Altran Italia

Focus on Asking the Right Questions – Exploring the Design of a Medical System with Rapid 1D System Simulation

About the Customer

Altran is a leading global engineering consulting company. With 46,000 employees and operating in more than 30 countries, Altran offers its services in the Automotive, Aerospace, Energy, Healthcare & Electronics sectors among others. A longtime Altair customer, Altran recently adopted the system modeling solutions offered with Altair Activate® and Altair Compose®. Taking advantage of the Altair Units licensing system, it was easy for them to explore different designs by trying and using new Altair tools. "With the Altair licensing system, we were able to just open Activate without requesting a trial license, and even to fully adopt its use. Being Altair users was enough," stated Mario Carbonaro, CAE Consultant at Altran.

In one of their recent projects, Altran engineers designed a fluidic circuit for a hemodialysis system. One of the main requirements for hemodialysis is to maintain the temperature of the dialysis solution stable while it is flowing through the device. To achieve this, Altran engineers investigated different layouts and optimal parameters for the fluidic system to minimize heat loss.

The initial modeling and simulation, done with a 3D CFD solution, involved detailed FEA-based computation providing high accuracy results but with the cost of high simulation time. Furthermore, the length of the device (15m) made the simulation in 3D quite complex with a model of over 7 million elements. Since the number of potential layouts and many parameter values required a large number of simulations to optimize device performance, the Altran engineers were motivated to reduce solving time.

To achieve this, they decided to use a reduced order model (ROM) of the system based on a block-based modeling approach in Activate, implemented in three phases: a) Validating the block-based modeling approach; b) Comparing Activate models to experimental data; c) Optimizing layout and parameters.

Industry
Healthcare

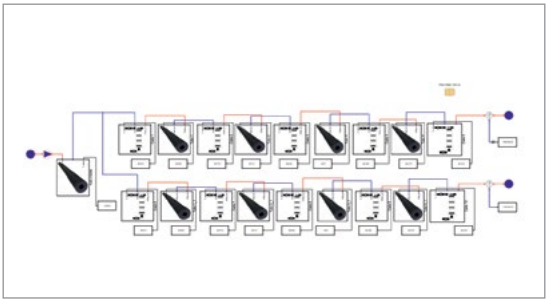
Challenge
Investigating different layouts and optimizing design of a fluidic circuit of a hemodialysis system to minimize the thermal losses and maintain a stable temperature

Altair Solution
Reduction of simulation time by using Altair Activate to create Reduced-Order Models of the circuit components, quick identification of optimal design parameters

Benefits
- >90% Simulation time reduction
- Maintaining accuracy
- Minimal thermal losses through simulation of significantly altered topologies

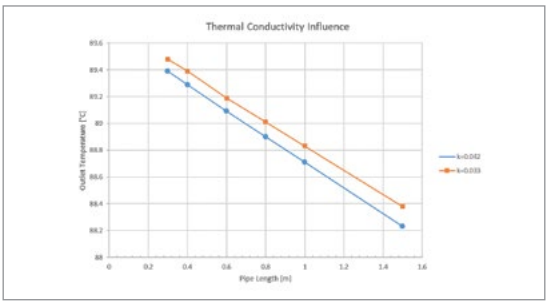
From 3D Simulation to 1D Optimization

Before designing the system in Activate, they created a simple 1D block-based pipe model to compare it to a 3D equivalent model and verify it. The error margin, ranging between 0.01-0.03%, validated the Activate block-based model and they were able to proceed to modeling the fluidic system. In the next development phase, they created ROMs of the components of the fluidic system and compared the Activate results with the experimental results for different topologies. With the modeled components, they were able to quickly investigate different layouts and optimize the parameters for their system.



Improved 10-cell topology with two 5-cell circuits in parallel

After their simulations helped them know that thermal conductivity as well as the use of valves both have low impact on the outlet temperature, Altran engineers confirmed that the main parameter affecting the heat loss was the pipe length. They were thus able to experiment with different topologies with the aim of reducing the total system length. To further refine their designs, they improved the system performance by investigating the influence of the inlet pipe length and an asymmetry in the length of a parallel cell system.

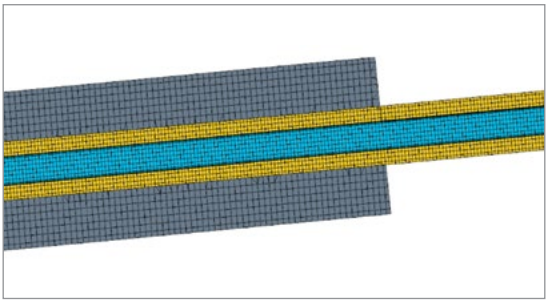


Main parameter affecting the heat loss is the pipe length

"Not only did we see a significant decrease of the simulation time, but to remodel we just needed to change the parameters in the diagram. Trying different topologies was just easy. We only needed to focus on asking the right questions."

Mario Carbonaro
CAE Consultant, Altran

Through this multitude of simulations, they concluded that for a 10-cell system, it is preferable to use two 5-cell topologies in parallel and also found the optimal parameters for this design. "We were able to use the simplified component models as building blocks and find the optimal layout for our system. Using reduced-order models, the time cost for each simulation was low, making it easier for us to explore different designs," stated Mario Carbonaro.

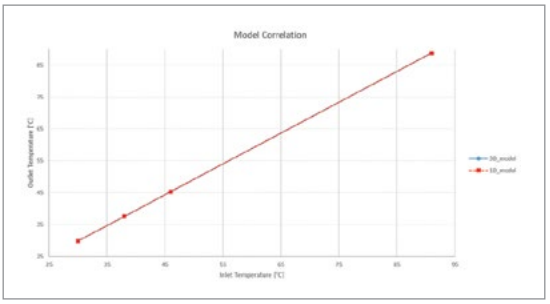


7-million-element CFD model

"We rely on simulation to help us confirm that our designs will perform as intended, and to explore more design ideas in less time. The significant speed-up that we have achieved with Altair's 1D systems simulation technology is helping us to develop better hemodialysis products, faster, so we can achieve our aggressive time-to-market goals," said Marco Morone, Advanced Solution Manager at Altran.

Quicker Simulation Leads to More Solutions

Altair Activate, with a complete set of blocks aimed at creating reduced-order models but also with native support for 3D co-simulation, provides a quick and streamlined transition from 3D to 1D block-based models. The adoption of 1D solutions, while verified by detailed 3D FEA models, not only decreases solving time but also the time to remodel.



The error margin of the 1D diagram compared to the 3D model results is maximum 0.03%.

While comparing the 7-million-element 3D FEA pipe model to the block-based equivalent model in Activate, Altran engineers noted a simulation time of 30 minutes on a dedicated server using CFD tools versus 50-60 seconds using Activate on a local machine. This 30x decrease of the solving time together with the decrease of the time needed to change the layout of the system allowed them to increase the number of designs they considered by 1000% (from 5 to 55) and ask questions that would normally have a tremendous time cost for the design process.

Visit the Altair Library of Customer Stories at altair.com