rescale

DENSO Partners with Sorbonne University to Accelerate FreeFEM Simulation and Streamline Industrial Product Manufacturing on Rescale

Case study

Headquarters: Kariya, Aichi, Japan

Industry: Automotive component and systems manufacturing

Founded: 1949

Reduced Costs of Prototyping and Simulation

75% Reduced Simulation Time

50% Reduced Product Development Time

Building on a Legacy of Automotive Innovation

DENSO, a leading automotive and Fortune 500 company, operates globally in 35 countries and regions around the world and manufactures a wide variety of components. Additionally, in its non-automotive business, DENSO is working to industrialize smart agriculture using factory automation and sensing technologies. Within the thermal management systems team, a core businesses at DENSO, new initiatives are underway to respond to electric vehicles and automated driving. Mr. Hiroshi Ogawa of DENSO's Heat Exchanger R&D Division explains how this differs from conventional thermal systems:

"In conventional gasoline-powered vehicles, the engine is used as the heat source to heat the cabin. In the case of electric vehicles, using battery power for heating affects electric power consumption when driving. In addition, batteries have an optimum operating temperature, which affects their performance and service life. On the other hand, in automated driving, heat generated by the computer that controls the vast number of sensors becomes a problem. We are developing technology to improve electric power consumption by using heat pumps to effectively utilize heat generated from the air and various devices, as well as technology to precisely control battery temperatures. The development of thermal systems for electric vehicles requires new technologies and methods."

Product development for thermal systems in electric vehicles involves the development of a key element of the thermal system, the product development in the thermal systems requires unconventional technologies and methods. It is essential to consider a variety of factors when undertaking new designs. Because of the limitations of manual checking through prototyping, simulation is becoming even more important to improve development efficiency. Mr. Ogawa has championed the development and promotion of simulation methods and tools in the Heat Exchanger R&D Division, which develops heat exchangers used in air conditioners and radiators, key components of thermal systems, and he describes the difficulties of utilizing simulation.
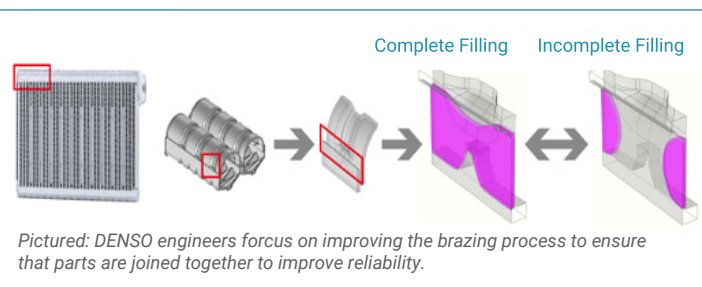
Getting Started on Rescale with Just a Few Clicks

"We were immediately surprised at the ease of use of Rescale ScaleX for COMSOL multiphysics calculations, which can be run with just a few clicks. The amount and cost of computing resources can be controlled according to simulation usage. Rescale ScaleX allows us to build our ideal simulation environment, which is ideal for our various needs," said Mr. Ogawa.

In addition to Rescale, Mr. Ogawa said the company also evaluated FOCUS, a supercomputing service that had previously been used in-house at DENSO. "FOCUS is a supercomputer for industrial use that can be shared by multiple users, but its computing resources are limited, and it is sometimes booked up when engineers need it. We chose Rescale ScaleX because of its ability to provide us with computing resources on-demand as needed for development."

In September 2017 the Heat Exchanger R&D Division selected Rescale and began to implement it, following necessary security checks and setting up their existing software licenses in a license server on Rescale ScaleX. DENSO's engineering and IT teams leaned on the support of Rescale and its partners to arrange documentation to ensure compliance with the automotive industry association's guidelines for the use of cloud services, as well as to develop the network and data security. The Heat Exchanger Development Division provided one hour of education to designers on Rescale ScaleX, with overseas members participating online. The system can be easily operated with a web browser, so once mastered, all development members are using it without any problems," said Mr. Ogawa.

Figure 1 - Focused on Optimizing Engineering Processes

Complete Filling   Incomplete Filling

Pictured: DENSO engineers forcus on improving the brazing process to ensure that parts are joined together to improve reliability.

Streamlining FreeFEM on Rescale ScaleX

Performing parallel calculations with commercial simulation software is fraught with high licensing costs. So in 2019, DENSO chose to pursue the use a culmination of many open-source software for large-scale parallel calculations and without licensing costs.

The Heat Exchanger R&D Division collaborated with Dr. Atsushi Suzuki of Cybermedia Center, Osaka University, Japan to conduct simulations using an open-source software for finite element method, FreeFEM*, which is developed and maintained by the J.-L. Lions Laboratory at the Sorbonne University, France. Dr. Suzuki of Osaka University is a former researcher at J.-L. Lions Laboratory and is well-versed with FreeFEM. Open-source software is often a culmination of multiple software. As a result, the process of properly installing open-source software can be complicated, and the GUI is often not as user-friendly nor well-organized as commercial software, making it difficult for engineers to use.

FreeFEM is mainly used by simulation specialists, and is expected to be applied to industrial fields in the future. To achieve this, we want to implement FreeFEM on Rescale ScaleX. "The team had been using FreeFEM mainly for simulation specialists, and was considering expanding the application of FreeFEM to other industrial fields, and we wanted to implement FreeFEM on Rescale ScaleX to make that possible," said Mr. Ogawa. Development began under the guidance of Dr. Suzuki and with the cooperation of Prof. F. Hecht and Dr. P. Jolivet, who are main developers of FreeFEM and with help of Rescale, and it has been finished successfully. Another challenge for improving usability is to develop an intuitive graphical interface for FreeFEM, which consists of script-based software and is run by the command line. This is carried out in collaboration with Airthium, a member of the FreeFEM development team and results in TANATLOC, software.**

Solution Impact: Driving Engineering Agility

One year after the Heat Exchanger R&D Division deployed the FreeFEM environment implemented on Rescale, the team had achieved dramatic improvements in simulation speed. Mr. Ogawa commented, "Designers, including those at overseas sites, are now running FreeFEM simulations from their own PCs using the
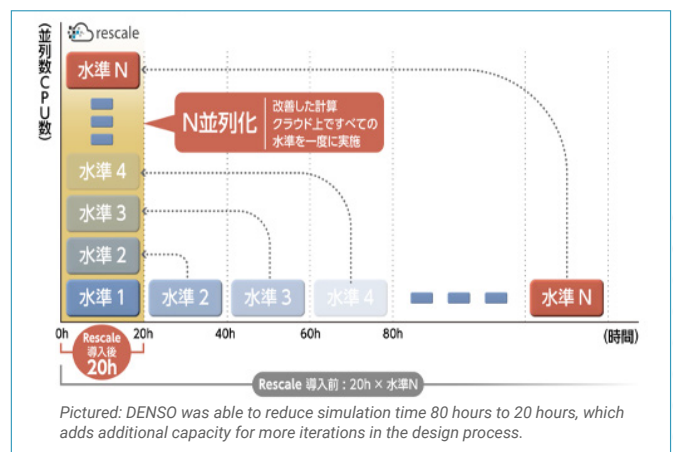
* Learn more about FreeFEM at www.freefem.org
** TANATLOC is currently in beta version. Airthium plans public launch in 2022. Learn more at www.airthium.com

computing resources of Rescale ScaleX, without having to worry about where to submit their jobs. Having a friendly GUI tool for FreeFEM has been very well received, allowing users to set up calculation conditions and submit them in about five minutes."

"In the development of heat exchangers, we were able to significantly reduce the number of prototypes by using simulation. This has led to significantly reduced costs shorter development times and has contributed to the company-wide goal of halving the number of development man-hours. In addition, when we come up with a hypothesis, we can immediately check it through simulation to expand our ideas. We will continue to develop and invest in engineering tools that accelerate product development, like Rescale, which ultimately help us to drive the best products."

Following the successful deployment of Rescale ScaleX in the Heat Exchanger R&D Division, DENSO is now working to combine its in-house on-premises HPC with cloud resources through Rescale ScaleX to utilize its computing resources most efficiently. By downsizing the in-house on-premises HPC and making Rescale ScaleX available seamlessly during periods of concentrated development, the company aims to optimize the overall computing efficiency. As DENSO deploys more commerical and proprietary software on Rescale ScaleX, they will be able to expand their use of Rescale ScaleX, leading to greater convenience and efficiency for designers and increased product quality.

Figure 2 - Parallelizing Workflows to Accelerate Results

Pictured: DENSO was able to reduce simulation time 80 hours to 20 hours, which adds additional capacity for more iterations in the design process.