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Simcenter 3D for fluid dynamics simulation

Providing insight for flow in complex assemblies

Solution benefits

- Accurately solve the Navier-Stokes equations that describe fluid motion
- Speed up the preprocessing time for CFD analysis by rapidly creating fluid domain geometry and meshes from complex assemblies
- Achieve faster CFD results by using a consistent environment that allows you to quickly move from design to advanced CFD results
- Couple 1D to 3D flow submodels to efficiently simulate complex systems
- Integrate CFD solution with the broader Simcenter 3D platform to streamline simulation processes by 70 percent
- Speed solution time using parallel flow calculations

Simcenter™ 3D software offers a comprehensive set of sophisticated tools to model and simulate fluid flow for complex parts and assemblies. The integrated computational fluid dynamics (CFD) solution enables fast and accurate fluid-flow simulation and provides insight into product performance during all design development phases, limiting costly, time-consuming physical testing cycles.

A powerful and robust CFD solver

Siemens Digital Industries Software's Simcenter 3D fluid dynamics modules combine the power and accuracy of the well-established control-volume formulation with cell-vertex formulation to discretize and efficiently solve the fluid motion describing Navier-Stokes equations. The Simcenter 3D fluid dynamics solver employs a robust algebraic multigrid solution scheme in combination with multiple first and second order discretization options and time integration schemes to deliver a capable and fully integrated CFD solution. Within the Simcenter environment, it also uses an immersed boundary, flux-based halo-node approach for quick and easy thermal-flow evaluation.

siemens.com/simcenter3d

Simcenter 3D for fluid dynamics simulation

Rapidly create fluid domains

Automatically and rapidly extracting fluid domains using traditional Boolean operations, surface wrapping and defining immersed bodies helps improve CFD analysis productivity. Treating dissimilar fluid meshes at interfaces between parts allows the user to quickly investigate many what-if simulation scenarios involving complex assemblies.
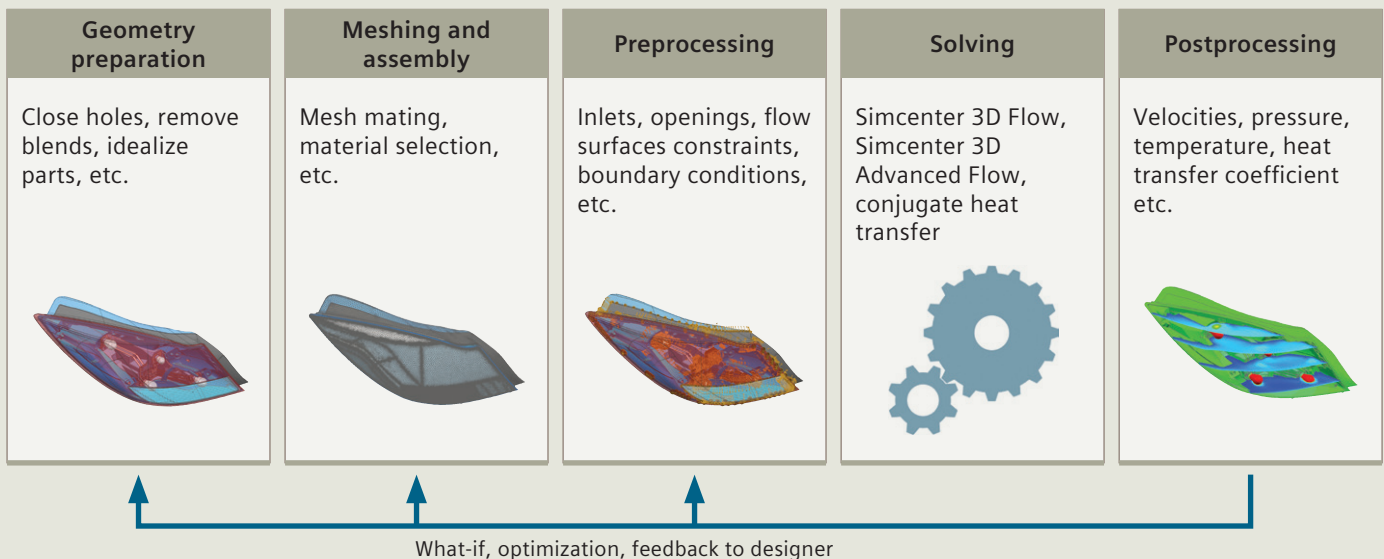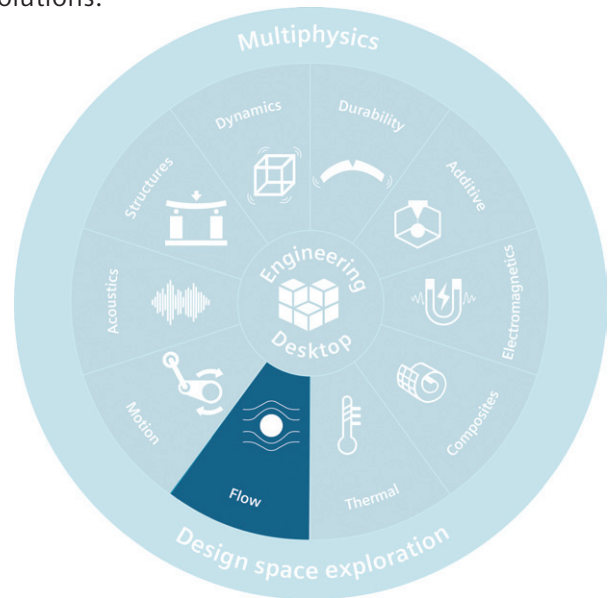
A strong coupling with thermal solver

The flow and thermal modules of Simcenter 3D can be seamlessly coupled. CFD and thermal models can be created separately and then combined by simply dragging and dropping the boundary conditions into the coupled simulation. This provides a powerful and easy-to-use solution for applications that require explicit modeling of CFD along with detailed thermal analysis.

A dedicated tool for electronics system cooling

Simcenter 3D Electronic Systems Cooling provides a fully associative end-to-end electronics thermal design capability. Changes in the electronics computer-aided design (ECAD) can be seamlessly propagated to the thermal/CFD model to recover the new system temperatures and airflows.

Providing a platform for multidiscipline simulation

The Simcenter 3D fluid dynamics solution is part of a larger, integrated multidiscipline simulation environment with the Simcenter 3D Engineering Desktop at the core for centralized pre-/postprocessing for all Simcenter 3D solutions. This integrated environment helps you to achieve faster CAE processes and streamline multidiscipline simulations that integrate flow and other disciplines like aero-vibro-acoustics that requires acoustics and structural solution, fluid-structure interaction or thermal coupled problems that require thermal solutions.

Geometry preparation	Meshing and assembly	Preprocessing	Solving	Postprocessing
Close holes, remove blends, idealize parts, etc.	Mesh mating, material selection, etc.	Inlets, openings, flow surfaces constraints, boundary conditions, etc.	Simcenter 3D Flow, Simcenter 3D Advanced Flow, conjugate heat transfer	Velocities, pressure, temperature, heat transfer coefficient etc.

What-if, optimization, feedback to designer

Industry applications

From the gust of air that pushes a sailboat to the hot exhaust exiting an automobile's tailpipe to the burst of medication issuing from the nozzle of an oral inhalation device, fluid dynamics are an essential and inextricable part of industry applications.

Automotive and transportation

Simcenter 3D provides porous blockage models for a quick and effective simulation of under-hood components like radiators, charge air coolers and condensers. Further automotive applications include thermal management in automotive lighting systems, cabin comfort and humidity analysis, gas mixture modeling of exhaust and pollutant species transport.

Aerospace and defense

Transporting humidity along with film condensation modeling, the flow simulation capabilities of Simcenter 3D can be used to obtain estimates of passenger comfort. Lift and drag forces can be computed and reported, based on the pressure and viscous shear acting on flow surfaces. The fluid dynamic forces can be automatically mapped to structural solutions.

Electronics and consumer goods

Critical thermal design issues such as open and closed electronics enclosures can be addressed using Simcenter 3D flow modules, which offer a complete solution for the thermal design of electrical and electronics systems. Humidity and film condensation on electronics components can be readily simulated.

Industrial machinery

Flow in rotating machinery can be modeled using the rotating frame of reference methods. Mold cooling simulations can be performed, including forced/free convection and non-Newtonian material behavior, flow in porous filters and heavy-particle-laden flow. Two-phase flow conditions, with constituents having significantly different densities and viscosities, are also supported.

HVAC

Cabin comfort

Industrial processes

Engine block cooling

Hydraulics
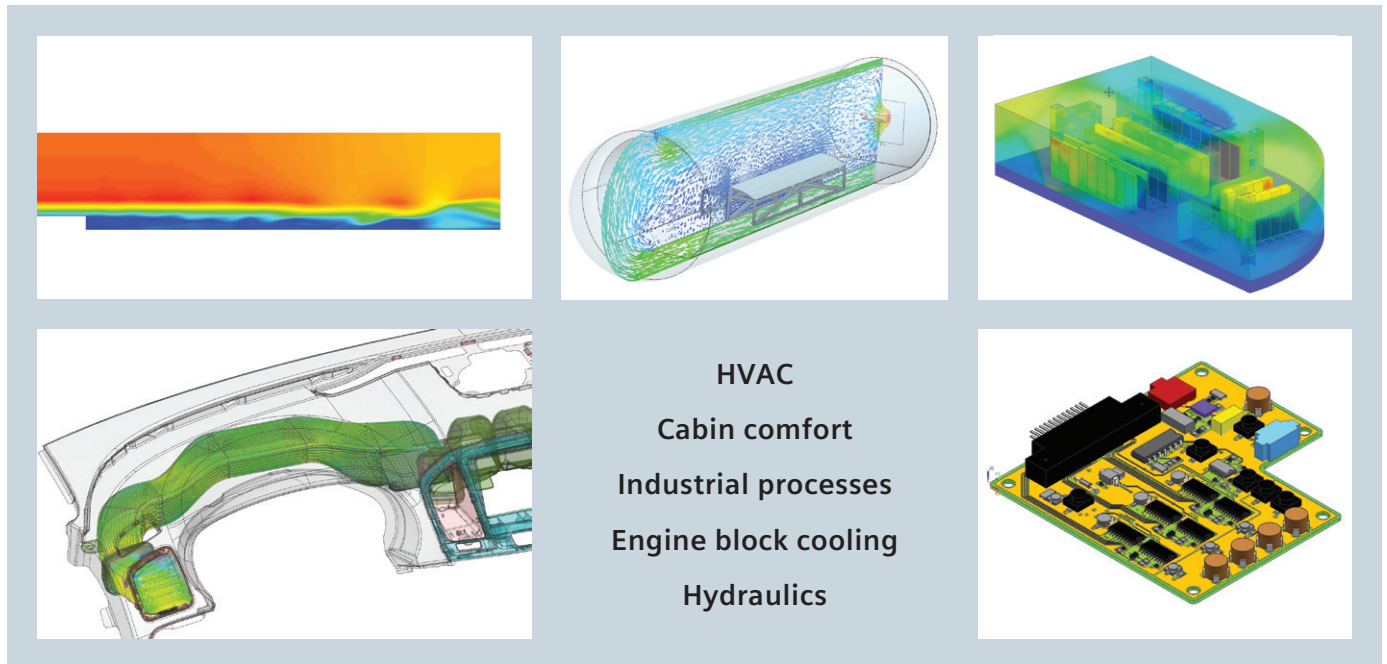
Simcenter 3D Advanced Fluid Modeling

Simcenter 3D Advanced Fluid Modeling delivers state-of-the art tools to rapidly and efficiently create complex fluid models used for either CFD or acoustic simulations. Simcenter 3D Advanced Fluid Modeling enables you to create fluid domain geometry from complex component or assembly models along with specialized boundary layer meshing capabilities that deliver accurate results.

Module benefits

Reduces time spent creating meshes for CFD and acoustic simulations

Rapidly creates fluid domain geometry from complex assemblies

Accurately meshes fluid domain and boundary layers

Supports full-assembly to extract air volume in complex systems as well as mesh assemblies

Key features

Enables fast and intuitive direct geometry editing using synchronous technology

Creates an airtight envelope based on the selected geometry or mesh using an advanced surface wrapping algorithm

Delivers a complete set of tools to define the boundary layer mesh and ensures optimal wall-adjacent meshes for turbulence modeling

Provides hybrid hex-tet meshing with a significant number of structured elements
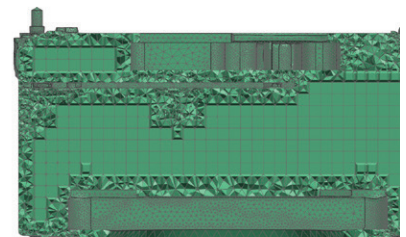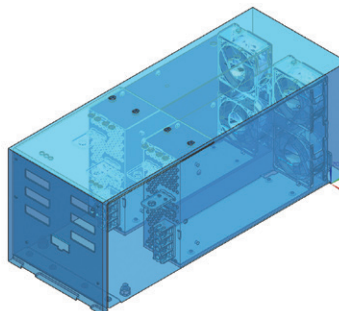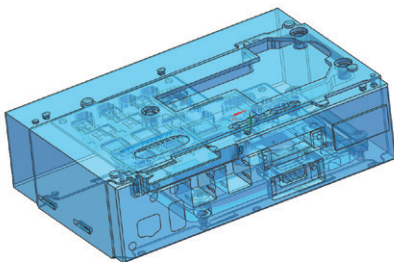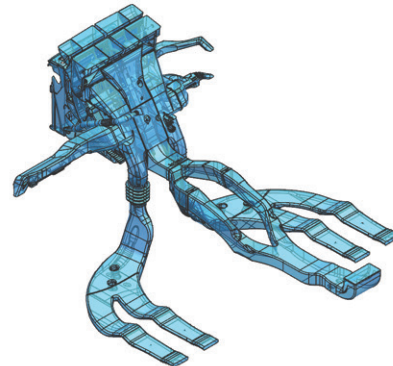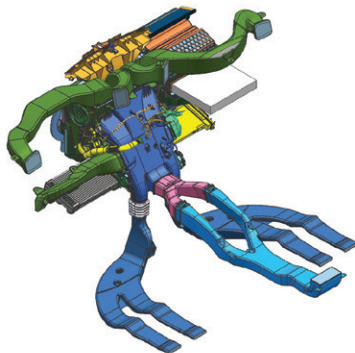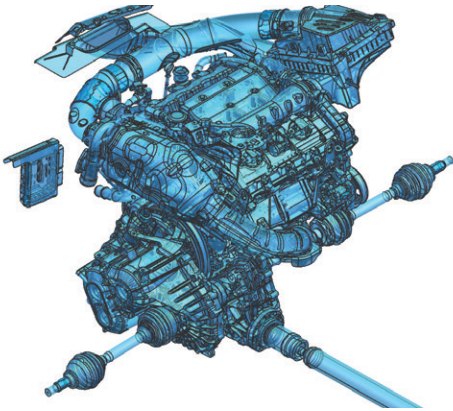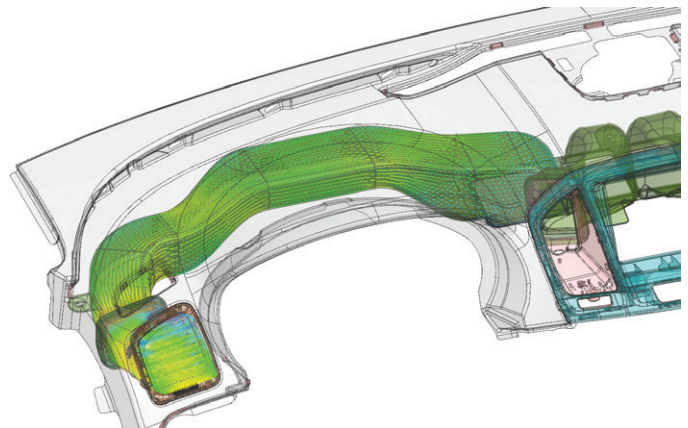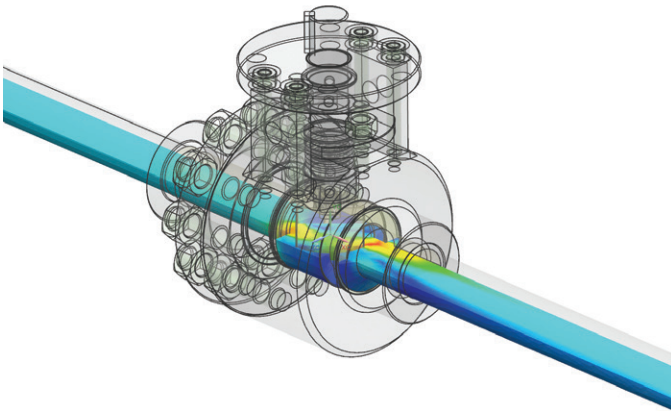
Simcenter 3D Flow

Simcenter 3D Flow is a CFD solution that provides sophisticated tools to model and simulate fluid flow for complex parts and assemblies. Simcenter 3D Flow combines the power and accuracy of the well-established control-volume formulation with cell-vertex formulation to discretize and efficiently solve the fluid motion described by the Navier-Stokes equations.

Module benefits

Reduce costly physical prototypes by simulating fluid flow in a virtual environment

Streamline processes that require a multidisciplinary simulation approach

Save time and avoid errors due to transfer of data and results for multiphysics simulation

Key features

Simulate internal- or external-flow problems in turbulent, laminar and mixed flows

Account for forced, natural and mixed convection

Connect dissimilar fluid meshes at interfaces between complex assemblies

Simcenter 3D Advanced Flow

Simcenter 3D Advanced Flow is an add-on module to both Simcenter 3D Flow and Simcenter 3D Electronic Systems Cooling. It extends the flow-simulation capabilities of these products to encompass internal or external fluid flow, including compressible and high-speed flows, non-Newtonian fluids, tracking of heavy particles and multiple rotating frames of reference.

Module benefits

Readily track the interface between two fluids in a sloshing problem

Efficient and accurate rotating machinery simulation

Couple 1D hydraulic networks with 3D flow models to simulate complex systems

Key features

Single and multiple rotating frames of reference

Additional turbulence models such as RNG k-epsilon, Realizable k-epsilon, SST, k-omega and LES

Multi-species filling and emptying

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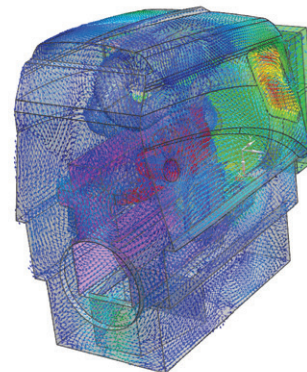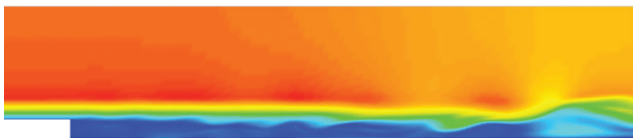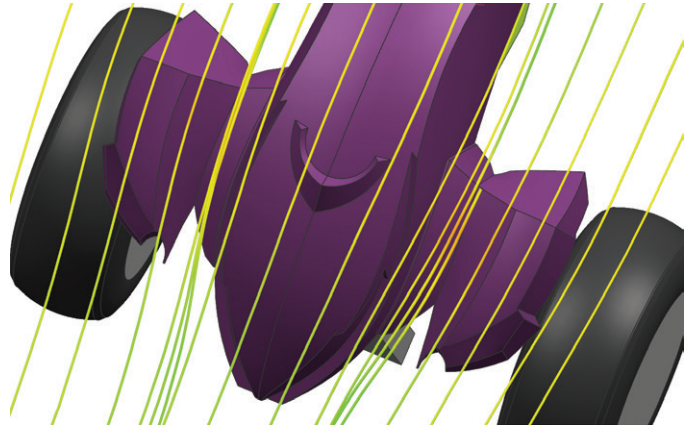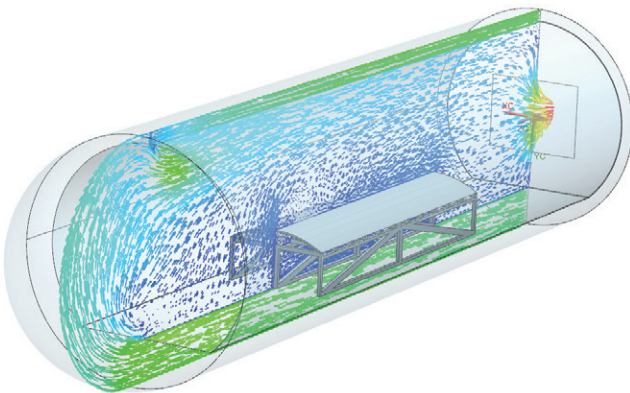
Simcenter 3D Flow HPC

Simcenter 3D Flow high-performance computing (HPC) makes use of hardware systems configured as a multi-processor desktop or a multi-node cluster. One license of Simcenter 3D Flow HPC together with the prerequisite solver licenses can be used to produce a solve over as many processors as available.

CFD analysis: humidity transport in a chiller
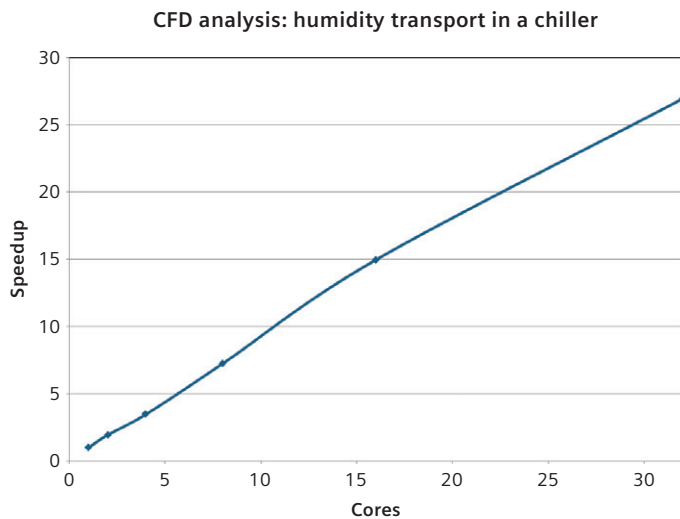
Module benefits

Enjoy the flexibility of solving on a single machine or across a distributed network or cluster

Maximize the value of your hardware investments and greatly improve your solution

Key features

Cores may be co-located on a single workstation, distributed over a local area network, or exist within a standalone computational cluster

Limitations on the maximum number of cores are eliminated, allowing solve speeds to scale up or down based on the number of available cores, not the number of available licenses

Domain decomposition techniques are included for solving large-scale flow models

Capabilities chart

General capabilities	Specific capabilities	Simcenter 3D Advanced Fluid Modeling	Simcenter 3D Flow	Simcenter 3D Advanced Flow	Simcenter 3D Flow HPC
Solver(s)	DMP flow parallel processing		+	+	•
	Flow parallel processing (serial solver)			•	•
	Multiphysics solve		+	+	•
	Condensation and evaporation			•	
File export	cgns		•		
	INPF		•		
	Mapping constraint		•		
File import	cgns		•		
	I-DEAS scratch file		•		
	INPF		•		
	NX xml		•		
	plot3d		•		
	Universal		•		
Advanced fluid modeling required during solve as well	3D Hybrid mesh	•			
	Constraint - auto refinement	•			
	Constraint - contact prevention	•			
	Constraint - local resolution	•			
	Boundary layer mesh control	•			
	CGNS import / export	•			
	PLOT3D import	•			
	Sim fluid domain SSSO	•			
	Sim fluid domain mesh	•			
	Recipe create (output body)	•			
	Recipe create (output body + 2D mesh)	•			
	Recipe create (output 2D mesh)	•			
	Recipe create from 2D element faces	•			
	Tet Mesh (with BL mesh control)	•			
	WRAP (output body)	•			
	WRAP (output body + 2D mesh)	•			
	WRAP (output 2D mesh)	•			
	WRAP recipe with constraints	•			
	WRAP recipe from 2D element faces	•			

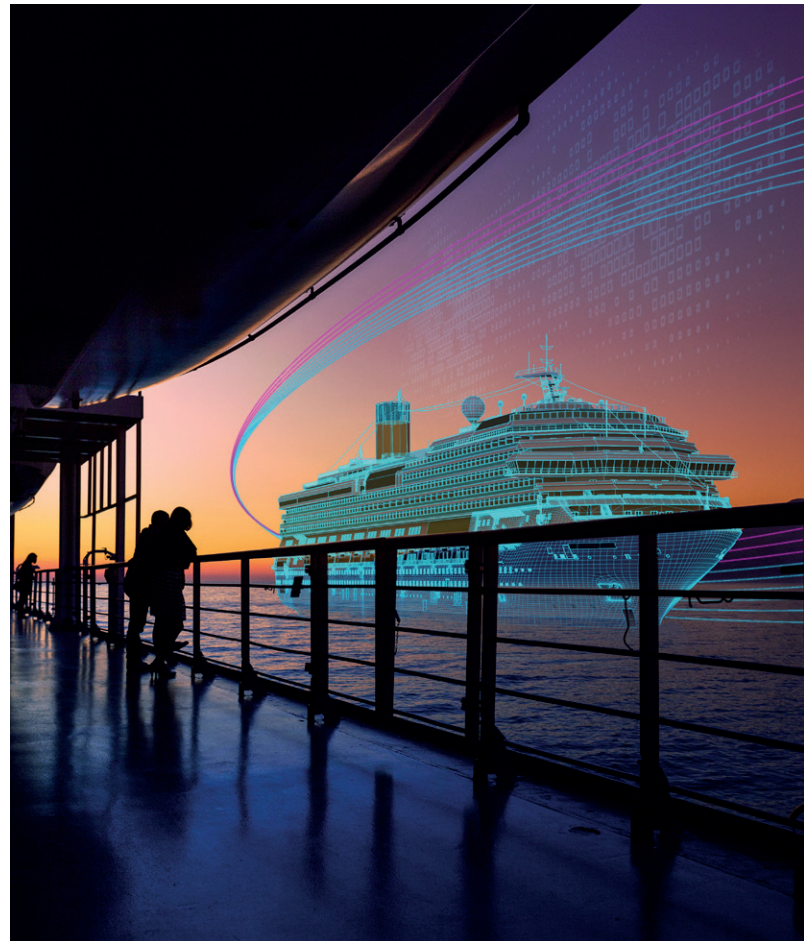| General capabilities	Specific capabilities	Simcenter 3D Advanced Fluid Modeling	Simcenter 3D Flow	Simcenter 3D Advanced Flow	Simcenter 3D Flow HPC
Solution attributes and parameters	Fixed turbulent viscosity		•		
	Standard K-epsilon		•		
	RNG K-epsilon			•	
	Realizable K-epsilon			•	
	K-Omega turbulence model			•	
	LES-Large eddy simulation			•	
	Mixing length		•		
	Laminar flow		•		
	Spalart-Allmaras			•	
	Shear stress transport			•	
Modeling objects	Advanced parameters flow		•		
	Convection properties		•		
	Duct convection correction			•	
	Duct head loss			•	
	External conditions		•		
	Fan speed controller			•	
	Generic entity		•		
	Homogeneous gas mixture			•	
	Immiscible fluid mixture			•	
	Non-Newtonian fluid			•	
	Planar head loss		•		
	Thermostat		•		
	Tracer fluid			•	
Loads	Thermal loads (heat load, heat flux, heat generation)		•		
Constraint	Association target zone		•		
	Initial conditions		•	•	
	Flow mapping target set		•		
	Mapping		•		
	Temperature		•		

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General capabilities	Specific capabilities	Simcenter 3D Advanced Fluid Modeling	Simcenter 3D Flow	Simcenter 3D Advanced Flow	Simcenter 3D Flow HPC
Simulation objects	Convection coupling			•	
	Deactivation set		•		
	Deactivation set advanced				
	Disjoint fluid mesh pairing		•		
	Duct flow boundary condition			•	
	Flow blockage (porous, isotropic, orthotropic, solid)		•		
	Flow boundary condition				
	– Bursting membrane			•	
	– Convective outflow		•		
	– Flap			•	
	– Inlet		•		
	– Internal fan		•		
	– Opening		•		
	– Outlet		•		
	– Recirculation loop		•		
	– Static pressure		•		
	Flow surface (boundary and embedded, with obstructions)		•		
	Fluid domain (fluid mesh and surface mesh)	•			
	Immersed boundary	•	•		
	Mixing plane (disjoint and joint)			•	
	Moving frame of reference (rotating and translating)			•	
	Particle injection			•	
	Peltier cooler				
	Periodic boundary condition (rotational and translational)			•	
	Report		•		
	Screen		•		
	Selective results		•		
	Supersonic inlet			•	
	Symmetry plane		•		
Catalogs	Advanced parameters		•		
	Correction			•	
	Fan curves		•		

Legend:
• = included in module
+ = additional product required

Note: Simcenter 3D Engineering Desktop is a minimum prerequisite for all Simcenter 3D products. Other dependency or prerequisites may apply for individual products.