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Flow Dynamics: A CFD Implementation Case Study

Leonardo Chonkan
Circuito-JCI

Learning Objectives

- 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

Description

Implementing new technologies in your company is always a challenge. Everything from getting approvals, licensing, training, testing and failing are just a part of the process. Once you get it right, then you need to document your findings and train your staff. In this case study you will learn about some of the business and technical challenges of a CFD implementation project in Costa Rica's largest MEP Design Firm. After a brief introduction to CFD, we will cover how to get support from management, how to get appropriate training, documentation and other resources to help you get started. Finally, we will explore some of the difficulties encountered in implementing CFD and the strategies adopted to overcome them. This class will feature a real world forced ventilation example for basements as a case study.

Speaker

Leonardo Chonkan is a Civil Engineer with a passion for technology who works as a BIM Coordinator in Costa Rica's largest MEP Design firm. He began teaching people how to use Autodesk Revit for Construction Modelling while completing his graduation project on Building Information Modeling in 2015. Since then he worked for a Land Developer, a General Contractor and a BIM Consultant before finally arriving at his current position with Circuito-JCI, where he is directly involved in the planning and execution of BIM Projects being delivered in Costa Rica, Mexico and Panama. Leonardo is an Autodesk Certified Professional and a member of Autodesk Developer's Network. He regularly teaches BIM related subjects at Universidad de Costa Rica, Universidad Creativa and Cámara de Construcción Costarricense.

About Johnson Controls Inc.

Johnson Controls' Center of Excellence Network enables global customers to streamline and standardize their security, HVAC, mechanics and fire systems on a global basis. It is Johnson Control's goal to serve as a key player in driving innovation and delivering unique value to our strategic customers. Customers who leverage the CoE Network benefit from local talent which is backed by Johnson Controls' 140+ years of experience and breadth of technology expertise, freeing them to focus on moving forward with new, differentiated solutions.

About Circuito

Our Circuito CoE provides services and integrated engineering solutions with a large focus on MEP design. Since 1975, Circuito has helped architects, corporations and business owners to obtain successful, sustainable solutions that are innovative and quality-driven.

- 140+ Circuito employees
- Three (3) Circuito offices throughout Costa Rica, Mexico
- and Panama
- 1,500+ customers served
- 3,500+ projects delivered
- 20+ high-level certifications held

About Zavia Capital

ZAVIA CAPITAL is a real estate development company based in Costa Rica focused exclusively on identifying, acquiring, and developing successful and innovative projects in Costa Rica and the United States. ZAVIA Capital is focused on creating value by developing projects with a high added value within growing industries.

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Introduction

What is CFD?

Computational Fluid Dynamics is a branch of fluid mechanics that uses numerical analysis to solve problems that involved the movement (flow) of fluids. The equations characteristic of this type of analysis are impossible to solve by hand. CFD enables engineers across the world to get a better understanding of the behavior of fluids in buildings, machines, products and a wide variety of other applications by leveraging the capabilities of today's computers. Autodesk CFD is a Software solution that brings Computational Fluid Dynamics to an integrated environment where data is coming in and out of the software as part of a larger, integrated process.

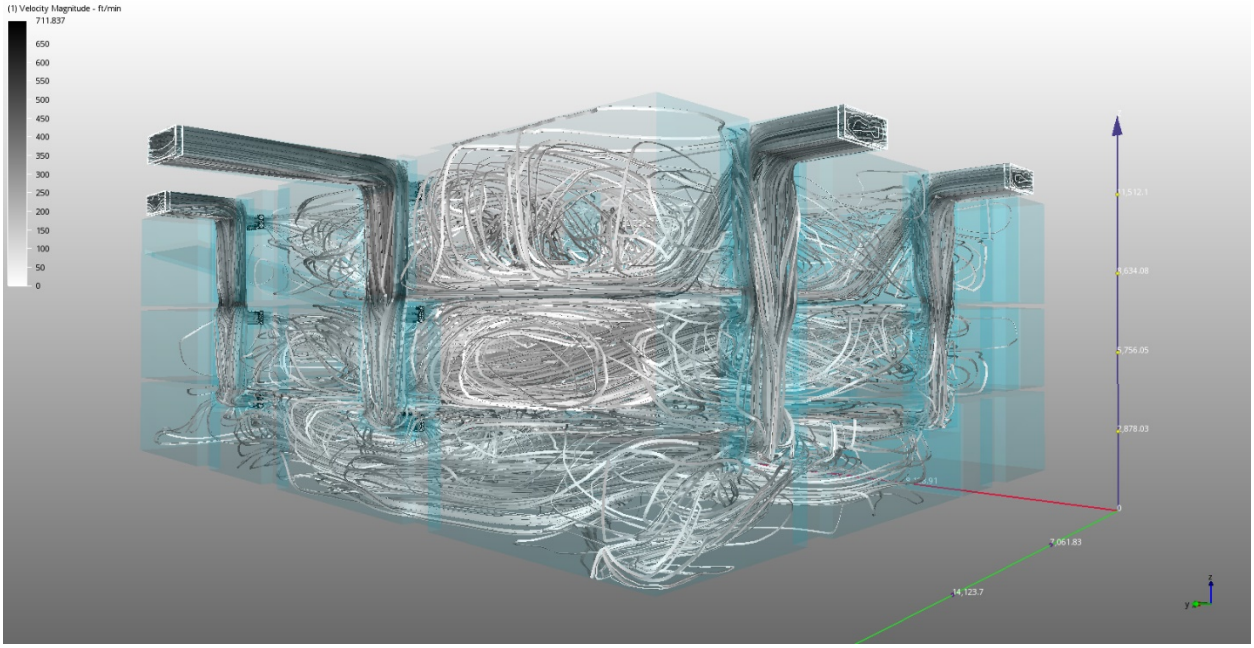

Figure 1. Sample Simulation of Basement HVAC Application

Why use CFD?

By using CFD, designers can take advantage of today's computational advancements to gain insight on their designs and make better decisions in less time. In AEC applications, for example, engineers are using CFD to solve increasingly complex scenarios dealing with internal ventilation, comfort, contaminant extraction, clean rooms, HVAC applications and more.

The Business Case for CFD

What can be solved?

There is wide variety of scenarios in which CFD can be applied. NASA engineers have been using CFD for decades to better understand the pressures and stresses in aircrafts during extreme launching conditions. Product designers are using CFD to better understand their performance and make more efficient solutions. Architects an engineers can benefit from CFD when making decisions that affect the building's performance, overall cost and even human safety.

Improved decision making

There is always an implied level risk in designing a building. In their work, engineers have to make decisions that sometimes are based on assumptions. Think of an architect trying to define the best possible location for a basements air intake given a difficult location. Think of three story basement that needs to move a certain amount of air to avoid dangerous concentrations of carbon monoxide. Think of two people in a design meeting providing arguments as to why air moves in a certain way. CFD results visualization is great way of coming into agreements on how things behave. Not everybody understand the equations of fluid dynamics but most people will understand the path followed by a particle if you represent it's path in a 3D simulation environment.

In-house vs Outsourcing

There are several specialized companies worldwide that will happily carry out pretty much any CFD analysis for you. The cost of these analysis is usually high and the delivery times don't always meet your project's deadlines. Moreover, design changes are sure to happened and the cost of those changes will reflect on your bill. By implementing CFD in your organization you will gradually get the same benefits while paving the road for future savings and improved results. Your team will get better at it and you will win more business if you can offer those same services in a more timely manner with in house resources.

Impressive Results

By using CFD analysis in combination with post processing and specialized visualization tools you can generate impressive graphics that pose great commercial value. **Figure 1** is a basic example of an HVAC application in a basement. When shown to the client, they requested a quote for natural ventilation scenarios in the upper levels of the building. This will most likely be the case once you start pitching your services along with imagery of real applications done by your company.

Learning Materials

There is quite a bit on information available for those interested in learning to use Autodesk CFD software. Here are some recommended product guides and learning materials available to support your implementation efforts:

Official Product Documentation

The most valuable source of knowledge for starters. You can access the official product Documentation directly from the software's user interface or by following this link. Make sure to visit the New User Quick Start section for a guided learning experience. Visitor can follow one of the Quick Start Tutorials according to their field. Most of the general examples involve the product industry but there are some great AEC Examples and Recommended practices that will get you started right away. These short examples use the data set files that come with the software and are designed to show you results in very few steps.

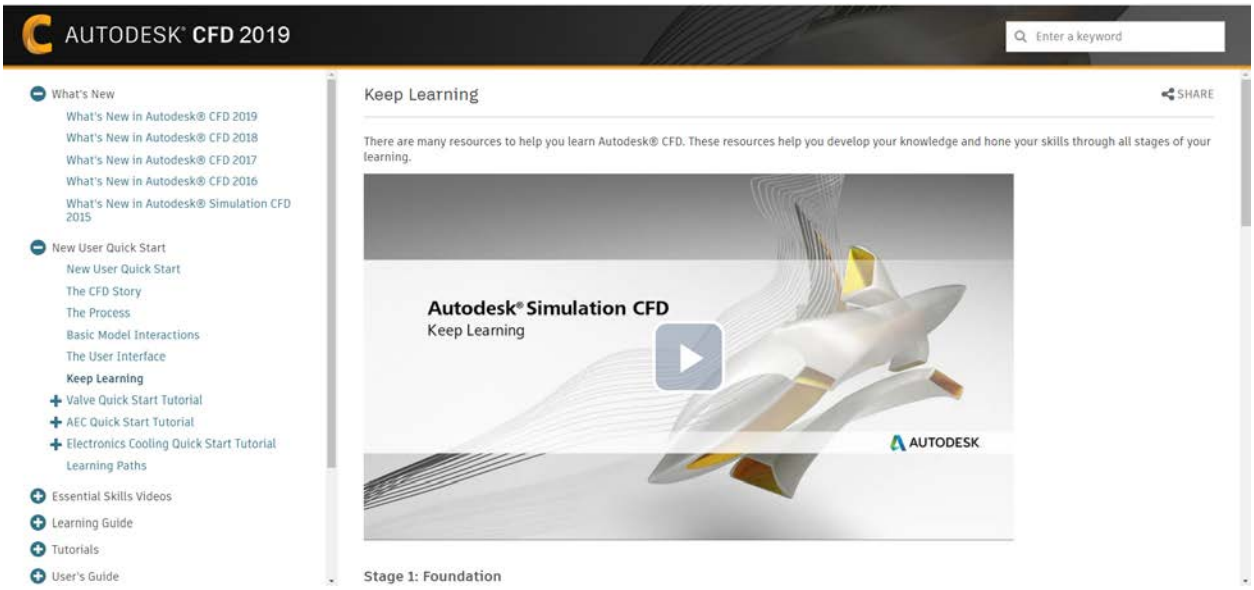

Figure 2. Official Product Documentation

Third-Party Content

There is an Autodesk CFD Essentials book published by **Ascent** that covers everything necessary to teach the user that is new to CFD how to navigate the user interface an d successfully analyze a model. This publisher has been known for generating great content and there are an Autodesk Authorized Publisher. The essentials guide was written for the 2017 version but it will cover the basic principles that are found in all versions of the software. You can buy a electronic version of this book for less than USD 70

Autodesk YouTube Channels

The Autodesk Simulation Channel on YouTube is also a great resource for those looking to see some interesting workflows and applications in quick, summarized manner. There are playlists specific for each simulation software and there is one exclusively dedicated to Autodesk CFD. In here you will find short concept demonstrations of key features of the software.

Other Support Channels

Sometimes we follow the tutorial and don't get the expected results. Some times we are in real project and still don't get results. You are not alone. Luckily enough, CFD has been around for years. This means that for every problem you encounter there is probably someone that has already encountered the same obstacle. Whenever we run into issues we should always look first in the available documentation. Visit https://knowledge.autodesk.com/support/cfd to access Forums and Troubleshooting solutions for a wide variety of known obstacles.

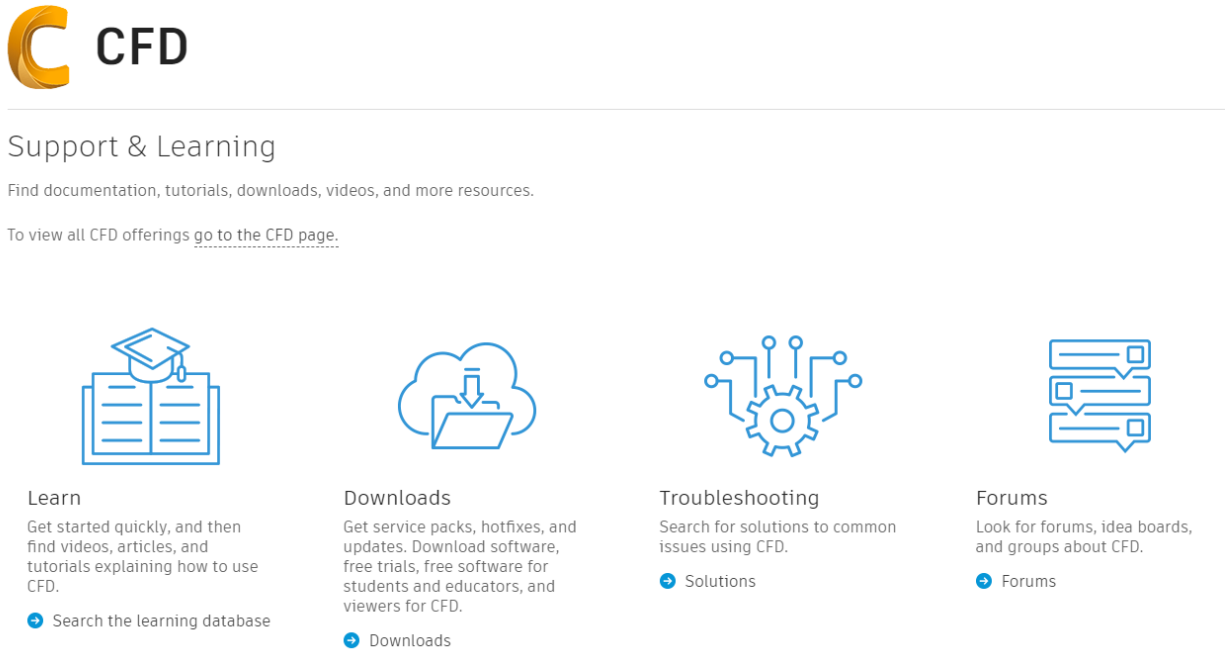

Figure 3. Autodesk Knowledge Network

If you can't find what you need through this website and you have an active subscription to Autodesk CFD, you can create a Support Case through your Autodesk Account portal. There as team of highly involved individuals willing to assist you with your learning and implementation efforts.

What You Will Need

Build your team

Having the right people is key for a successful implementation. Here some recommendations on how to handle the *soft* side of things:

- Be realistic about your team's capabilities and take into consideration current workloads and responsibilities. If assigned incorrectly, your implementation can lead to no results and even losses.

- You can always bring external consultants into the equation if you want to accelerate the process. Make sure they are experienced enough. You don't want to hire a company that doesn't have a single engineer in their staff.

- It is highly recommended that you set deadlines to keep people focused and motivated.

- CFD results need interpretation. If you don't have the right people in the project. You will end up with very colorful visualizations with no meaning. A good combination is to have your BIM people teaming up with your Mechanical Engineers in this effort. Collaboration is key.

Gather your data

In order to determine where you succeeded or not, you will need to apply engineering knowledge and criteria to determine if your results make any sense. Below are some recommendations on the *technical* side of things:

- Understand the problem. Pay close attention on what needs to be solved and what are the variables involved.

- You might need to gather material properties, code requirements, weather data and other information that is particular to your project or region. This is true of any engineering endeavor in both commercial and non-commercial environments. Be aware that there will be information that is not included in the software or the documentation.

- Be ready to make assumptions. This also supports the idea that building the right team is crucial. When modeling, for example, there will be times when simplifications and assumptions can benefit the solution.

- For example, when analyzing the forces caused by wind in structures you will need to determine maximum wind speeds for the location of your project. Without this information there will be no criteria for assessing the accuracy of your results. Make sure you have this information is available to your team in a timely manner.

Take CFD for a Test Drive

Choosing an Appropriate Project

Choosing a appropriate project will greatly impact your chances of success when implementing a new tool. Here are some things to consider when making your first move into CFD:

Timing

Please keep in mind that all new tools have a learning curve and pose a level of uncertainty. Your first project will give you the baseline you need to estimate the required effort in subsequent projects. For your first project, you should allocate at least 16 hours of training plus an additional 30 hours of implementation.

Complexity

In this case, simple is better. Choose a project that poses a challenge to your team but doesn't scare them away. Your first results will give the team the confidence they need to take on bigger challenges.

Risk

Make sure you can afford to allocate the necessary resources and that your are not risking the project timeline by implementing a new methodology. If you have to deal with fines and tight deadlines, it is better not to offer CFD analysis unless you are confident using the tool and interpreting the results.

Retrofits

A great way of learning how to use a tool like CFD is to analyze a project that has already been built/manufactured. This kind of project provides valuable insight and at the same time there is the chance of taking real measurements to validate your results.

Project Example

In this example, we look at how Autodesk CFD was used to make decisions on the number of inlets/outlets required for extracting Carbon Monoxide (CO) out of a three story basement. The criteria for this analysis was the minimum volume of air to be extracted and the maximum permissible speeds for air coming in and out of the basement.

The example provides a level of geometric complexity characteristic of a real project and poses an interesting challenged that can be solved with the aid of CFD. By the time we took on this project we had already done a couple of simulations and were able to determine the amount of effort required.

It took about 15 hours of 3D modelling, 4 hours of analysis and a few meetings to get value from the solution. Engineers were able to simulate forced ventilation in the basement and measure speed coming in and out of the openings. Results were presented to the client and the architects as way of supporting our design propositions. Project changes required to re-run the simulation on separate occasions. It took about 2 to hours of adjustments each time.

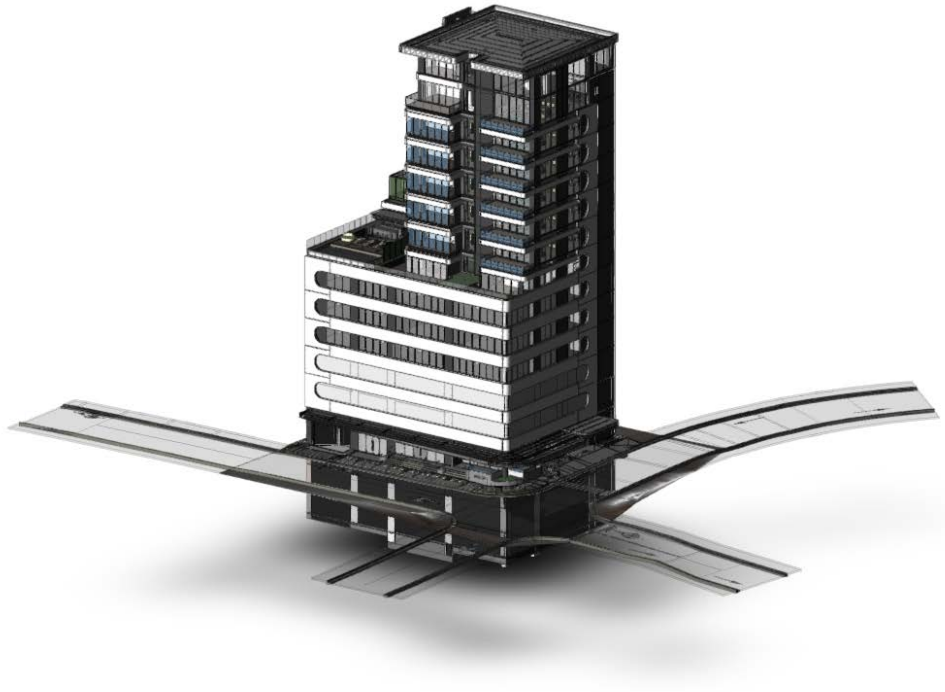

Figure 4. NUBAE Project. Courtesy of Zavia Capital.

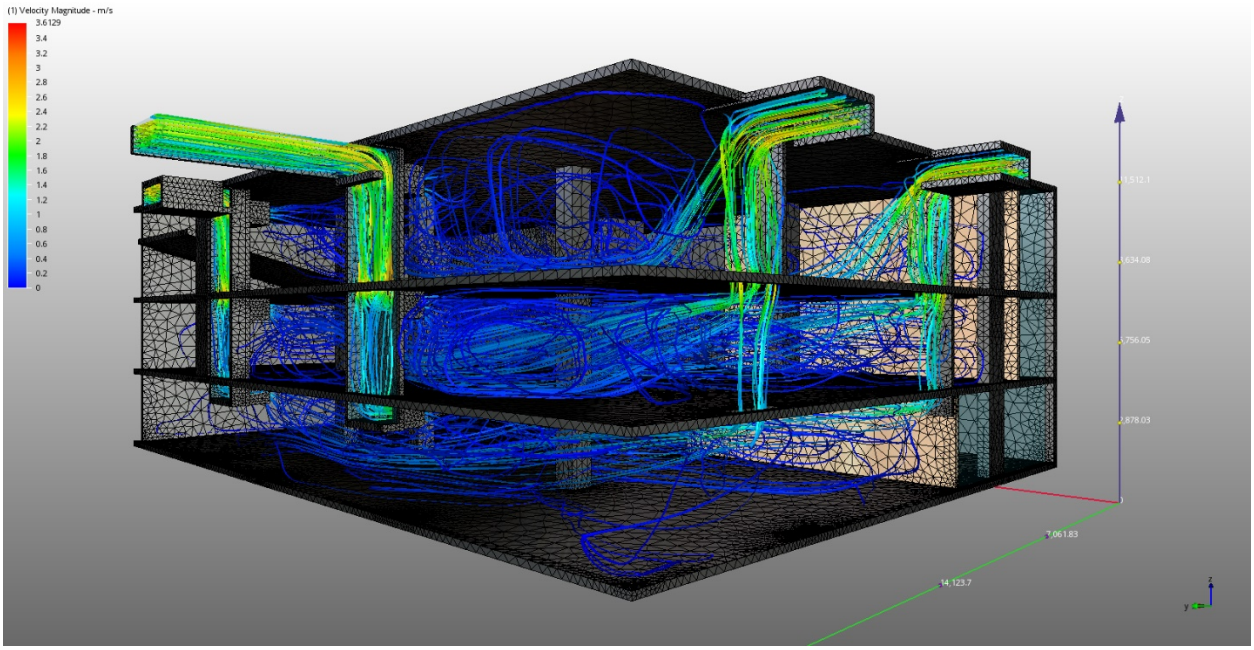

Figure 5. Basement Force Ventilation Simulation