CFD for Datacenters: Keeping Computational Clusters Clean and Happy

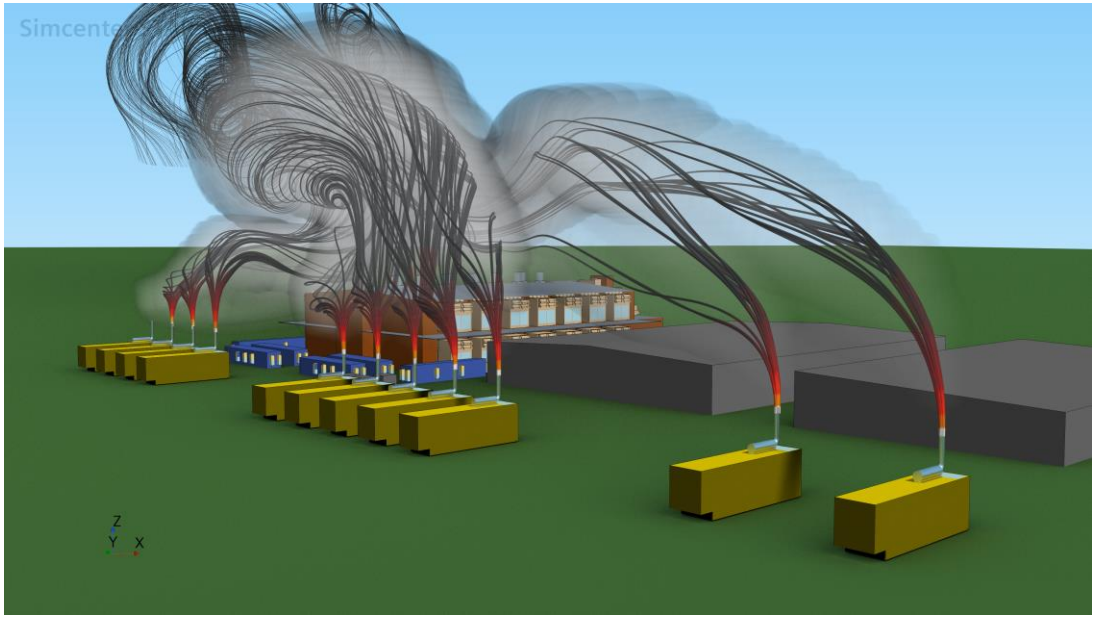
What we have found interesting about these projects is the quest to ensure that only the cleanest air is entering the buildings and that once inside, it circulates efficiently. Years ago, it used to be just about keeping the banks of servers cooled with massive amounts of HVAC since detailed CFD flow analysis was just not possible given engineering budgets or schedules. Nowadays, the new normal is to perform CFD studies on the exterior and interior air flow. On the exterior of the data center, it is to ensure that the air entering the CRAHs (cooling room air handling units) is not contaminated by engine exhaust (idling trucks at loading docks or delivery stations) or emergency backup generators. On the interior, it is about maximizing the efficiency of the cool air distribution around the banks of servers.

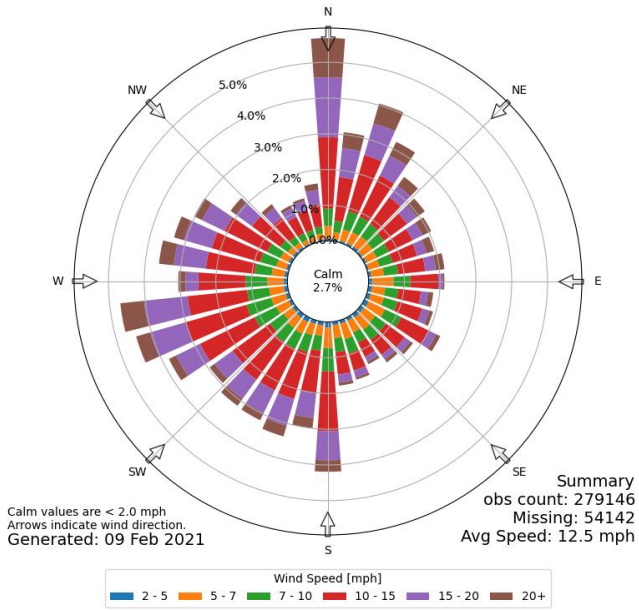
In our CFD consulting business, it has been an interesting shift from circuit-level thermal-fluid analysis (i.e., motherboards and server enclosures) to building-level thermal-fluid analysis or from micro-level to structure-level CFD services. Nowadays, it is all about air-flow around the data center, placing CRAHs (or HVAC units) away from contamination sources, and putting CRAHs outlets in locations to optimize the cool air flow within the rooms.

The following slides and video show just a few of CFD consulting projects. We pride ourselves on being knowledgeable CFD engineers that can work collaboratively with your team to ensure that the project will meet its goals and of course, its budget.

Exterior Flow for Two Story Datacenter Hall

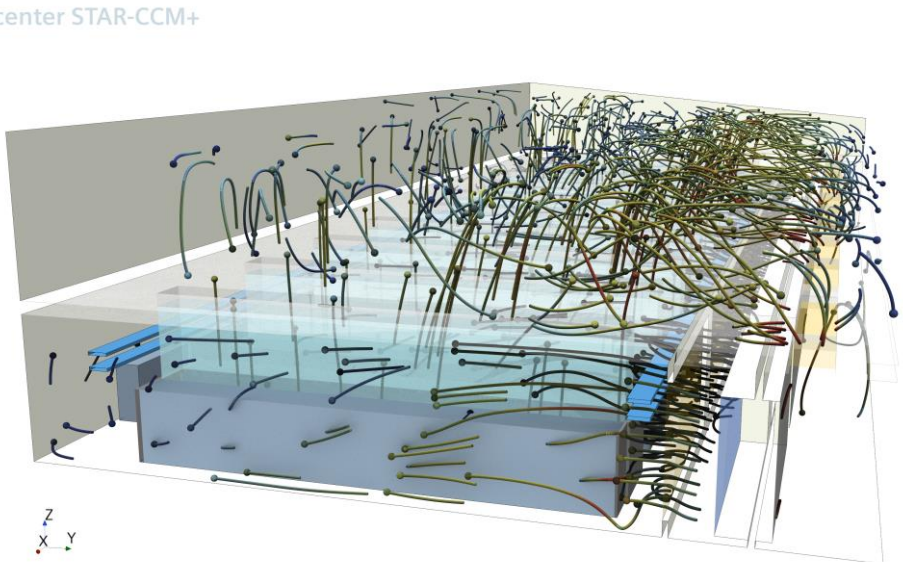
A common challenge for building and layout designs of datacenters is to avoid inhalation of exhaust and or waste heat by the CRAHs (cooling room air handling units). The design constraints become even more challenging when a two-story design is pursued, where waste heat from the lower floor must be exhausted, while avoiding recirculation with the upper-level air handling units. In addition, we must also avoid exhaust intake from the nearby diesel generators that provide emergency backup power to the site. We use CFD analysis to evaluate these different operating conditions at the specific sites based on local wind rose data. These analyses are used to adjust the site design and ensure that the datacenter will maximize uptime and performance.

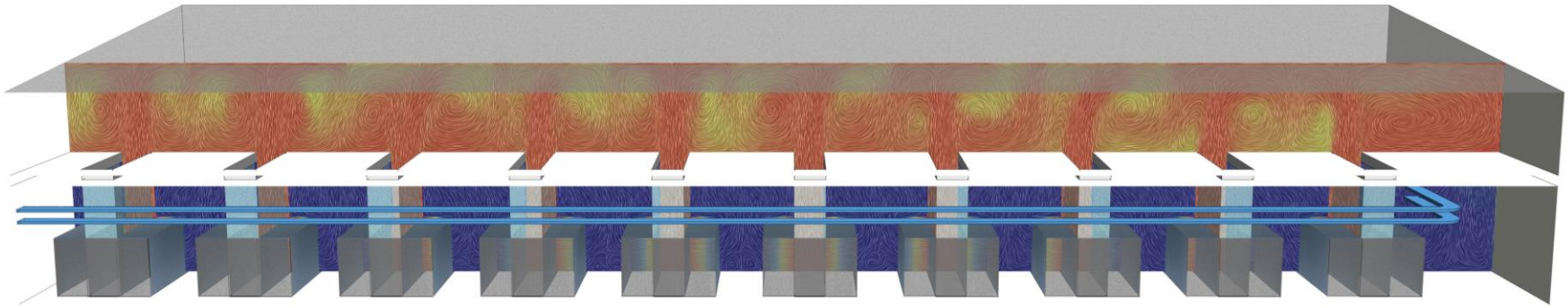




Interior Data Center Flow and Temperature Distribution

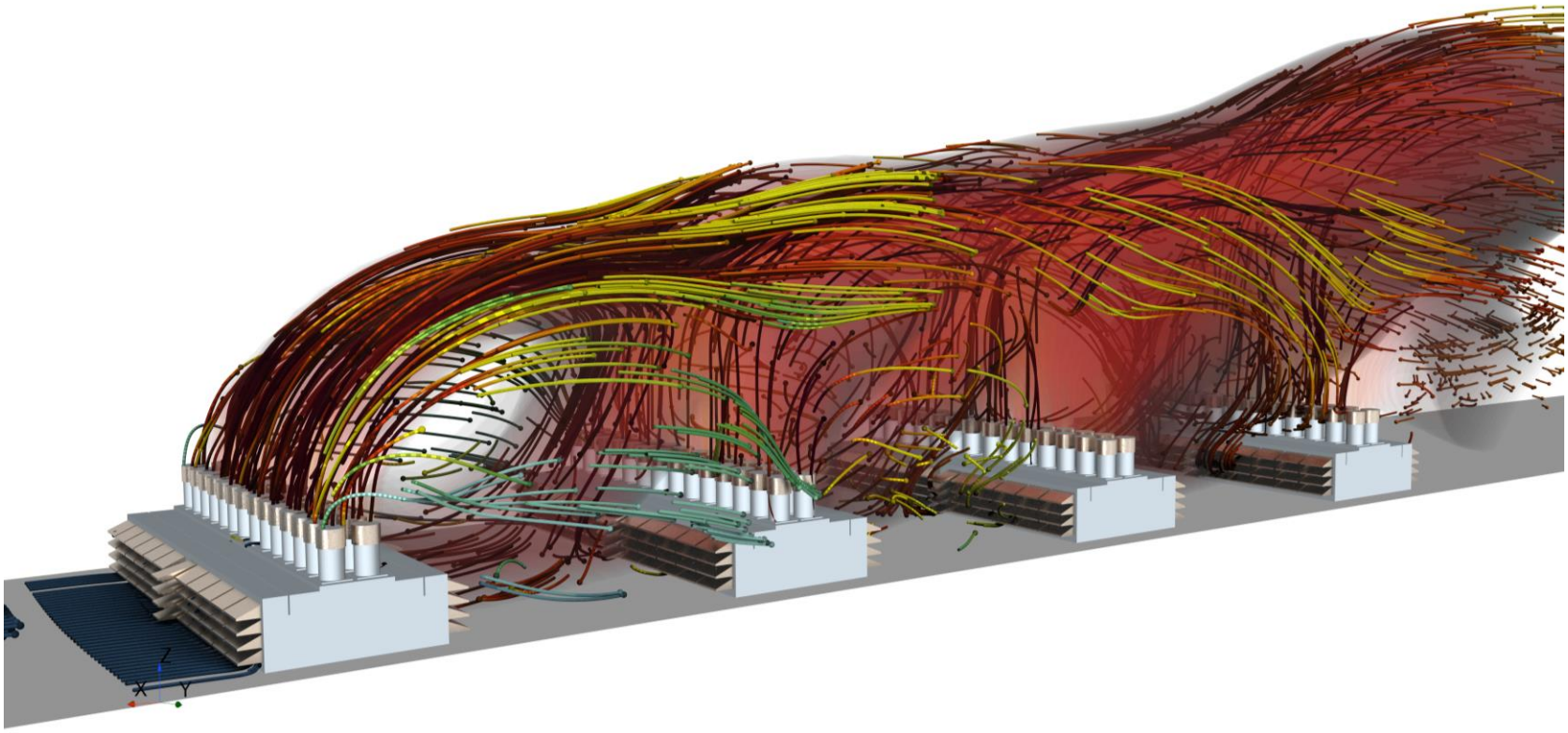
Air flow and temperature distribution within the data centers are extremely important factors to ensure the heat generating servers are kept cool and avoid detrimental downtime. The primary concern with these CFD simulations is to ensure that uniform flow enters the server racks and meets the expected pressure drops as air flows into the hot aisle containment to return to the CRAHs (cooling room air handling units).





Portable Data Pod CFD Analysis

Here was an interesting opportunity to model the intersection of onsite data computing power with land use restrictions. Similar to other data center projects we've done, there is always a concern of recirculation between server units, especially when multiple MWs of heat must be disappated. In this project, the question was how close could we place self-contained server pods to avoid unit to unit recirculation and ensure that the computing power to land use is maximized. In order to evaluate these designs, we created full site parametric models that captured the interior and exterior flow for each server pod, and allowed us to array these pods within the model and evaluate potential recirculation at various wind conditions. Our results guided the end-client on where their limits were for locating the server pods.



Predictive Engineering FEA and CFD Consulting Services, Portland, OR USA

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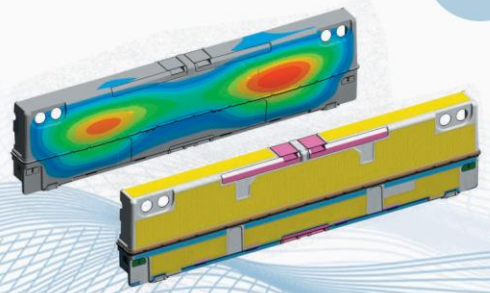
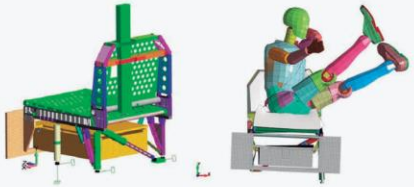
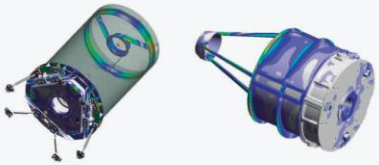


Project Examples

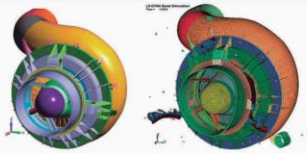
FAA 16G SLED TEST VERIFICATION



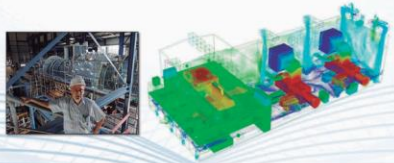
STRESS AND VIBRATION ANALYSIS OF SATELLITES



LS-DYNA TURBINE BURST SIMULATION



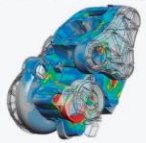
CFD STUDY ON CO-GENERATION POWER PLANT BUILDING



Our Services

FEA

Predictive Engineering brings to bear more than 20 years of finite element analysis FEA consulting experience in solving the most difficult mechanical engineering analysis challenges.
Our validated experience ranges from transmissions to submarines to satellites.



TRANSIENT NONLINEAR

At Predictive Engineering, we pride ourselves on the ability to idealize complex structures and systems into predictive numerical models. Our nonlinear, static and transient dynamic work has been validated against strain-gauges, drop and sled test results, accelerometers, crack growth and fracture and in extreme service environments.

ASME-BPVC

From seismic to buckling to cyclic service (fatigue), Predictive can assist in verifying the most challenging pressure vessel designs. Our hard-earned experience allows us to safely classify tanks and vessels as "fit-for-service" that would typically have required extensive redesign or re-work.

CFD

Our expertise in computational fluid dynamics (CFD) comes from hundreds of thermal-fluid projects in medical, aerospace, marine, HVAC (data centers), civil and automotive. This experience gives us the capability to quickly optimize and provide accurate digital prototypes.