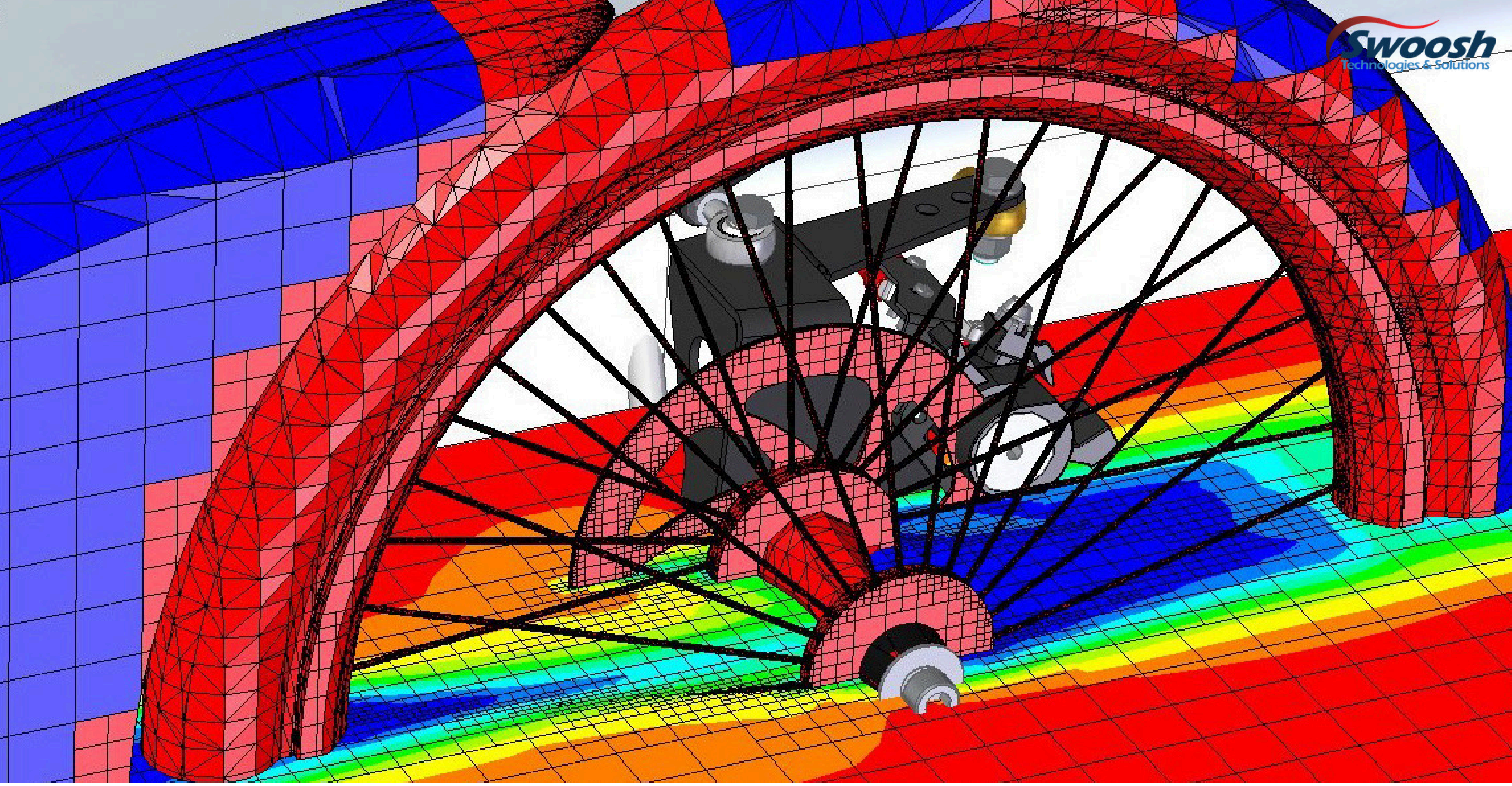
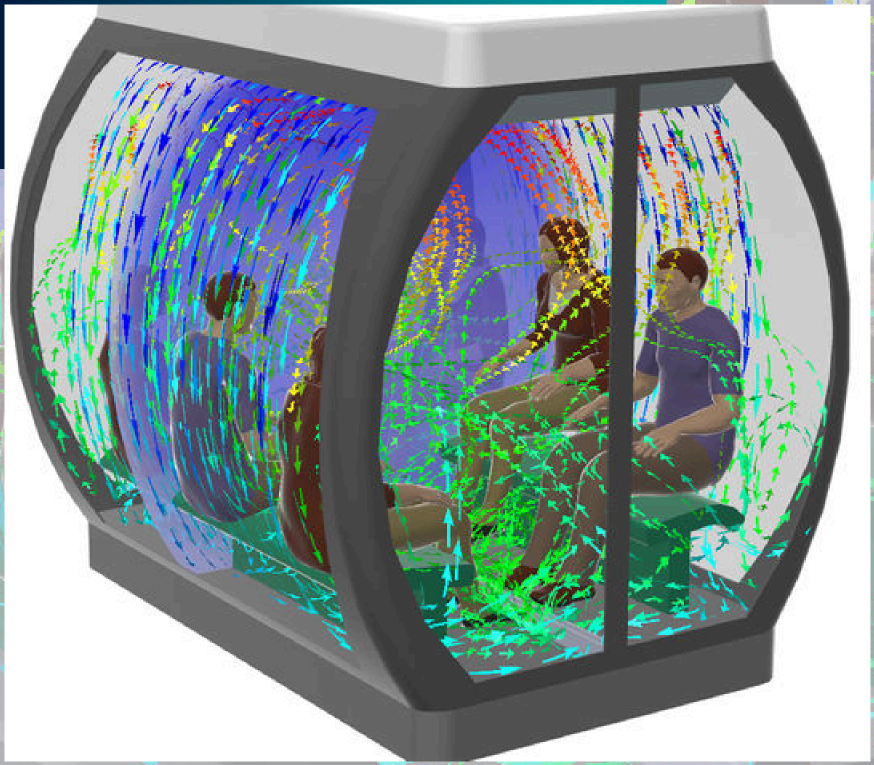


DIGITAL INDUSTRIES SOFTWARE

Five best practices for computational fluid dynamics simulation

CFD simulation is an integral step during the design stage – it is no longer a luxury; it is a must. Companies that embrace this will prosper and avoid wasting precious resources.



How do you increase your productivity? Do you continuously repeat the same action and expect a different outcome, or do you examine every step in the process to make sure you have an optimal design that enables your team to work smarter and produce more?

Many of the most successful companies in their markets assess performance early in the design process and promote collaboration and knowledge sharing between analysis experts and design engineers.

Products are designed to specification and overdesign can be reduced by using simulation technology. Moving simulation and analysis into early design stages is the gold standard with the highest return-on-investment (ROI). This is commonly called front-loading.

All sorts of simulations, including computational fluid dynamics (CFD) analysis which we cover here, can be used in the early design stages. The earlier simulation can be done in a design process the lower the cost of change is with higher room for cost reductions.

CFD is a well-established computer-aided engineering (CAE) simulation technique with almost 50 years in the commercial sector. CFD is based on numerical methods for solving the fundamental Navier-Stokes equations that govern fluid flow, heat and mass transfer.

This eBook focuses on five best practices for front-loading CFD analysis in the design process.

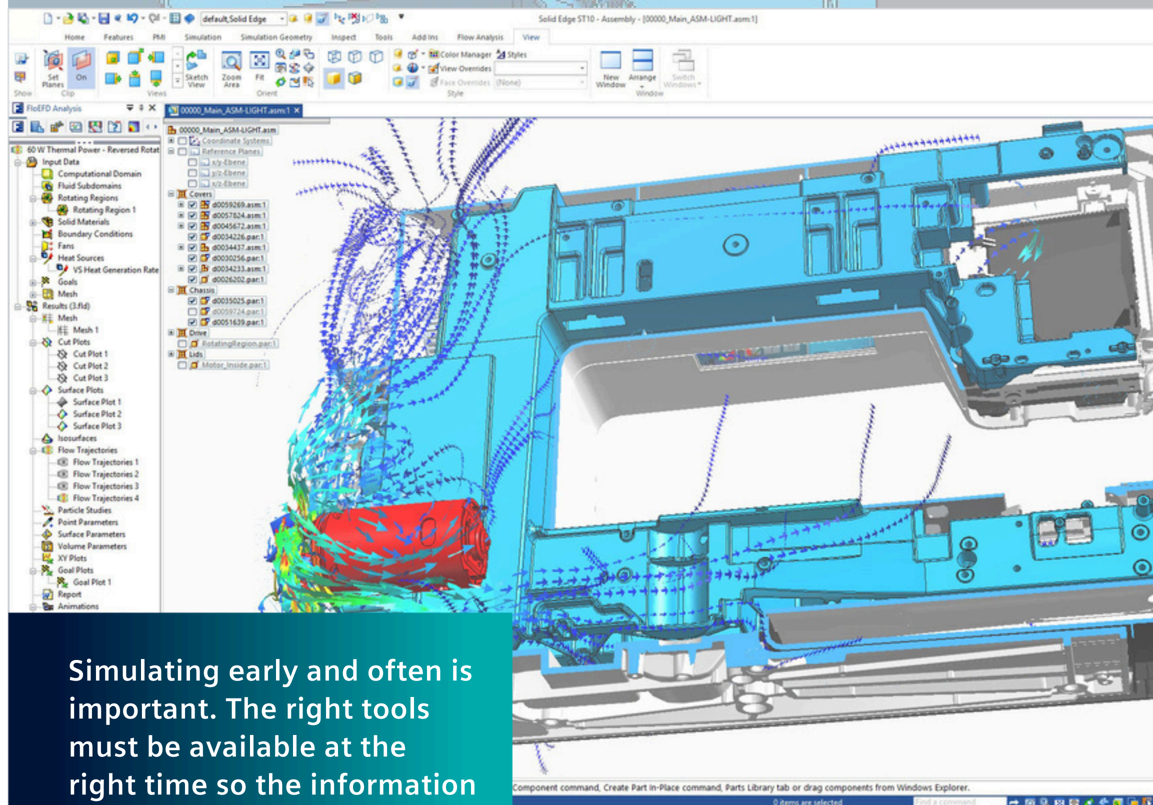
Best practice No. 1 – encourage performance assessment as early as possible

During the design stage, speed is of the essence. Engineering teams need a fast, easy-to-use and accurate tool to help them understand the behaviors of the various design alternatives and possibilities early on. The cost of each engineering change increases with each step from concept to production.

Front-loading CFD simulation is a method used to examine trends. It enables engineers to dismiss less desirable design ideas when the cost of change is lower. Along with using simulation early on, engineers must simulate often to keep up with the speed of design changes. By iterating rapidly, engineers can discount the less attractive ideas and innovate more. Once a design has been explored and identified as viable, it can move to the verification stage.

Historically, simulation efforts were reserved for specialists to use during the validation phase. However, design engi- neers are more than capable of assessing problems, finding and testing the most effective design variants and generat- ing a solid design. They are typically trained in mechanical engineering, which enables them to be versed in the background of the product they are designing.

Additionally, today's CFD software enables those without a fluid analysis background to perform CFD and thermal simulations. Promoting collaboration and knowledge sharing between analysis experts and engineers during the design process improves efficiency and productivity in an organization.



Simulating early and often is important. The right tools must be available at the right time so the information can be accessed for early evaluation, a practice called front-loading.

Best practice No. 2 –
reduce the number of prototypes and optimize cost

Testing a design solely at the prototype stage is proven to raise costs. According to the Lifecycle Insights report "Driving Design Decisions with Simulations," failed prototypes lead to project milestones being missed, extra rounds of testing, longer hours of work, etc. Engineers can help optimize cost by using better materials and reducing the number of physical prototypes.

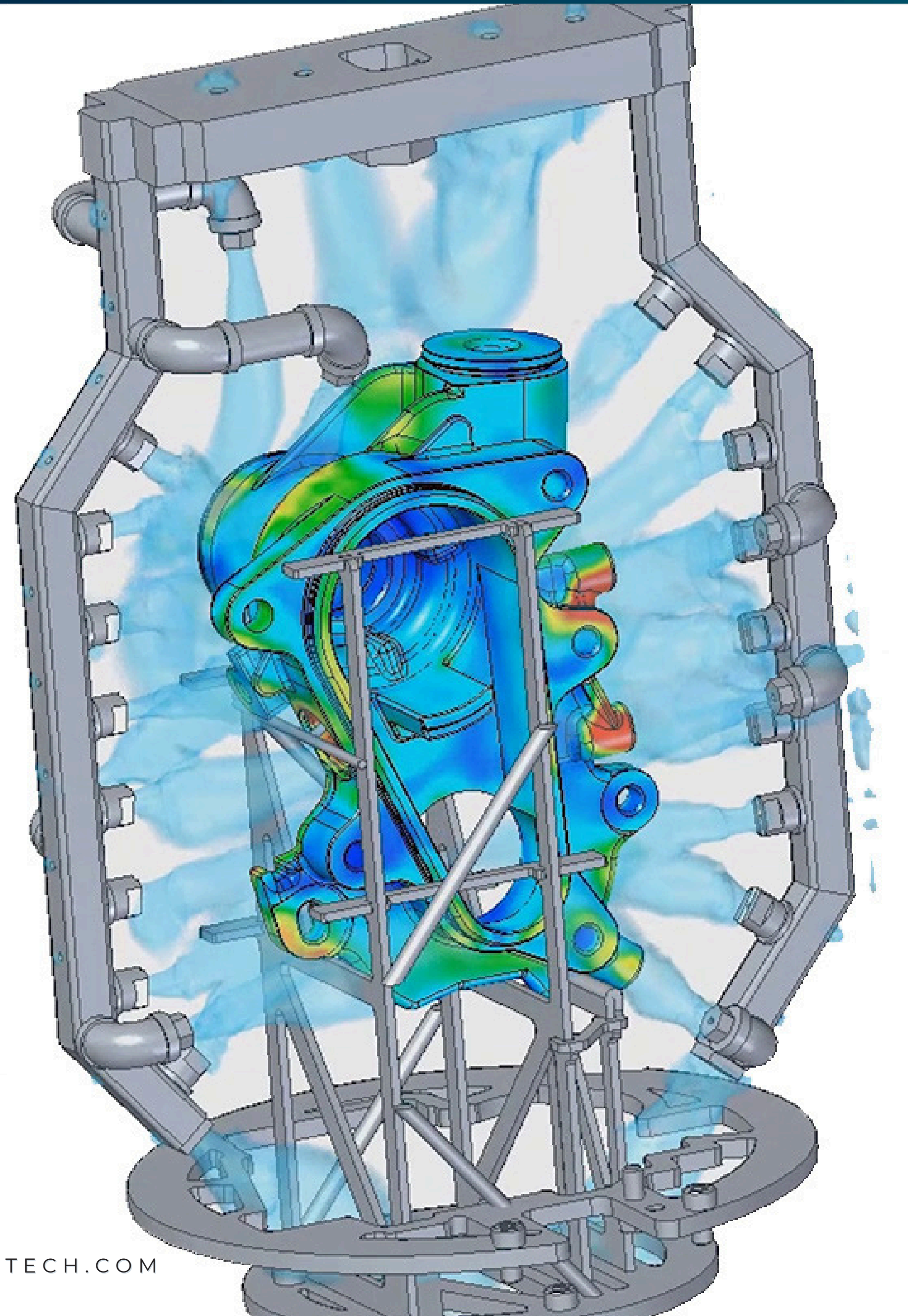
Virtual validation is the process engineers and designers follow using computer-aided design (CAD) and CAE to implement a 3D version of a product to test and approve validity. This includes simulation of products in multiple environments and conditions to make sure they work properly.

As manufacturing processes increase in complexity, virtual validation can help companies plan, design and implement their systems before investing significant capital.

Virtual validation benefits include:

- Reduced time-to-market
- Reduced costs
- Optimized product or machine performance

Engineers can help optimize cost by using better materials and reducing the number of physical prototypes.



Best practice No. 3 –
select the solution that fits into your existing processes

By using the right tool to front-load CFD, you can significantly shorten your simulation time and achieve a more competitive engineering design process. Front-loaded CFD solutions significantly compress analysis time – some organizations have reportedly reduced time by 75 percent. Front-loaded CFD solutions offer key proven technologies that greatly reduce model preparation and preprocessing, such as:

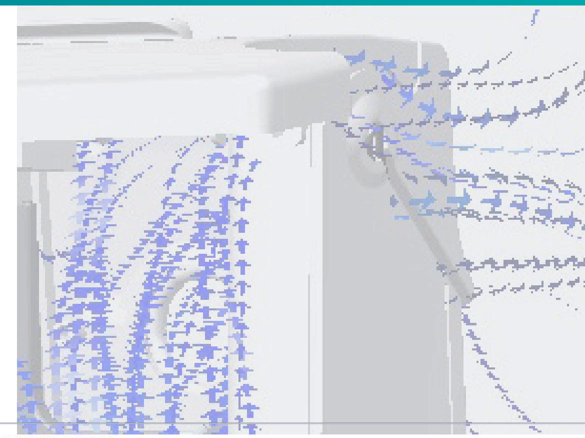
• Software that is fully embedded in CAD uses the same native geometry for analysis. Exporting data and heal- ing it in preparation for analysis is no longer required. Additionally, the software does not require you to learn a new interface or to be familiar with the interface every time the software is used. CFD analysis is simply another functionality offered by the CAD package

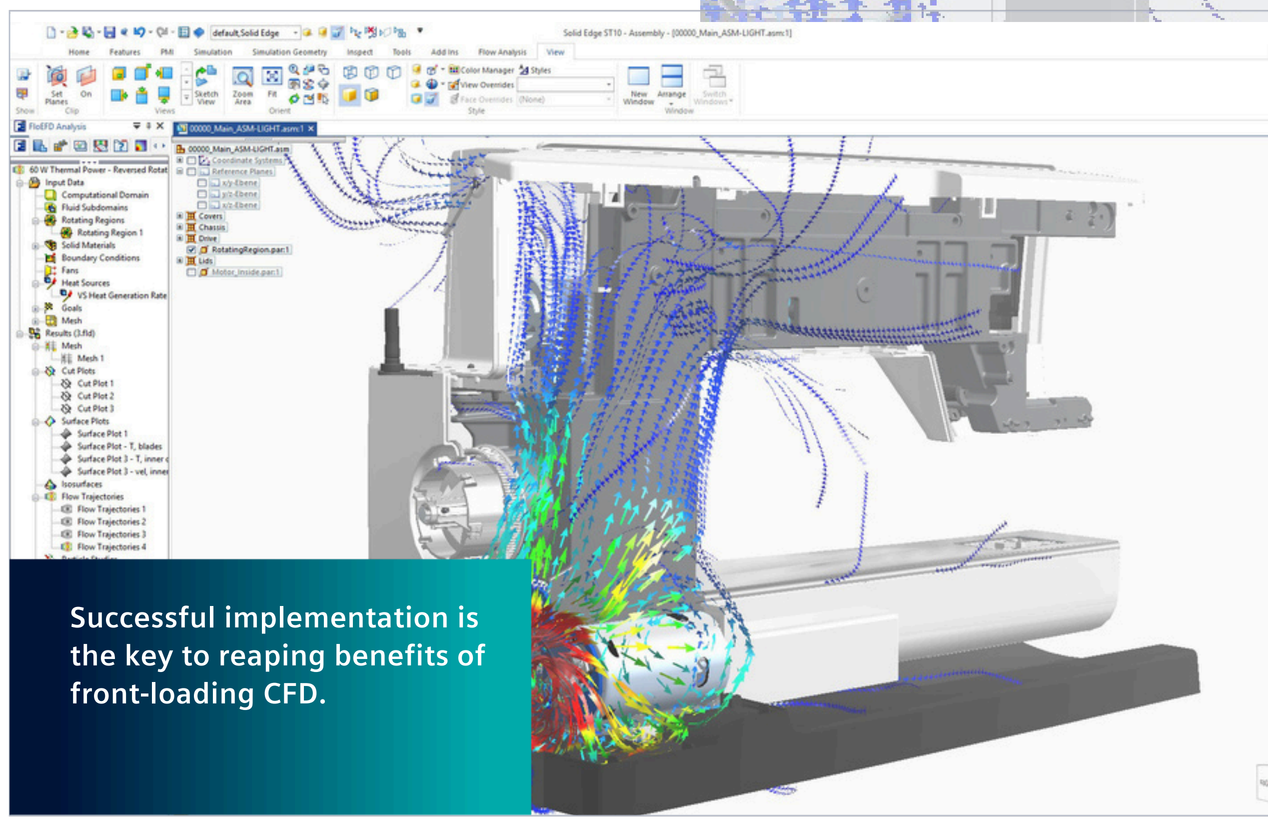
• In fluid-flow and heat-transfer analysis, we are interested in understanding what is happening in the negative space (empty space). With traditional CFD, additional geometry must be created to represent that cavity. Front-loaded CFD solutions are intelligent enough to recognize that empty space is the fluid domain, so no time is wasted creating geometry to accommodate software. This step is completely unnecessary

• Before analysis can begin, the model must be meshed. With traditional CFD, the engineer must be fully conversant in which algorithm best depicts the flow phenomenon being studied. Front-loaded CFD solutions have a fully automated mesher that will automatically generate the best possible mesh for the problem being set up. The software has built-in intelligence that makes it possible to use even coarse meshes without sacrificing accuracy

However, not all CFD tools can be front-loaded. For exam- ple, the CFD software used during the verification stage is not a good candidate for front-loading. This can be seen by reviewing the traditional CFD process where the CFD code receives geometry from a stand-alone CAD system versus a CAD-embedded one.

The key success factor is selecting the right solution that offers the right combination of application-specific functionality and fits into existing engineering processes without disruption.



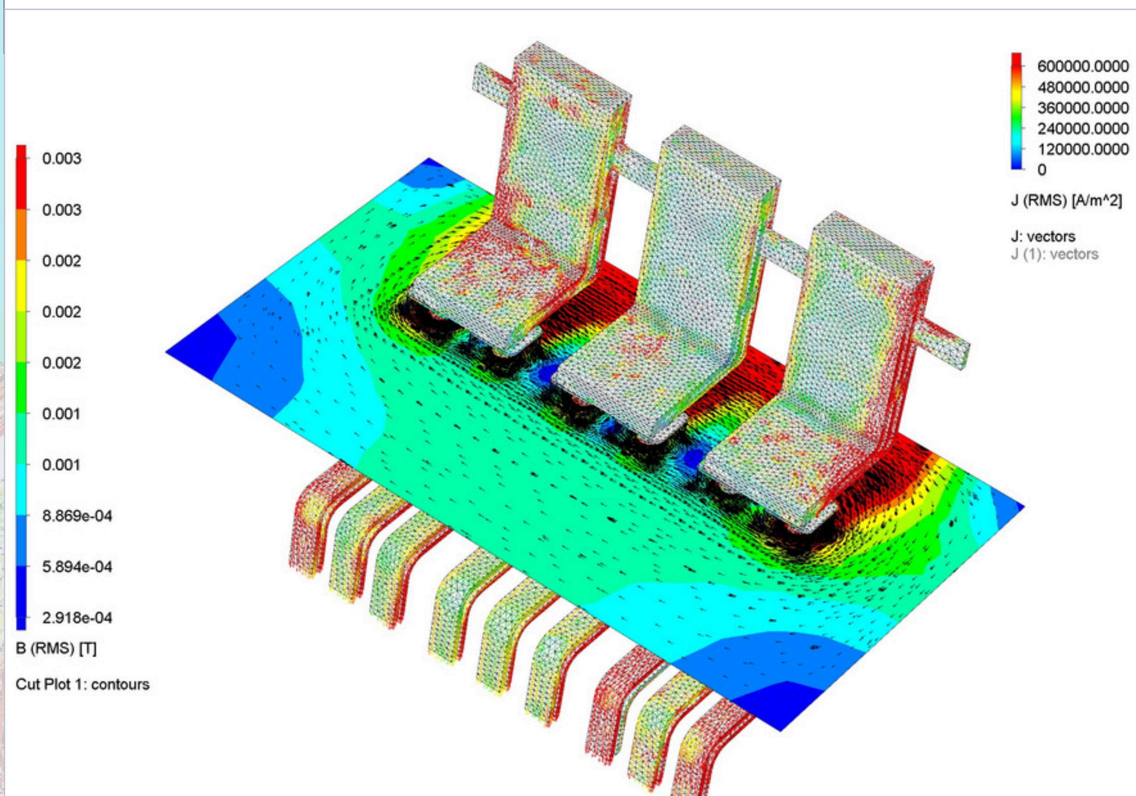


Successful implementation is the key to reaping benefits of front-loading CFD.

Best practice No. 4 –
front-load CFD to increase engineering productivity

Organizations that have successfully implemented front-loaded CFD do not need to reimagine their engineering process to benefit from it.

Traditional CFD tools are crammed with technology that requires advanced training and education, which is why dedicated analysts are usually assigned the task. For example, most traditional CFD tools support many types of meshing algorithms. The engineer must know which one is the most appropriate for the specific application. Additionally, they must work on the mesh until it is optimal for the model and application. In short, using traditional CFD tools can be extremely time-consuming and slower than what is needed during the design stage.



Front-loading CFD simulations directly on 3D CAD models eliminates these traditional challenges. The most efficient CFD approach is based on two principles:

- Using native CAD as the source of geometry information
- Synergy of full 3D CFD modeling with simple engineering methods when grid resolution is insufficient for full 3D simulation

Many leading manufacturers have abandoned the old serial design system, where various functions work along a continuum, and have shifted to a multi-disciplinary product design process that requires integrating multiple authoring systems and processes. Therefore, designers need access to multiple tools across mechanical and electric/electronic domains to enable timely delivery of products that meet customer specifications.

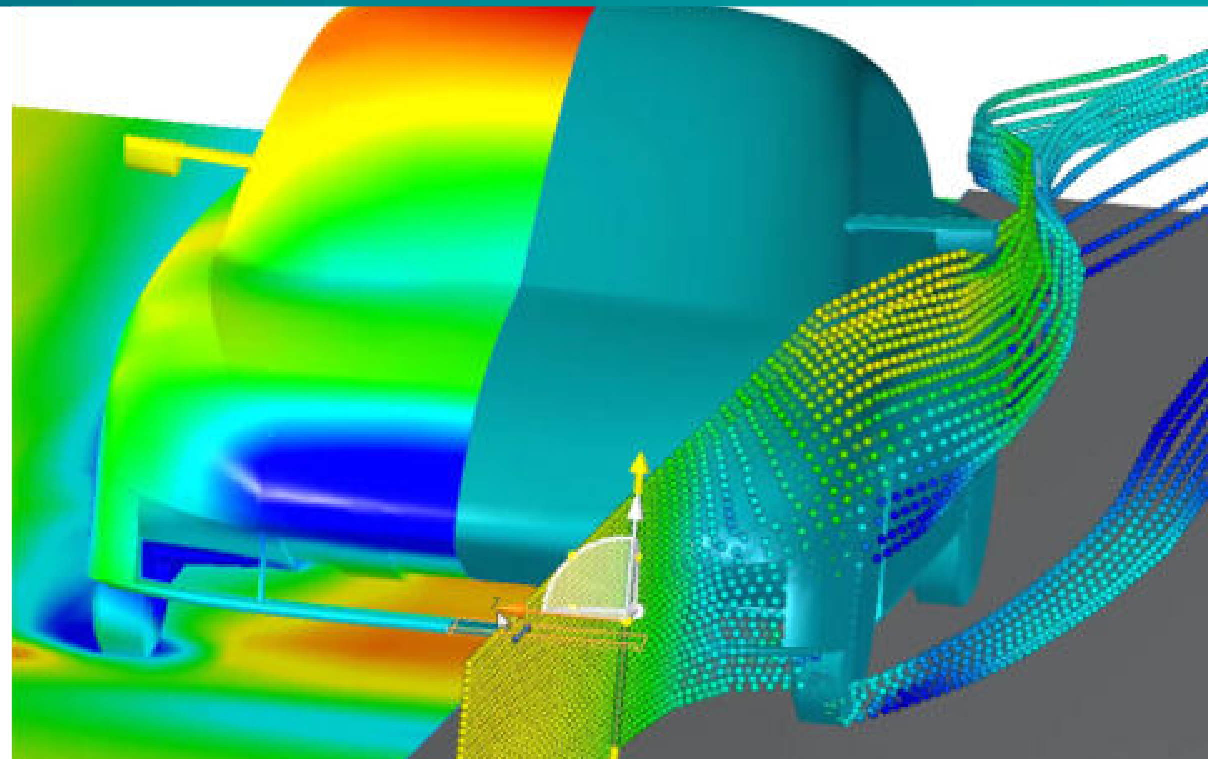
This complex environment requires a high level of interdependencies to function effectively. Despite this complexity, organizations that have successfully implemented front-loaded CFD do not need to reimagine their engineering process to benefit from it.

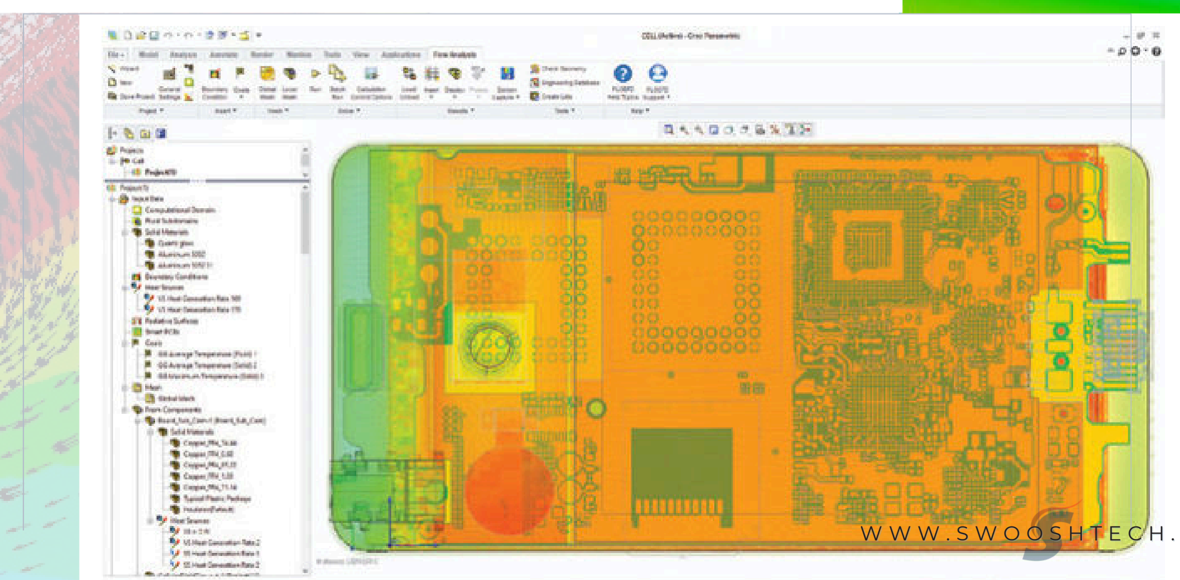
Best practice No. 5 – use embedded CFD in CAD environments

All CFD simulations use CAD models, geometry preparation including CAD clean-up and repair, meshing, solving, postprocessing and report- ing. However, each type of software deals with this process differently. The traditional process requires stepping inside and outside of the CAD package and repeatedly returning to the CAD tool with inherent risks of geometry approximations coming into the CFD simulation. Since design is iterative in nature, this process must be repeated for every geometry change. In comparison, CAD-embedded CFD is contained in the CAD software – all geometry changes take place inside the CAD environment.

CFD analysis in CAD efforts provides benefits throughout the product's manufacturing process. The top objectives for using fluid simulation as a design tool include:

- Meeting product requirements
- Avoiding downstream development delays and costs
- Satisfying customer contractual obligations or regulatory requirements
- Reducing product lifecycle costs
- Minimizing product costs





CFD analysis in CAD efforts provides benefits throughout the product's manufacturing process.

Simcenter FLOEFD for Solid Edge is the ideal tool

Simcenter™ FLOEFD™ software, introduced to the market in 1991, is used by thousands of engineers to front-load CFD in the design process. This is a part of the Xcelerator portfolio, the comprehensive and integrated portfolio of software and services from Siemens Digital Industries Software. The award-winning Simcenter FLOEFD will not disturb or require modification of the workflow. Simcenter FLOEFD fits in the process without any disruption. It provides increased flexibility to test many design ideas in less time when the project's research and design (R&D) cost is lower and flexible. It helps the design team increase efficiency by discarding suboptimal ideas sooner and lets the analyst team focus on solving more complex analysis problems and rapidly complete verification.

Conducting analysis with Simcenter FLOEFD is significantly fast. Using Simcenter FLOEFD for Solid Edge® software is rapid due to its intelligent automation, use of the CAD environment and ease-of-use. Simcenter FLOEFD is embedded in Solid Edge. Designers have reported being able to use the software with less than eight hours of training, which is much less than traditional CFD programs that may require up to 12 months of training to use the software productively.

Since the engineer operates Simcenter FLOEFD in the Solid Edge CAD environment and uses native geometry, data does not need to be transferred out of the CAD environment. The model is immediately available for analysis, which saves time and effort. Wizards, plain engineering language and extensive libraries further enhance the experience and enable the designer to set up models quickly and effortlessly. Its automatic mesher allows the designer to mesh the model with minimal intervention. Additionally, the software automatically recognizes the fluid region.

Simcenter FLOEFD for Solid Edge also makes it easy to analyze multiple variants of the design. The designer simply modifies the model in CAD and Simcenter FLOEFD for Solid Edge automatically attaches the previously set analysis information, including boundary conditions and material properties, to the new variant. Upon re-meshing, the model can be analyzed again.

Accurate and fast – Simcenter FLOEFD is the perfect solution for front-loading CFD.