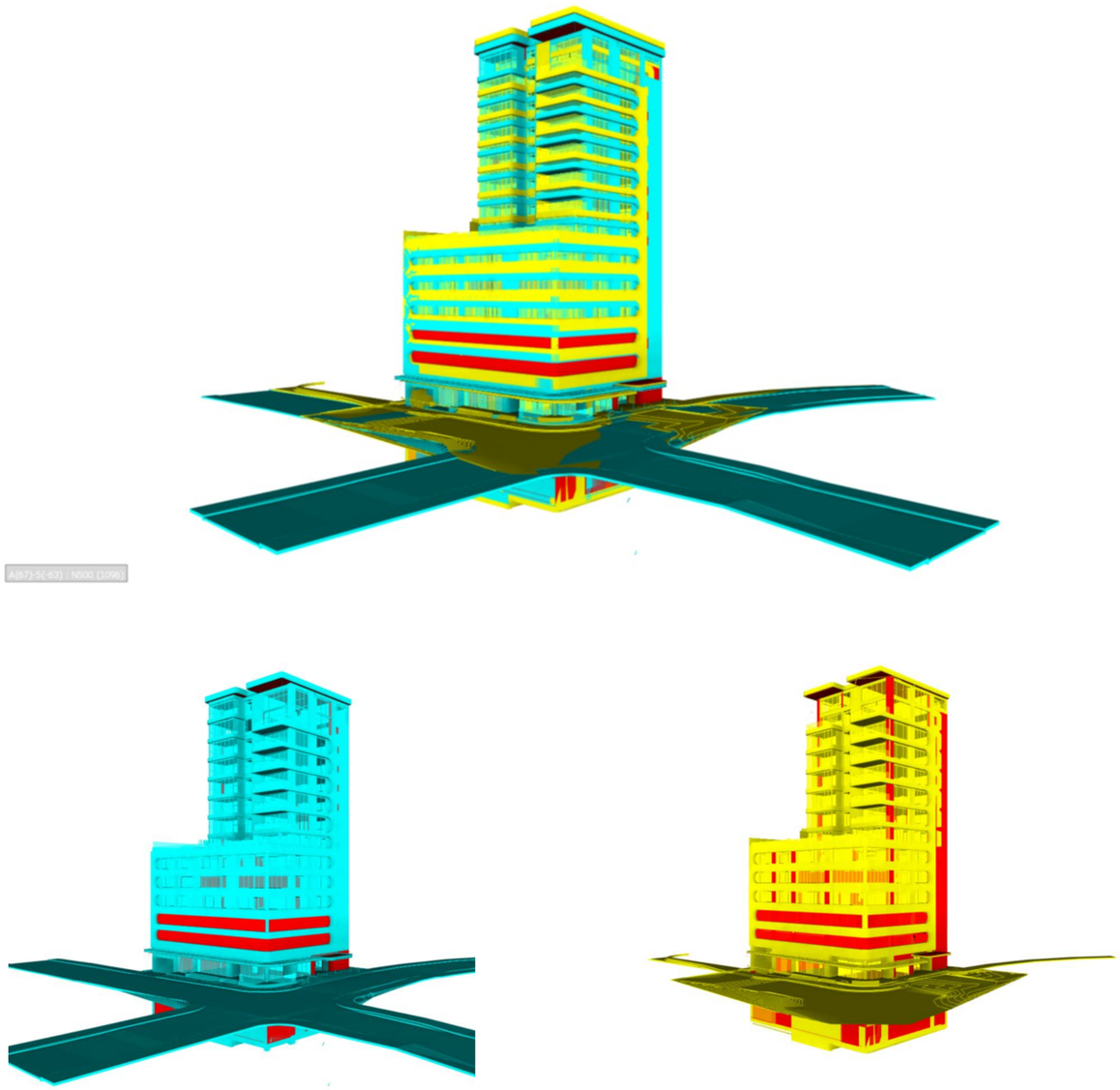


Improved Decision Making

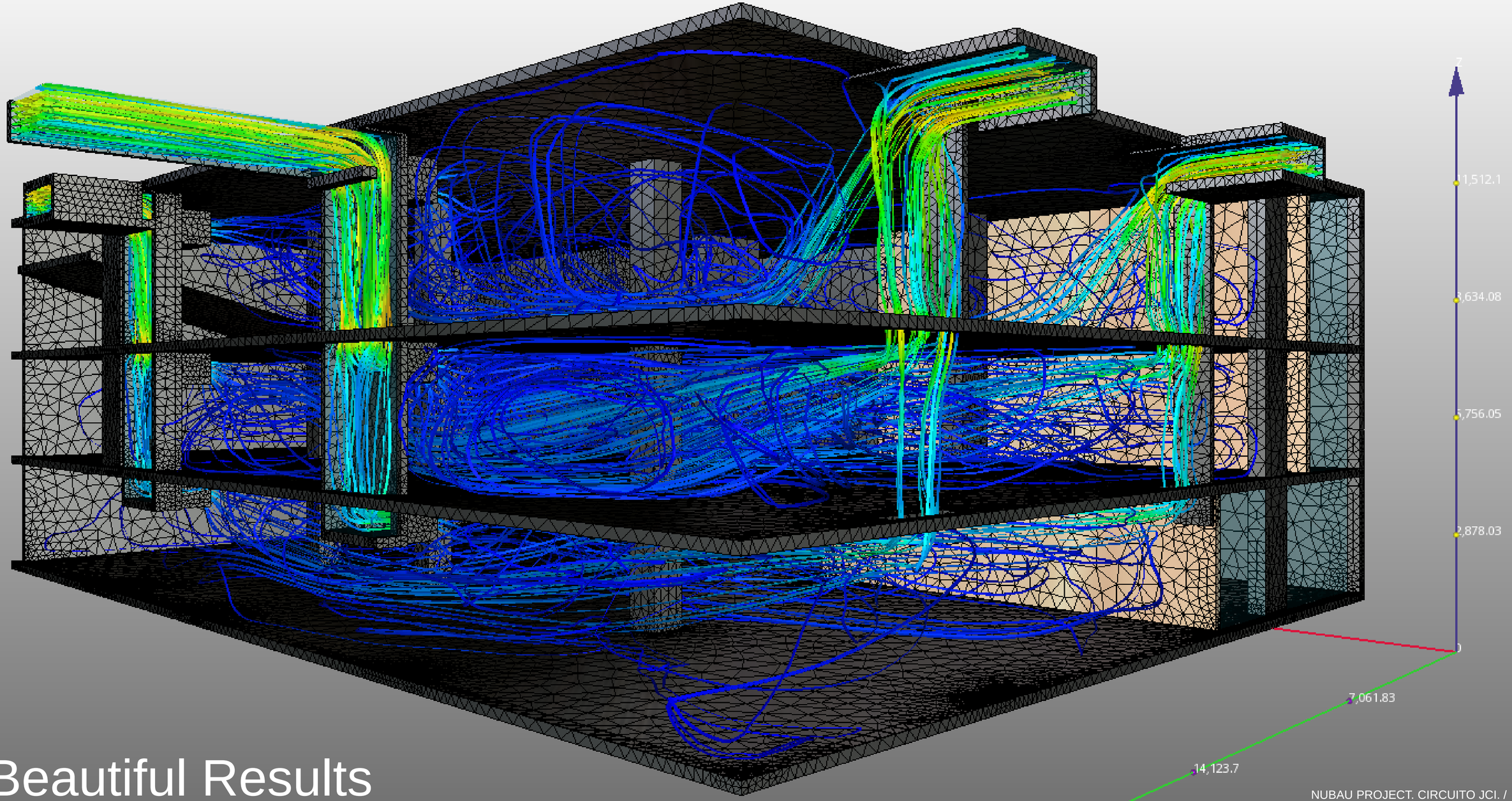




Responding to Design Changes



agnitude - m/s



Beautiful Results

NUBAU PROJECT. CIRCUITO JCI. / ZAVIA CAPITAL / MARLO TREJOS ARQUITECTOS

Learning CFD

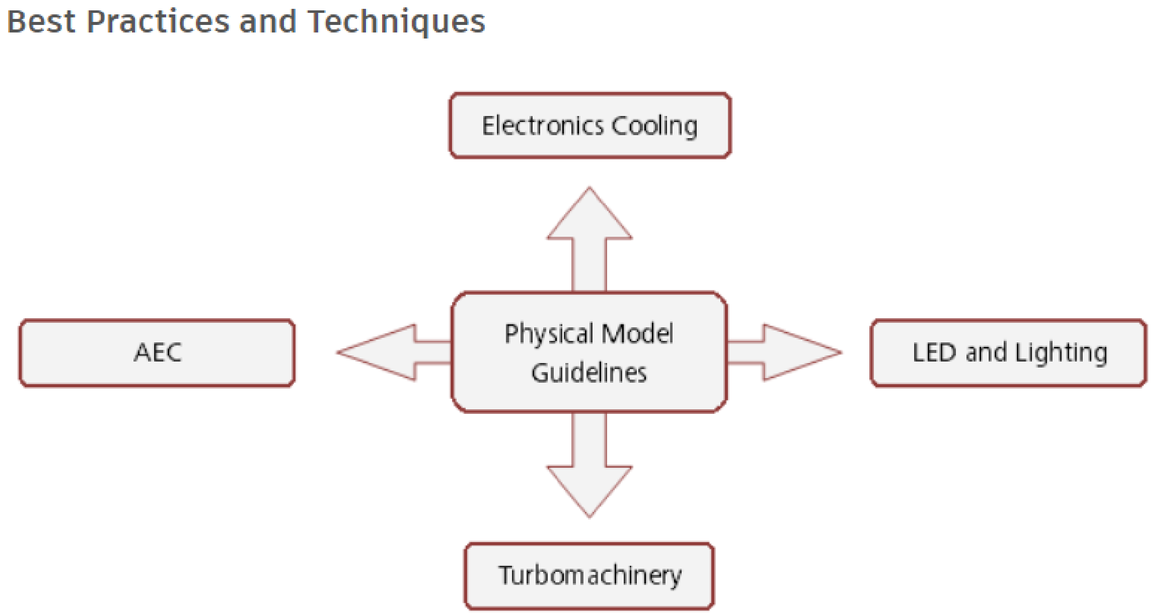
Free curiosity is of more value in learning than harsh discipline.

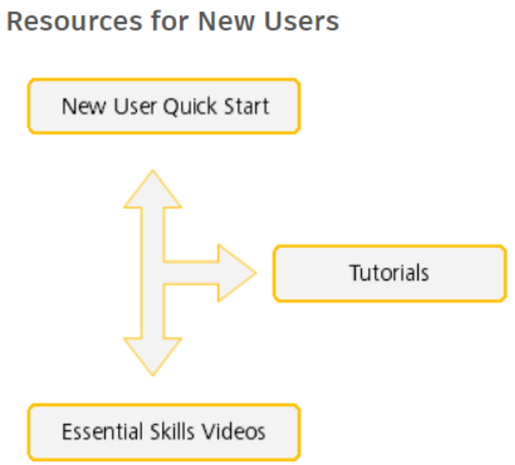
Saint Augustine

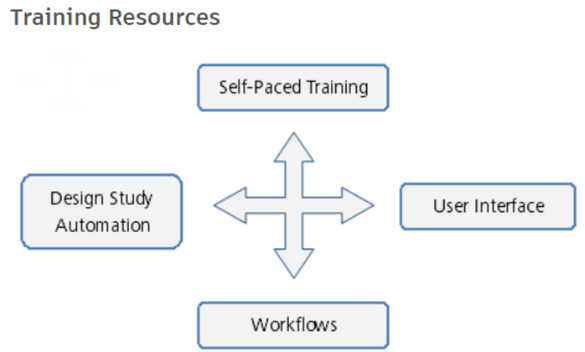
Resources

- Official Product Documentation
- Third Party Content
- Autodesk YouTube Channels
- Other Support Channels

Official Product Documentation

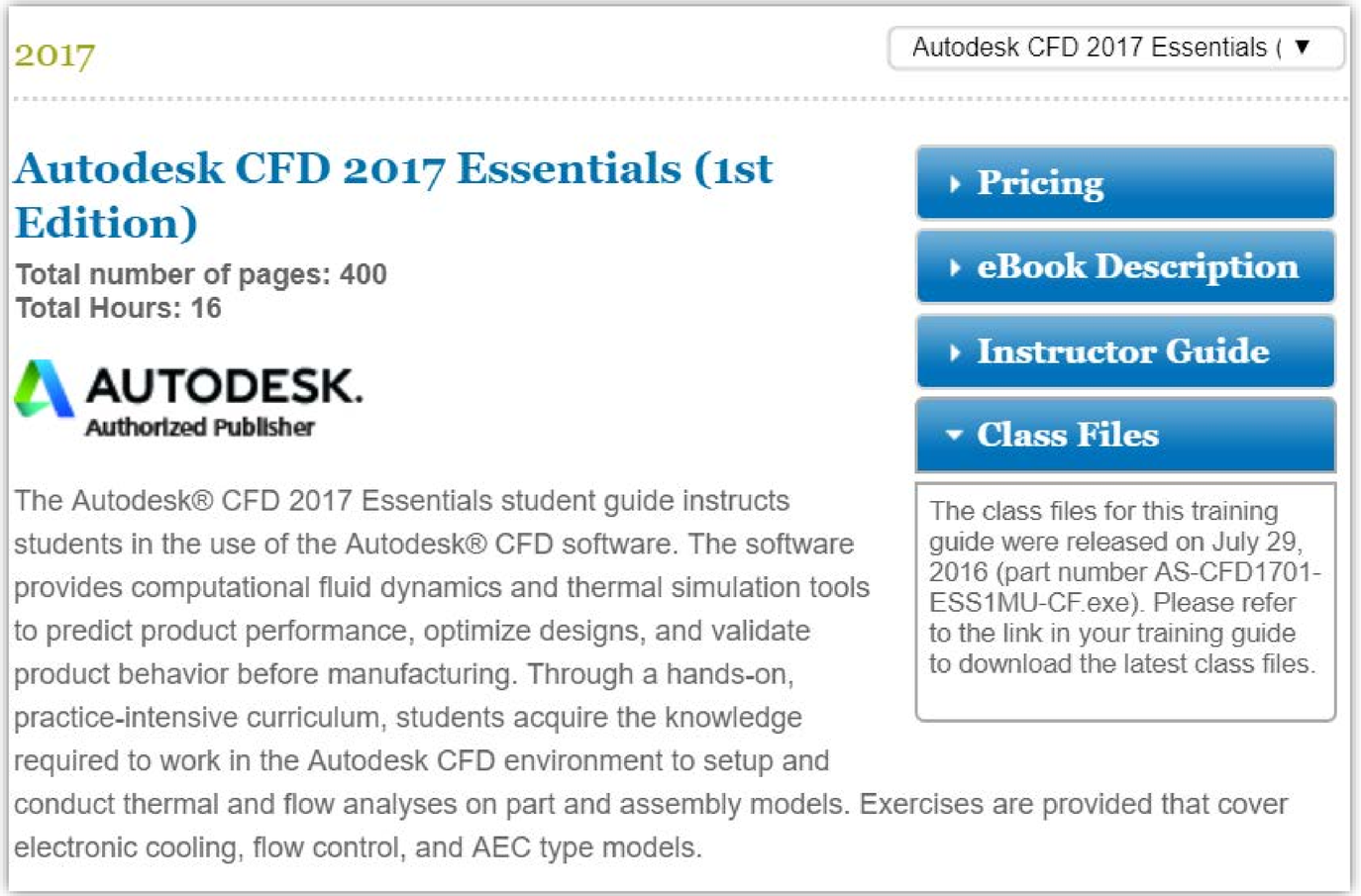






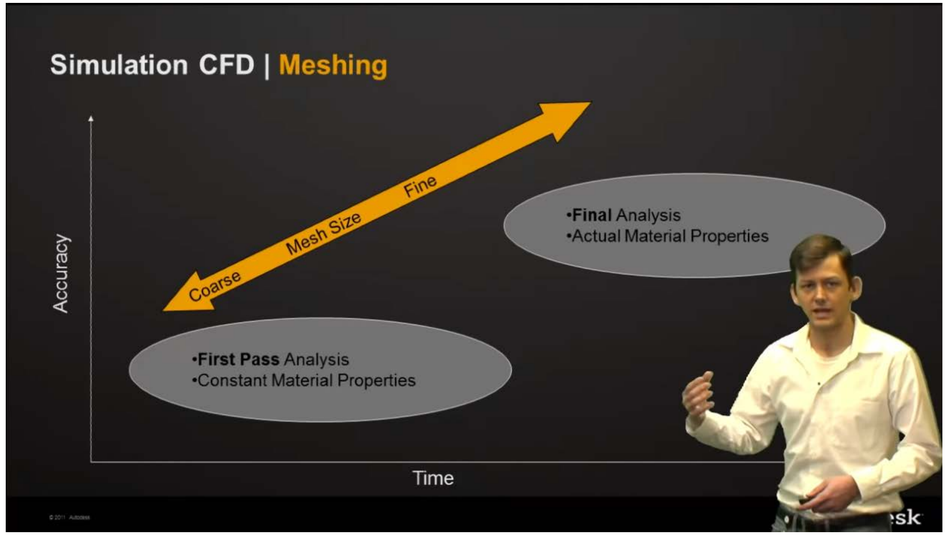
Third Party Content

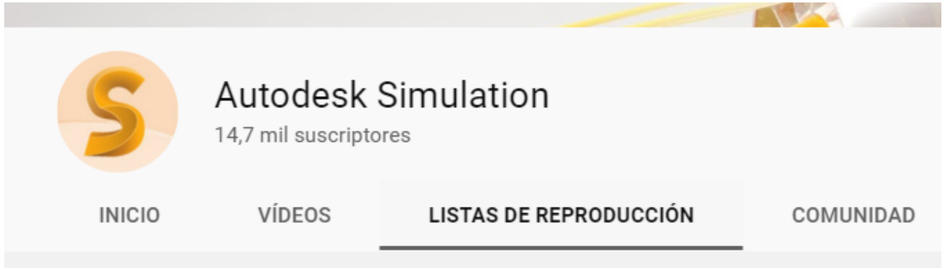
- ASCENT Books
- Autodesk Training Centers

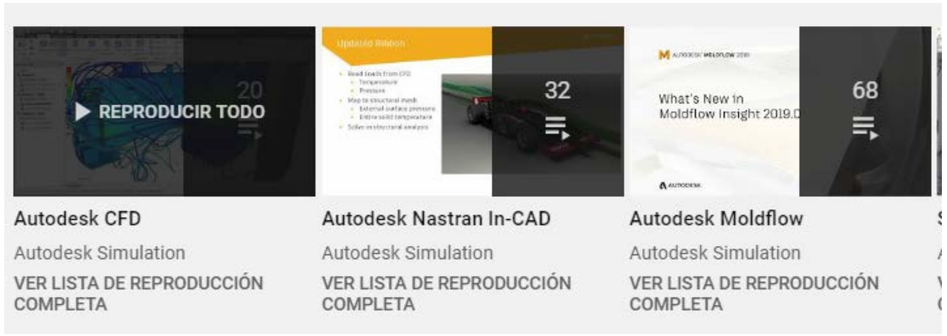


Autodesk YouTube Channels

- Playlists dedicated to Autodesk CFD
- Webinar recordings
- CFD Hangout Recordings
- Success Stories
- Tutorials







Other Support Channels

CFD

Support & Learning

Find documentation, tutorials, downloads, videos, and more resources.

To view all CFD offerings go to the CFD page.

Learn

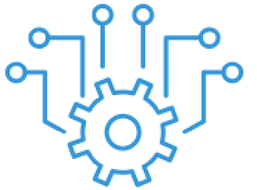
Get started quickly, and then find videos, articles, and tutorials explaining how to use CFD.

Search the learning database

Downloads

Get service packs, hotfixes, and updates. Download software, free trials, free software for students and educators, and viewers for CFD.

Downloads



Troubleshooting

Search for solutions to common issues using CFD.

Solutions

Forums

Look for forums, idea boards, and groups about CFD.

Forums

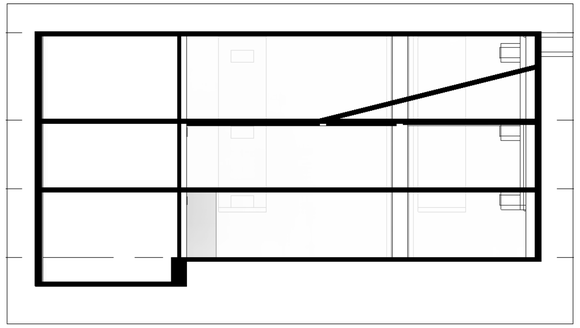
Things you will need

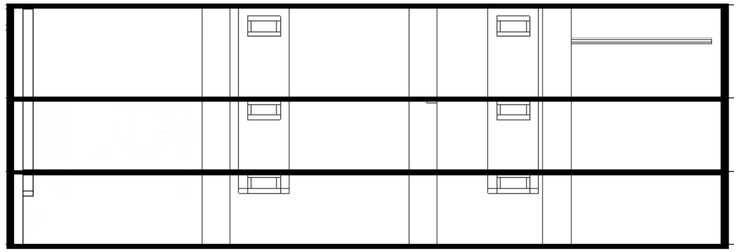
Building the Right Team

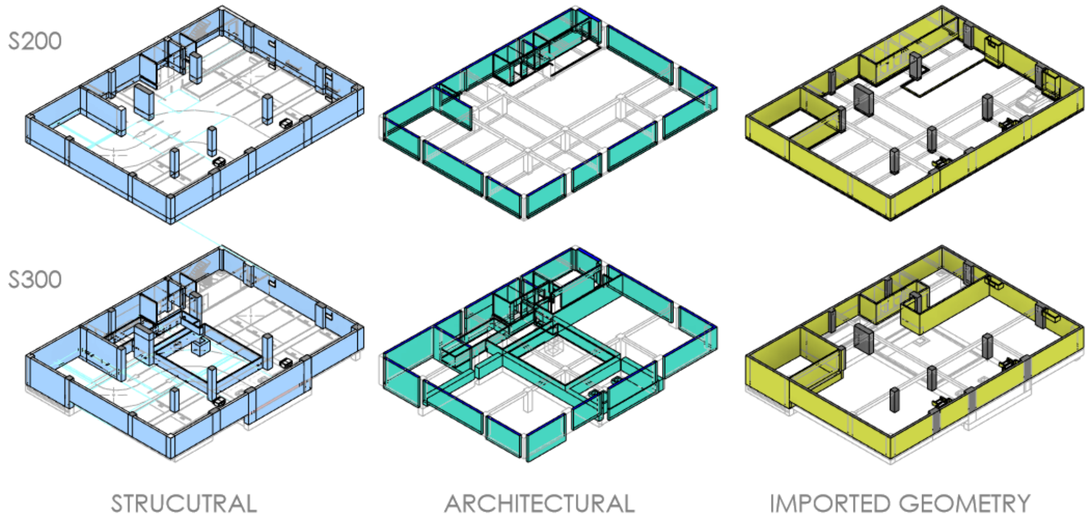
- Having the right people is key for a successful implementation
  - Be realistic about your team’s capabilities.
  - Consider hiring an implementation expert.
  - Be careful about your implementation expert.
  - Set deadlines!

Understanding the Problem

- Key aspects
  - **Design**
  - Flow Volume
  - Boundary Conditions
  - Materials







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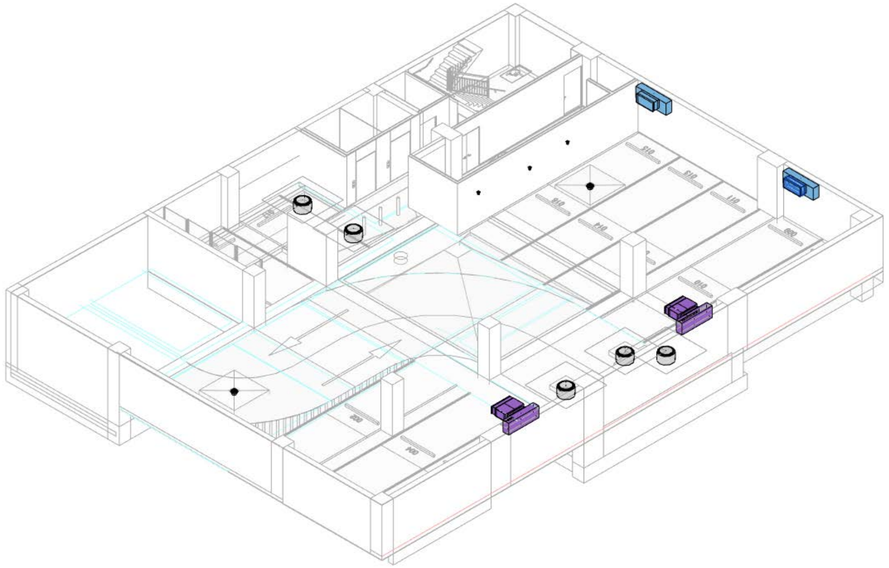

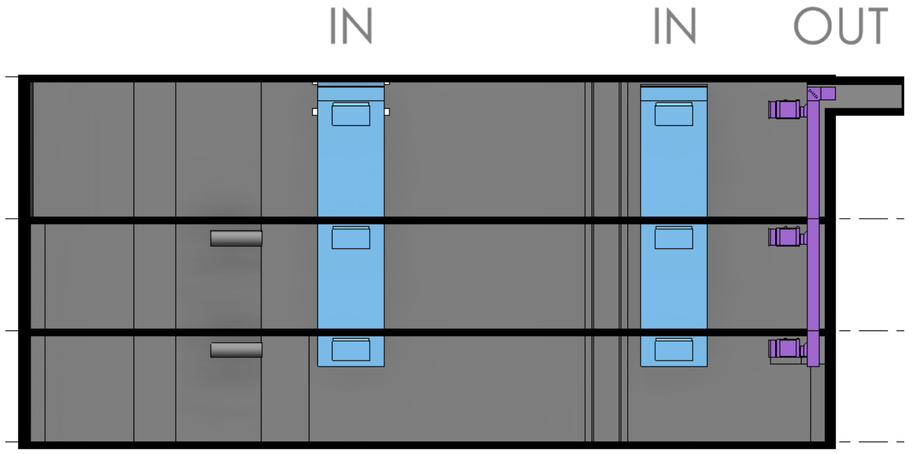

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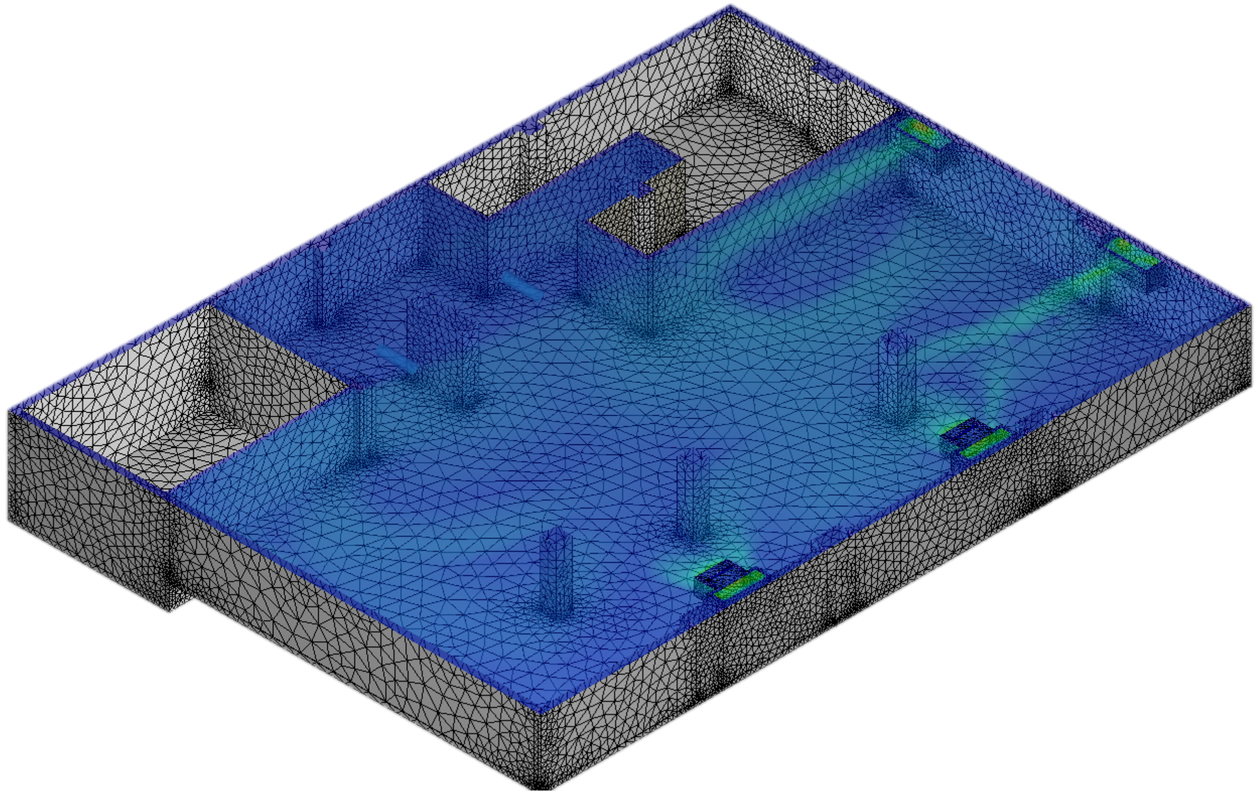

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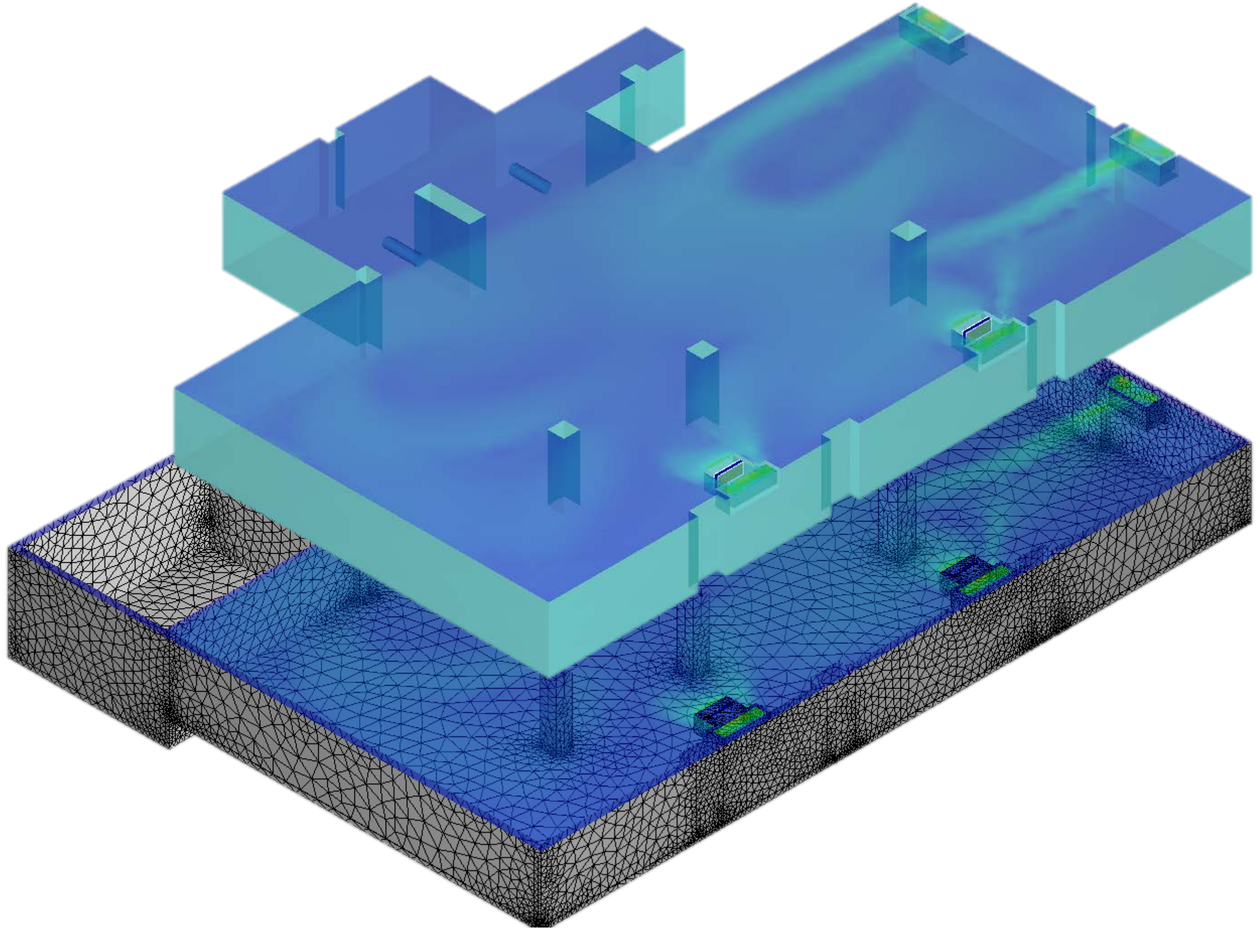

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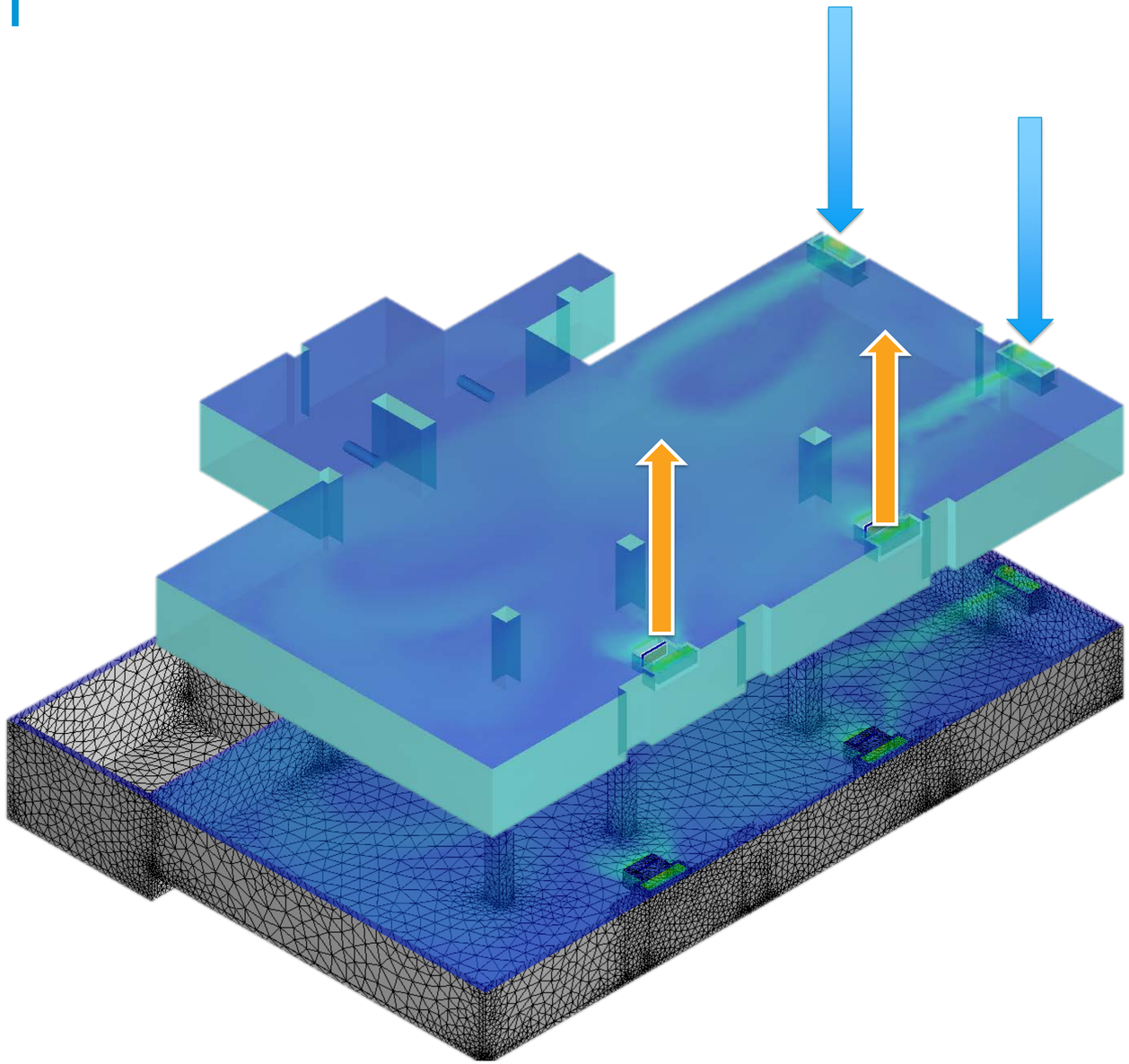

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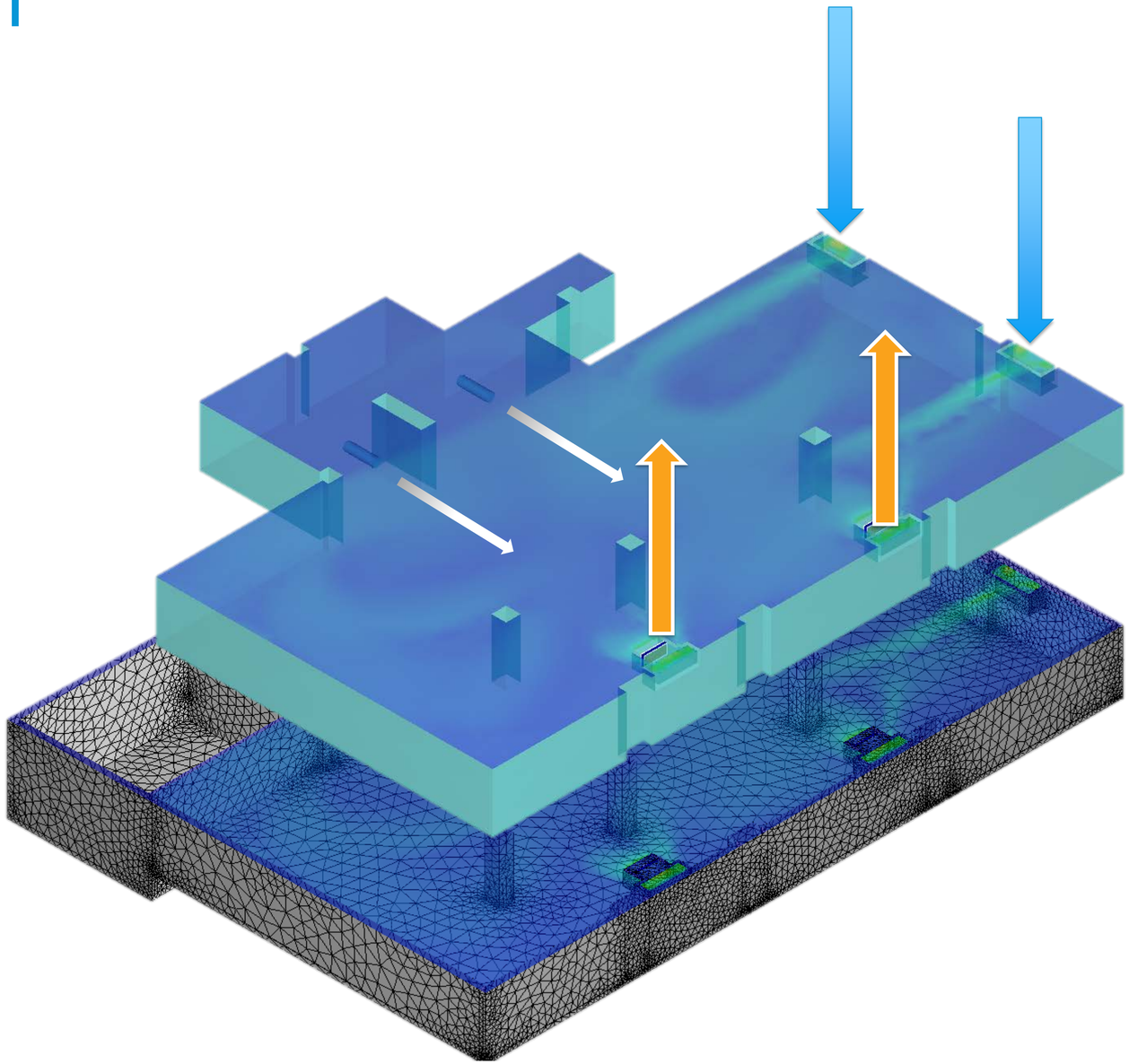
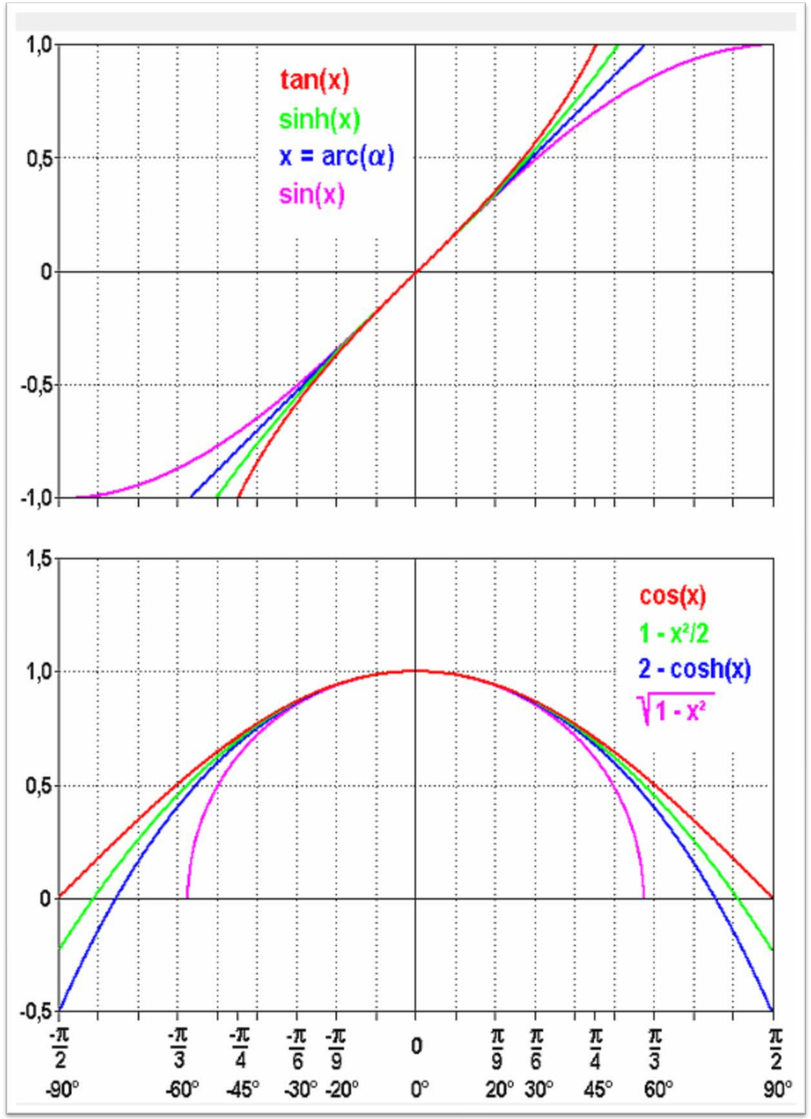


Making Assumptions

- Key aspects
  - **Assumptions**
    - Flow
    - Compressibility
    - Thermal Variables
    - Do we need them all?



Taking CFD for a Test Drive

Picking the *right* project

- Choosing a appropriate project will greatly impact your chances of success when implementing a new tool.

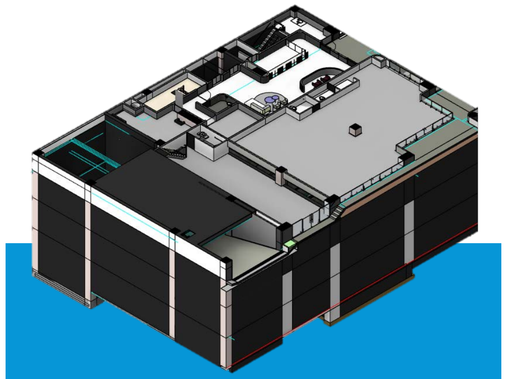
  - Timing
  - Complexity
  - Risk
  - Retrofits

Courtesy of Zavia Capital and Marlo Trejos Arquitectos.

Duration – Sample Project

16 h	30 h	6 h	8 h
TRAINING	MODELING	SOLVING	ANALYSIS
Estimated training time required to run your first analysis	Measured amount of time	3-5 Design Scenarios, plus testing.	Includes the collection of initial data and results interpretation

Complexity – Sample Project



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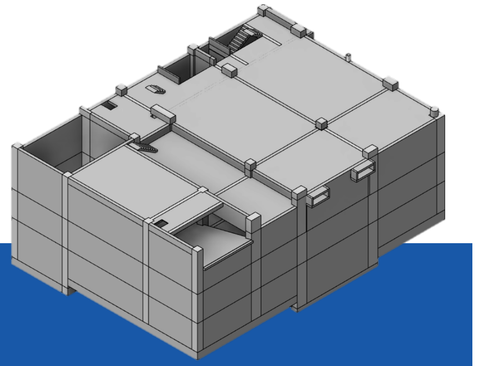
ELEMENTS

Elements in Architectural Model, Same Scope



285

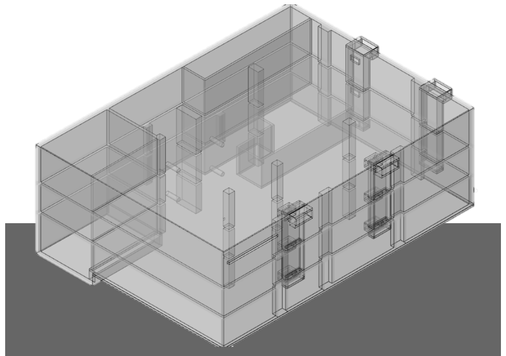
ELEMENTS

Elements in Structural Model, Same Scope

1611

ELEMENTS

Elements in Architectural and Structural Model, Same Scope

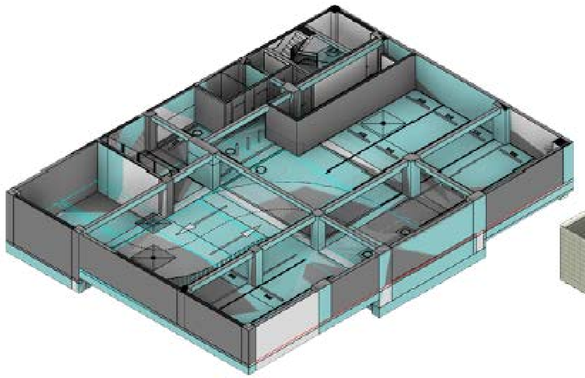


187

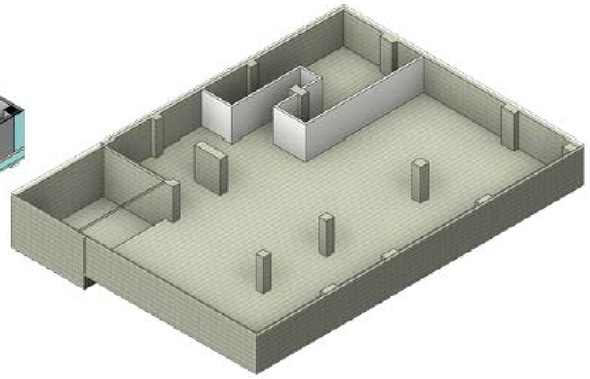
PARTS

Number of parts actually exported to CFD

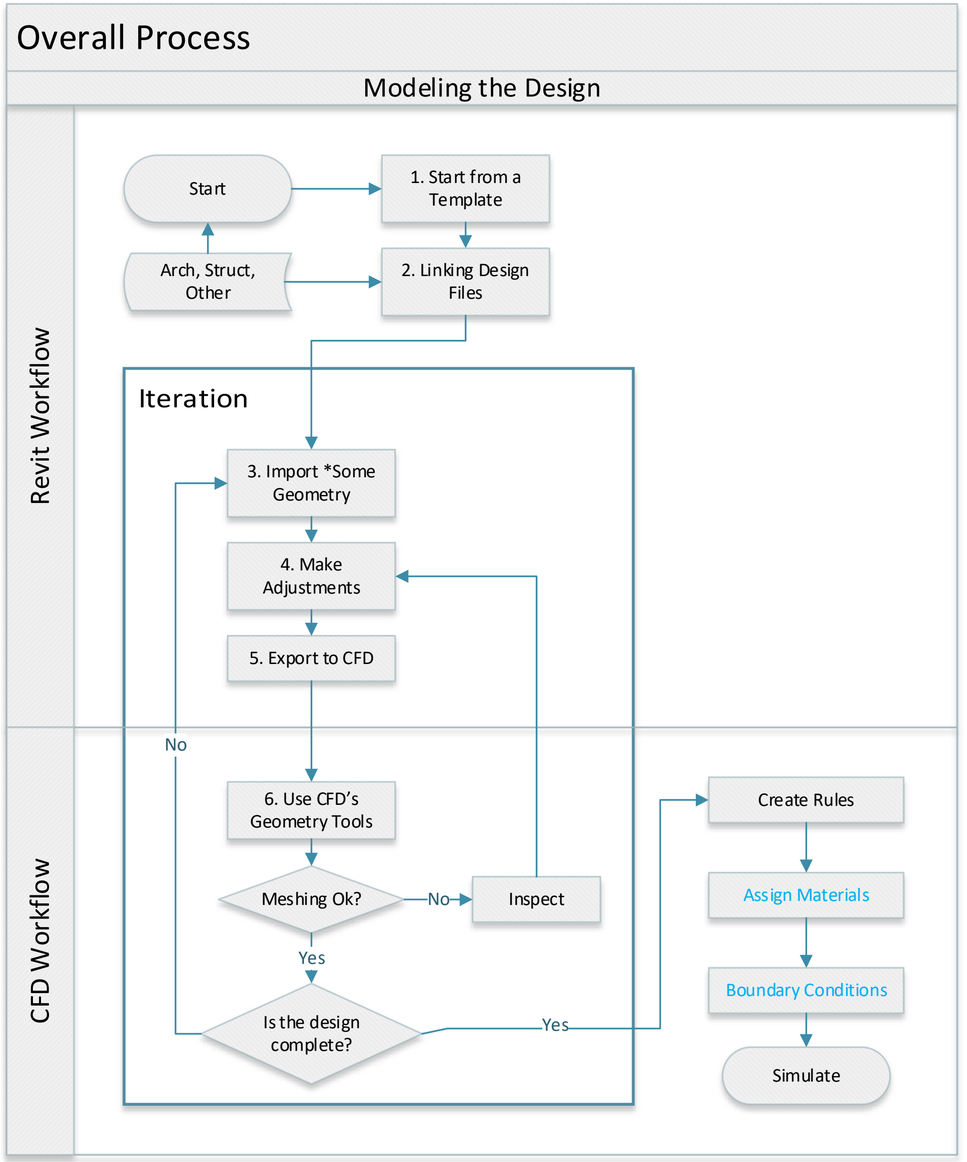
Overview of the Modelling Process



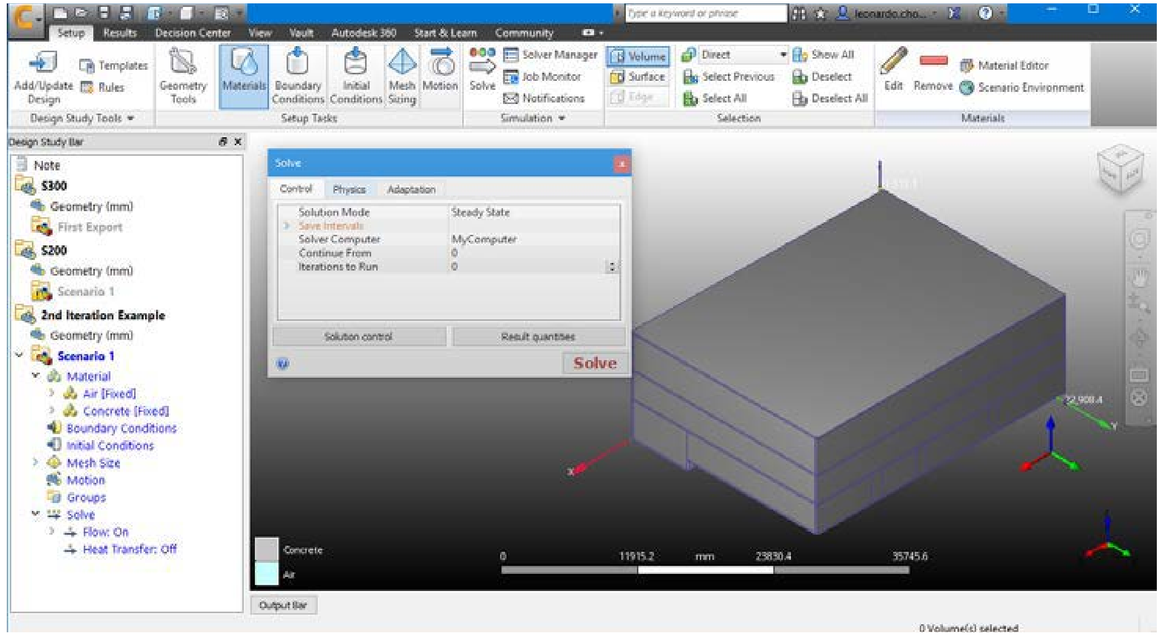
Linked Models

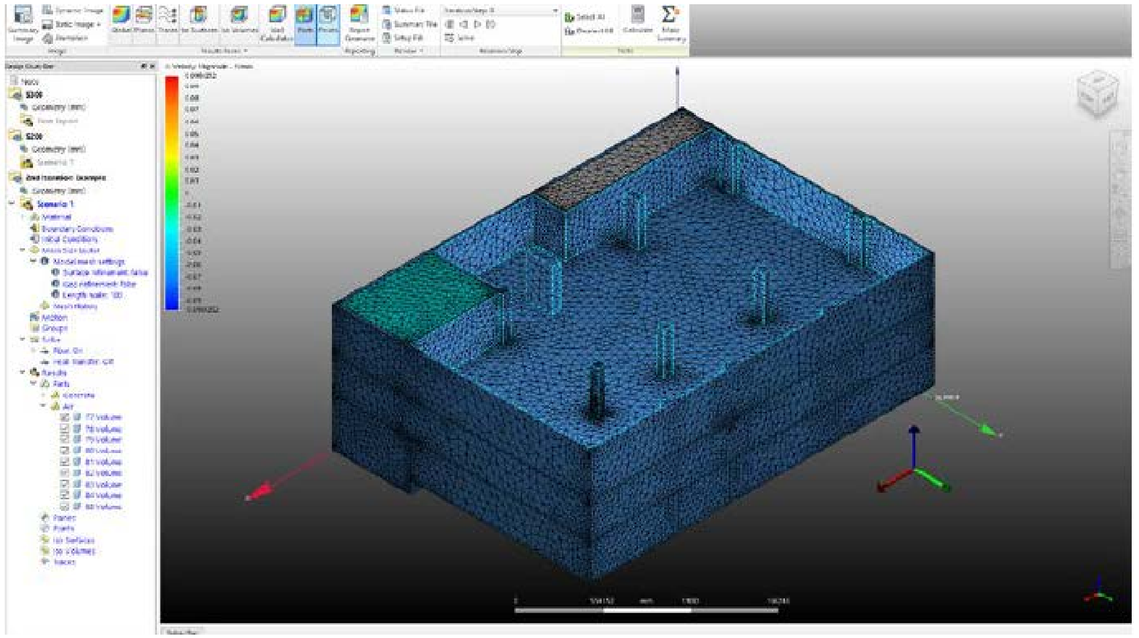


CFD Model



Meshing Challenges





Model Assesment

Active Model Assesment Tool

Use the "Transfer Set Up" button option in the MAT.

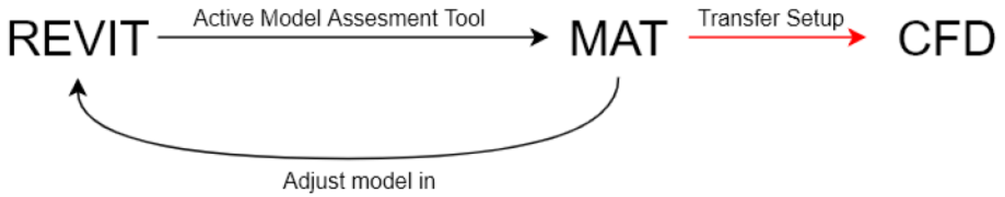


Figure 21a. Active Model Assessment Tool

Launch Active Model

Use the Launch Active Model tool to transfer the Design directly into CFD.

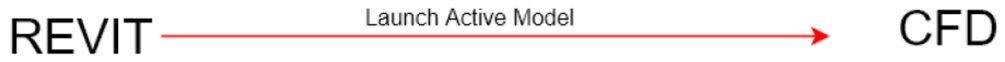
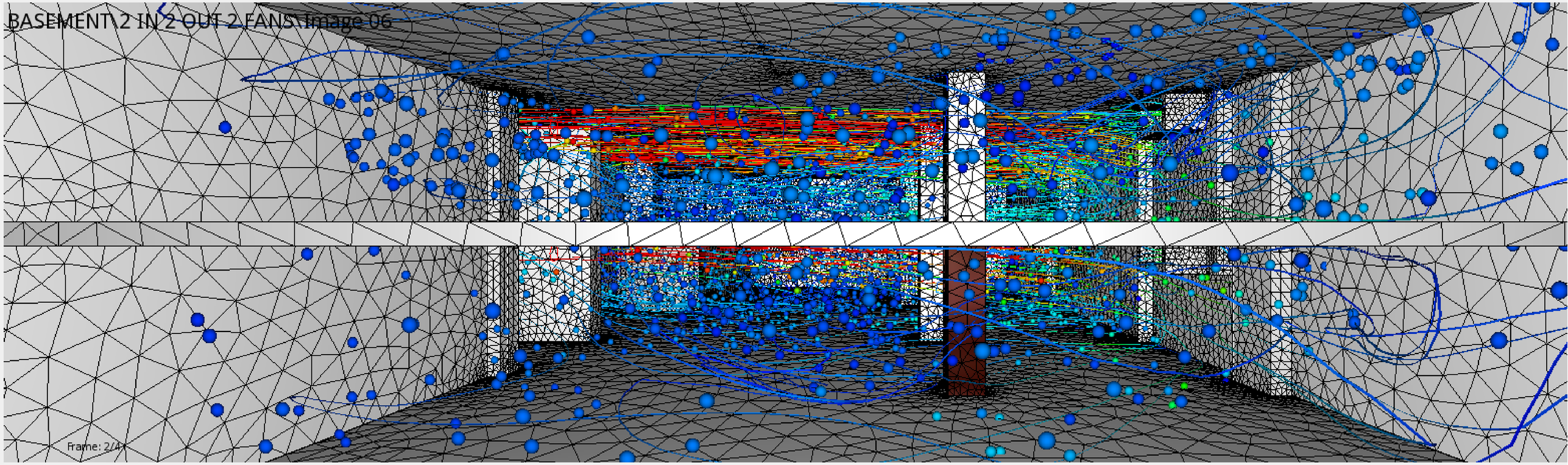


Figure 22b. Launch Active Model Tool

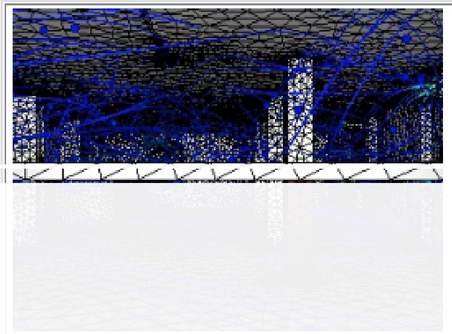


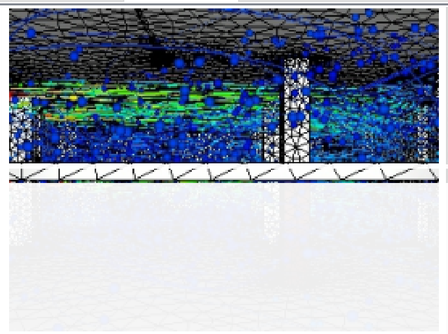
Output Bar

Design Review Center

Frame delay: 1000

Image 01 | Image 02 | Image 03 | Image 04 | Image 05 | Image 06


BASEMENT··2 IN 2 OUT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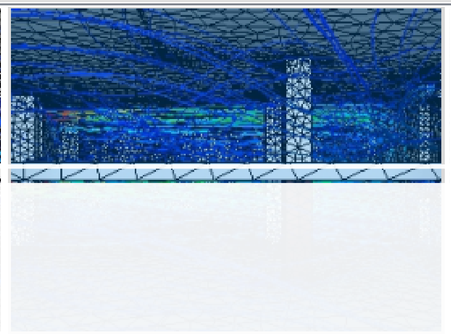
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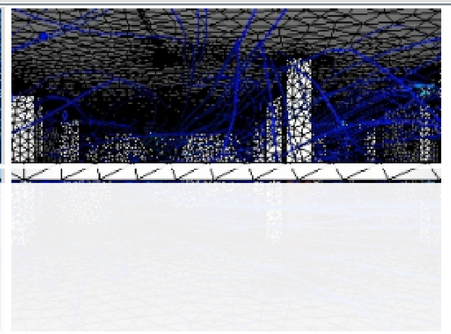
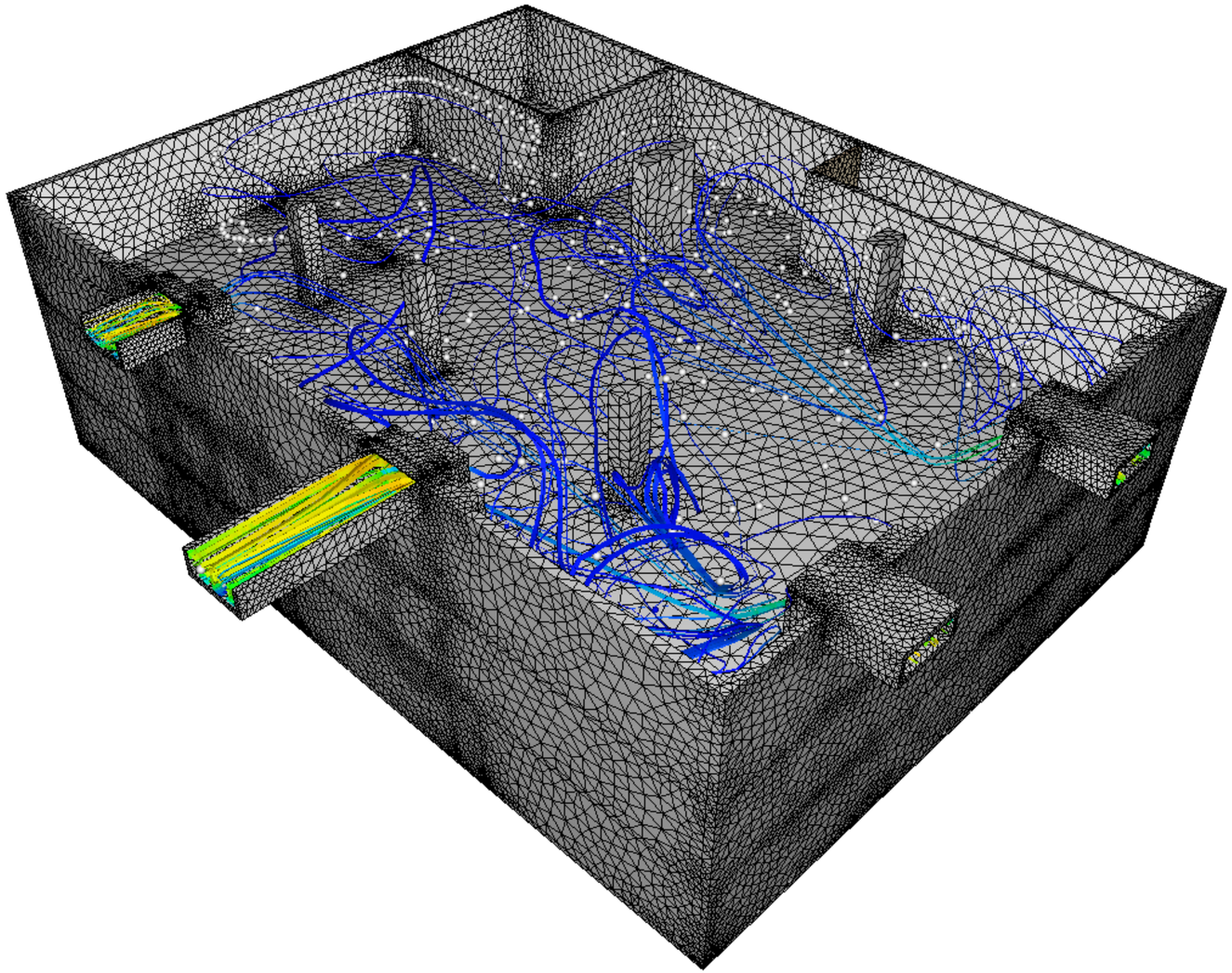

BASEMENT··1 IN 2 OUT

Results

Thank you



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