SIEMENS

DIGITAL INDUSTRIES SOFTWARE

Leveraging the virtual tow tank template

Automating advanced CFD simulation to perform resistance, powering and hull optimization studies

siemens.com/simcenter

Introduction

Workflow automation reduces the learning curve and embeds best practices, enabling you to get your simulation work done faster. For example, say you need to quickly analyze a new hull design and compare results to towing tank experiments. The most expeditious way to achieve this is by using a dedicated simulation template.

Simcenter™ STAR-CCM+™ software has a full suite of tools so you can automate processes and workflows and create simulation templates. These templates allow for repeatable workflows that can be created by experienced analysts and passed on to design engineers to make engineering decisions. Using simulation templates can eliminate most of the manual processes involved in building a computational fluid dynamics (CFD) simulation via a parameterized template model by boiling down the simulation to its minimal set of inputs. From there, all meshing calculations, boundary conditions, solver settings and postprocessing can be applied so simulations are repeatable and embedded in your organization's best practices. The templates use tools that are built into the software so they can be updated when desired; they are not black box tools you get from your software provider.

One such template dedicated to marine is the virtual tow tank (VTT) template, which is available on the customer portal free of charge as a baseline for performing marine simulations. The template can be used to perform hull resistance or power simulations of displacement ships at full or model scale.

This template simplifies the simulations of their primary inputs: the hull geometry, fluid properties, desired speed and vessel draught. Every other decision in the simulation setup is embedded in the template with Siemens Digital Industries Software's recommended best practices.

Custom tree and simulation guide

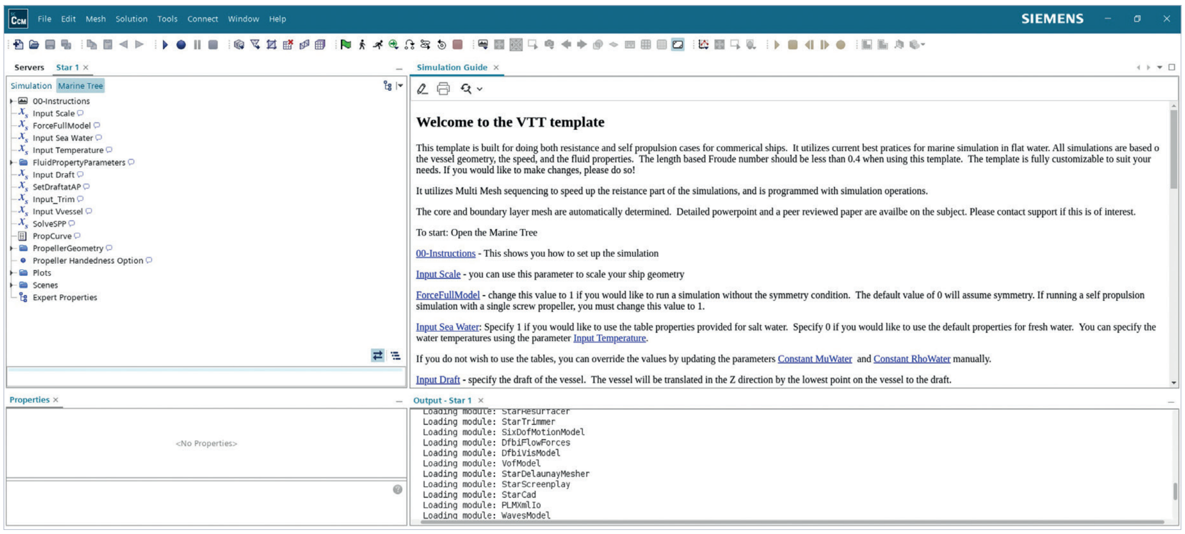

Figure 1. Upon opening a simulation template, you will have access to a simplified simulation tree and simulation guide so you can easily understand the template.

When a user loads the template, a user-created simulation guide and custom tree are populated. The guide gives the user instructions on what they can change in the simulation and what each thing does. The guide is linked to the inputs within the simulation. The simplified tree provides a user with the key inputs and outputs of the model, which makes for a more streamlined setup process.

The process

Instructions

The custom instructions tab allows the user to visualize all the inputs in an interactive scene. The vessel length dimensions, scale factor, orientation, Froude number, draught and propeller geometry (if included) can be visualized as the inputs to the simulation in a single place.

The scene also provides the setup process, which includes importing the hull. The hull can be any supported computer-aided design (CAD) type or linked to any of our supported CAD client models.

Fluid properties for both fresh and salt water are included in table form. The user can simply specify the water type and temperature to select the appropriate fluid properties or input the desired properties if preferred.

The user can specify a scaling factor. For example, if you have CAD data for a full-scale model, you can quickly enter the scale factor if you want to perform a model scale simulation.

The draft of the vessel is specified by the user. From here, hydrostatic calculations are automatically performed to determine the vessel's center of gravity and mass properties.

The user can perform a half-model analysis if the hull is symmetric or a full-model analysis if the hull is asymmetric.

The simulation will perform a bare hull resistance analysis by default. The user can also run a powering estimation with a set of user inputted propeller curves with the virtual disk model.

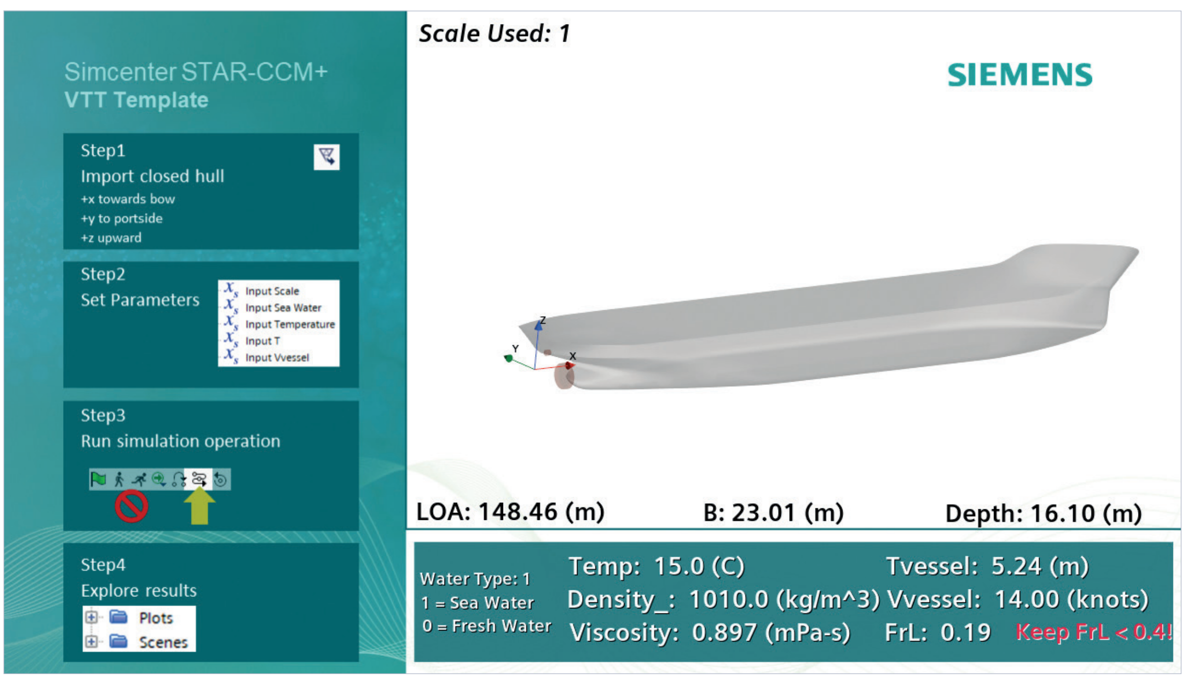

Figure 2. The instruction scene provides a single point of visualization of simulation inputs.

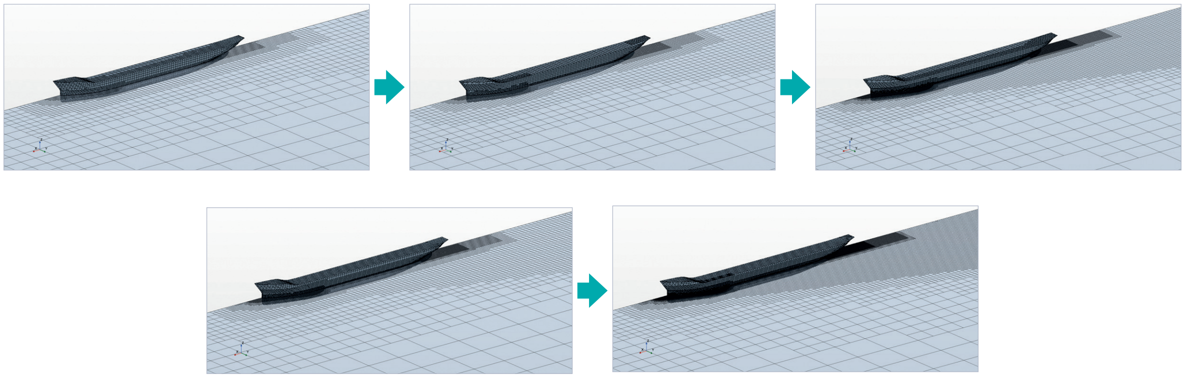

Figure 3. Illustration of MMS sequencing grid refinement.

Running the simulation

A set of simulation operations is embedded in the model. These operations are a step-by-step process that is embedded in the simulation file. The operations will determine all the meshing sizes, places for refinement and where to apply the boundary conditions, and will apply all the relevant solver settings and stopping criteria.

The use of simulation operations also allows for multi-mesh sequencing (MMS), which is a systematic refinement of the mesh. This allows the simulation to quickly converge the flow field with a coarse mesh to speed up the overall running process. As the simulation converges, it automatically refines the mesh, maps the previous solution to the mesh and continues the run. This process is repeated systematically until the final mesh discretization is reached. On average, this process improves the run time by a factor of 4 compared to running the model only on the final grid.

Postprocessing

Reporting for key metrics such as resistance, trim, heave or shaft power can be set up ahead of time. Field data such as friction coefficients, pressure coefficients and generated wave elevation can be shown in predefined scenes and exported to PowerPoint with the use of a macro. Key information such as local wake fraction can automatically be exported to comma-separated values (CSV) data to be read into other software packages for further analysis.

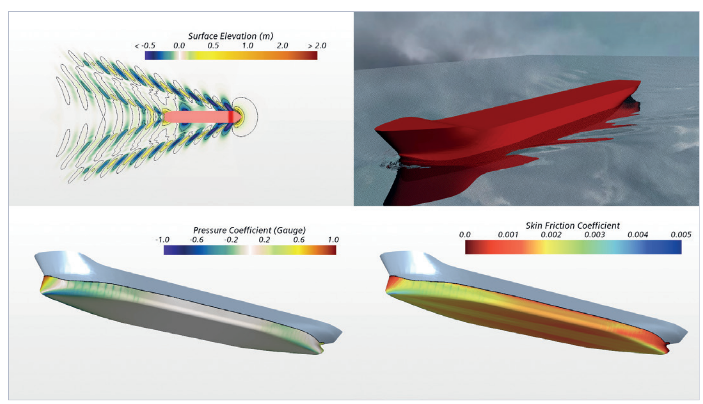

Figure 4. Layout view of various automated postprocessing visualizations.

Design exploration

The template is fully parametrized, meaning that any type of design exploration study can be implemented with the use of our Design Manager tool.

Resistance and powering versus speed curves
A common type of study would be generating resistance or powering versus speed curves. This can be done by using the Simcenter STAR-CCM+ design manager tool to save the simulation template with the hull geometry in it and creating a design sweep across the desired speed range. The full resistance or powering versus speed curves can be automatically generated and all visualization can be easily accessed within a single environment. Furthermore, if you have enough computing power, all designs can be run in parallel, allowing for the curves to be generated in the same amount of time it takes to perform a single simulation.

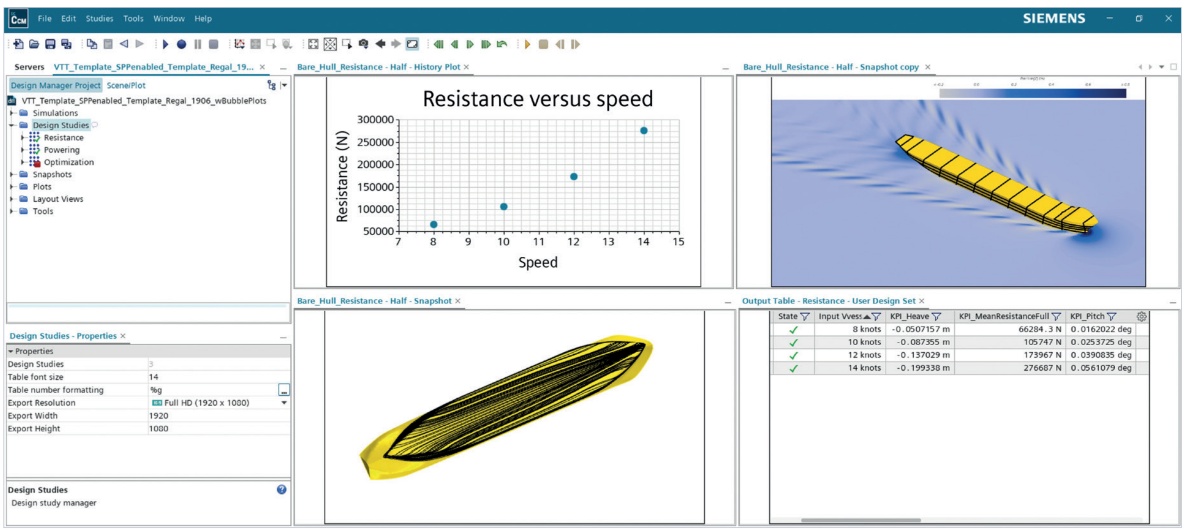

Figure 5. Using the Simcenter STAR-CCM+ Design Manager in a VTT template to execute a resistance-versus-speed analysis.

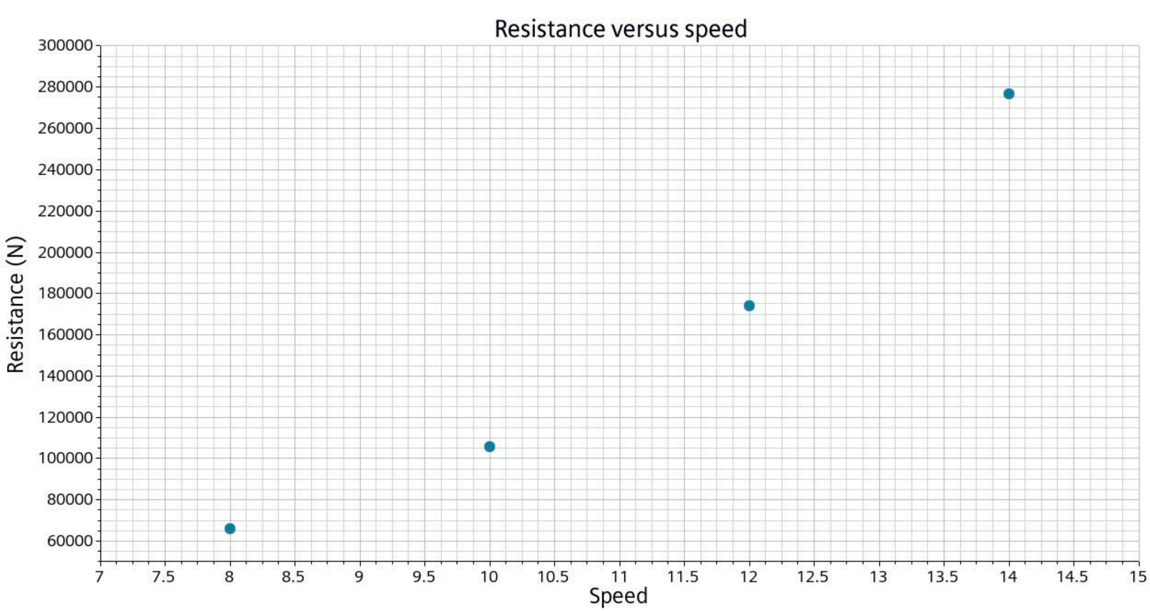

Figure 6. Alternate resistance-versus-speed curve.

Hull optimization

The template can also be used for hull optimization studies. The input CAD can be linked to a parameter and discrete hull forms can be studied. Alternatively, if you have a parameterized CAD model, you can link the model to a design manager optimization study via the use of our CAD clients if using one of the supported CAD packages, such as Siemens' NX™ software. If you use a different CAD package, such as Rhino, you can link your hull forms via HEEDS™ software.

Better together

Our support staff can help guide you through the template creation process, or if you are not comfortable creating or modifying a template yourself, you can work with Simcenter Engineering and Consulting services to create custom, tailored templates for more advanced applications.

Simcenter, Simcenter Engineering and Consulting services, NX and HEEDS are part of the Siemens Xcelerator business platform of software, hardware and services.

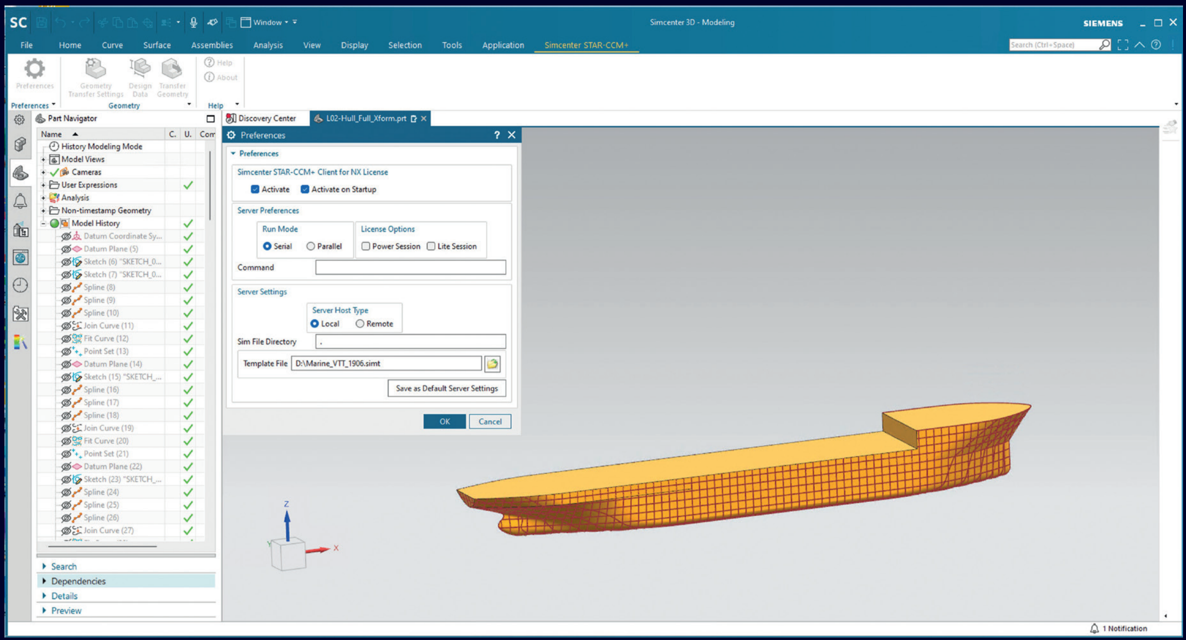

Figure 7. Import parameterized hull forms into the template via CAD clients for hull optimization.

Conclusion

Simulation templates, such as the VTT template, are powerful tools that will increase the productivity of your organization. By embedding your organization's best practices for performing simulations, automated workflows deliver repeatable simulations regardless of the user. The templates are geared toward design exploration studies, giving you the power to harness advanced CFD simulation to perform resistance, powering and hull optimization studies.

Siemens Digital Industries Software helps organizations of all sizes digitally transform using software, hardware and services from the Siemens Xcelerator business platform. Siemens' software and the comprehensive digital twin enable companies to optimize their design, engineering and manufacturing processes to turn today's ideas into the sustainable products of the future. From chips to entire systems, from product to process, across all industries, Siemens Digital Industries Software – Accelerating transformation.

Americas: 1 800 498 5351

EMEA: 00 800 70002222

Asia-Pacific: 001 800 03061910

For additional numbers, click here.

86352-D7 11/24 H