The ever-evolving latest CFD solution

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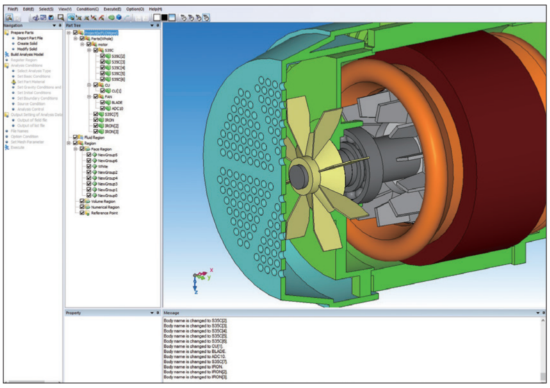
scFLOW SC/Tetra

SC/Tetra has been characterized by sophisticated mesh generation function, high speed computing capability, and user-friendly features throughout the operation. As its advanced version, scFLOW has been released. It is equipped with more stable Solver that achieves calculation speed three times faster (at maximum) than before, and new Preprocessor that helps entry-level users build complicated models and high-quality mesh. scFLOW, the new generation software, keeps on evolving.

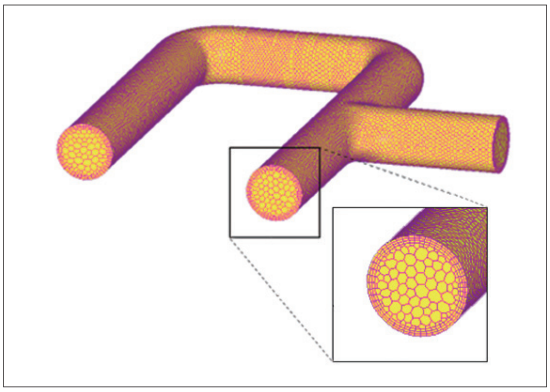
Simplification of Preprocessor operations FLOW

From the CAD data to analysis mesh data, the required operations are grossly simplified compared to before. The conservation of assembly information and the settings of conditions on the parts bring the sense of continuity from the CAD operations and reduce the operational burden of the users.



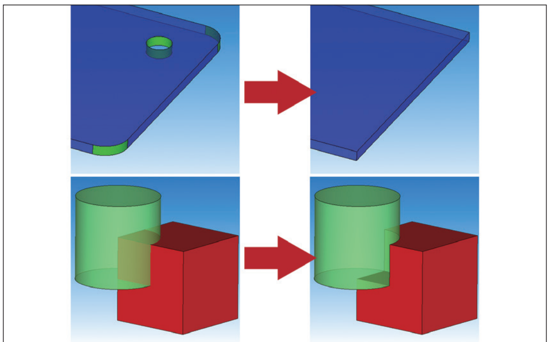
Polyhedral mesher FLOW

Using polyhedral mesh elements improves stability and calculation accuracy of cell-centered solver. In scFLOWpre, mesh can be generated according to the target number of mesh elements and automatically refined near wall area. The automatic mesher function also enables users to specify mesh refinement level of each part and region.



Modifying CAD data FLOW SCT

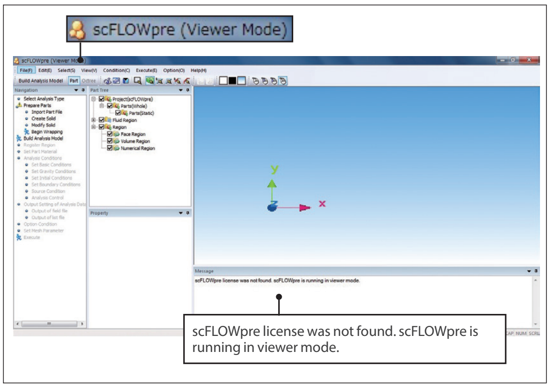
When CAD data to be used for simulation has a problem, the data can be modified with Preprocessor. Boundary conditions can be set based on the part names and color information set in the CAD data. When some regions are missing in the model, shapes such as cuboids and cylinders can be added.



Upper: Recognizing and deleting a model pattern
Lower: Deleting the overlapped area of solids

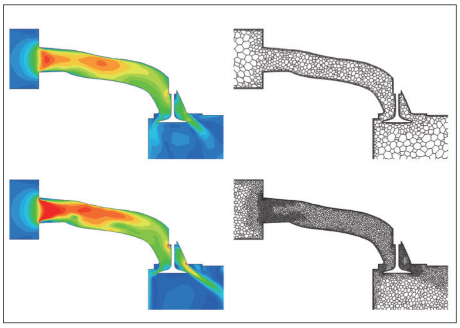
Viewer mode FLOW

Preprocessor data can be displayed in the viewer mode without the Pre-/Post-processor license, when the license is taken by the mesher or by Postprocessor and is unavailable.



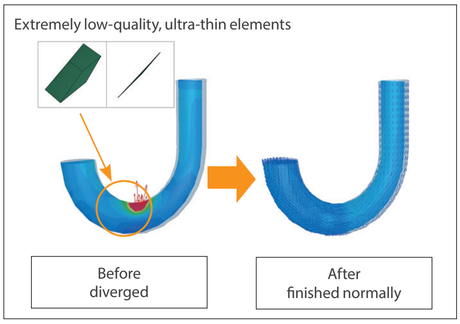
Mesh-adaptation analysis
FLOW SCT

With this function, mesh will be automatically refined where a flow or pressure changes greatly in a steady-state analysis. After the calculation in Solver is completed, Preprocessor automatically launches and executes gridding and meshing based on the calculation result. By specifying the target number of elements, coarse mesh is generated first and the mesh is automatically refined to be appropriate for the calculation. The function is useful for an analysis of flows in a tube with a complicated shape.



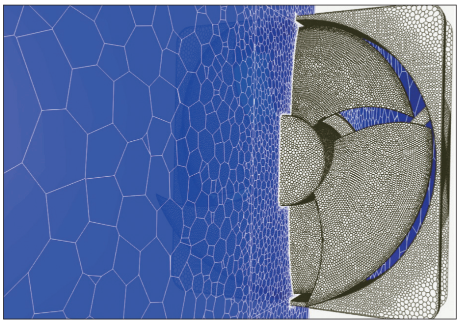
Stabilization of calculation
FLOW

Even for mesh data with elements of extremely low quality, the calculation can be stabilized by the automatic processing to avoid divergence. This function helps Solver be more robust.



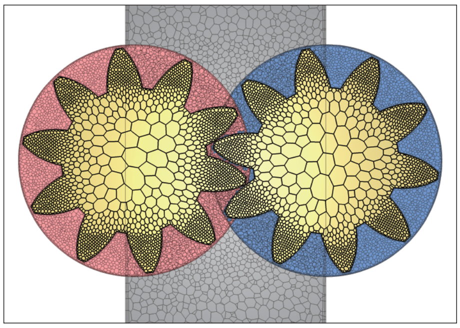
Discontinuous mesh
FLOW SCT

Flow with object motion can be calculated, including rotation of fans and turbines, and crossing travel of automobiles or trains (translation). The function enables an analysis with consideration on shear heating between rotor and pad in a disk brake. The function also makes it possible to analyze a combination of rotation and translation such as a piston pump.



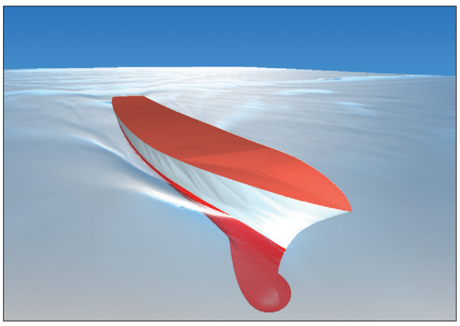
Overset mesh
FLOW SCT

Free movement of regions, that cannot be analyzed using existing functions such as stretching or rotating elements, can now be simulated by overlapping mesh elements for stationary and moving regions. This function supports an overlap of multiple moving regions, a contact between objects, and a 6-degree-of-freedom motion of rigid bodies. This is useful to analyze opening and closing of a valve of an engine port or a gear pump where gears engage with each other.



Free surface (steady-state / transient)
FLOW SCT

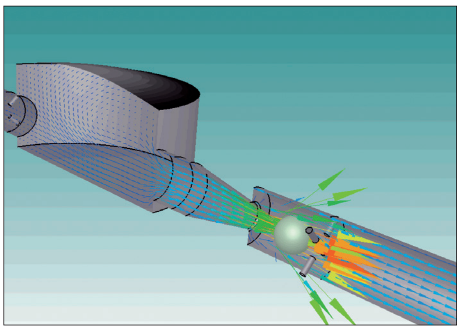
The shape of an interface between a gas and a liquid can be simulated. Calculations by VOF method (new method: FIRM) are fast and accurate, and functions including moving boundary, overset mesh, and particle tracking can be used in combination. Because a phenomenon where the phase interface becomes stable can be analyzed in a steady-state calculation, the result can be obtained in a shorter time than before.



*Only scFLOW supports FIRM. FIRM cannot be used for overset mesh or steady-state analyses.

6-degree-of-freedom motion (6DOF)
FLOW SCT

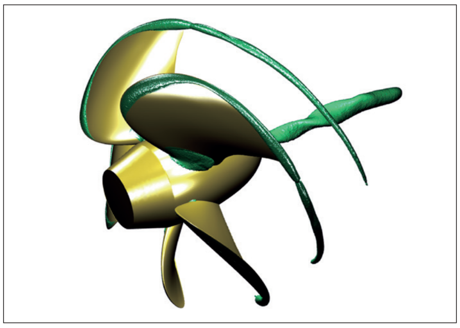
Passive translation and rotation of a rigid body receiving a fluid force can be analyzed. With the function, the user can analyze a ball valve with consideration of the elasticity of the spring (1D translation), and paper airplane with consideration of 6-degree-of-freedom rigid-body motion (3D translation + 3D rotation). In addition, the function is applied to analyses of check valves, wind power generators, and blades of wave power generators.



What is CAE?
scSTREAM | HeatDesigner
scFLOW | SC/Tetra
scPOST
Co-simulation with MSC Products
PICLS
Analysis Procedure
Main Mutual Features
Optimization Tool
License Type
Third-party Software

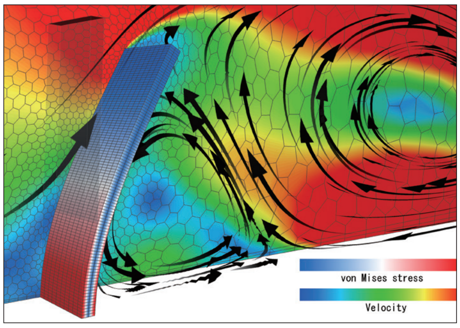
Cavitation
FLOW SCT

This function enables simulation of a vaporization phenomenon called cavitation, which is caused at an area where pressure of a liquid becomes lower than in the surrounding area, such as with a propeller rotating at a high speed under water. The occurrence of cavitation can be predicted by applying the cavitation model based on the pressure values. The software also supports problems caused by cavitation such as erosion.



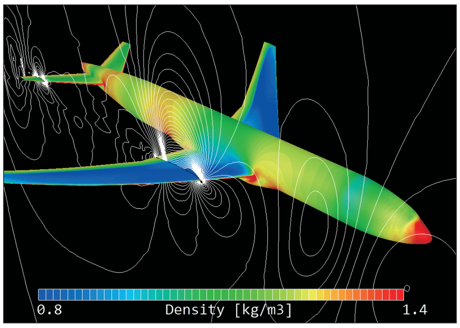
Fluid-structure interaction
FLOW SCT

This option is used for two-way FSI (fluid-structure interaction) with structural analysis software. With this option, not only rigid bodies but also elastic bodies can be treated. Deformation of an object caused by a fluid force and the change of fluid caused by the deformation can be analyzed.



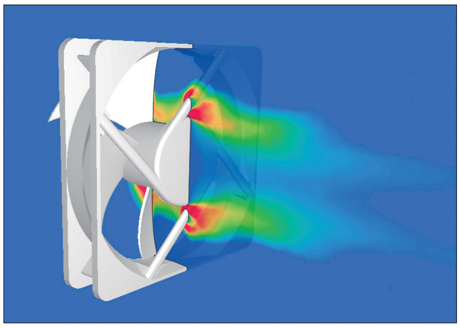
Compressible fluid
FLOW SCT

The software can analyze phenomena such as supersonic flow and significant expansion/contraction of volume. For a compressible fluid, both the pressure-based and the density-based Solvers can be used. The density-based Solver keeps the calculation stable even with high Mach number. You can select either Solver depending on the analysis target and phenomenon.



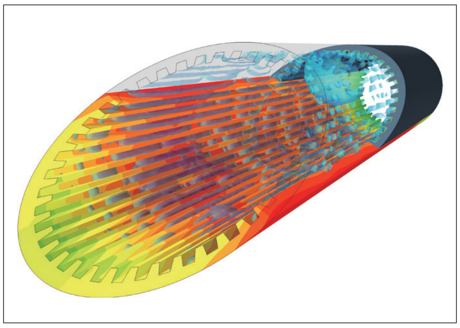
Aerodynamic noise analysis
SCT

Sound caused by pressure oscillation of a fluid, such as wind noise, and sound caused by resonance can be predicted. The calculation can be performed accurately by using LES and the weak compressible flow model. The frequency of aerodynamic noise can also be analyzed using the Fast Fourier Transform (FFT) method from the CFD analysis result.



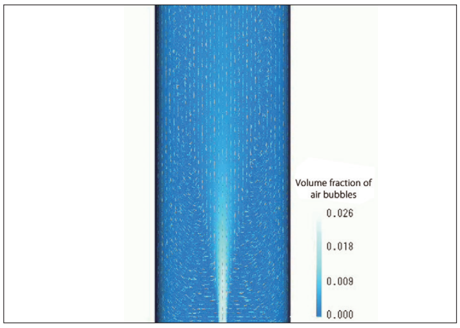
Evaporation/Condensation
FLOW

Free surface analysis function (VOF method) of this software can simulate phase change between gas and liquid, such as evaporation and condensation. By considering phase change, not only simple heat conduction but also heat transfer from latent heat can be calculated. For example, this method can be applied to internal flow simulations for heat transfer devices such as heat pipes, in which a refrigerant liquid changes to vapor by absorbing heat from an outer region.



Dispersed multi-phase flow
SCT

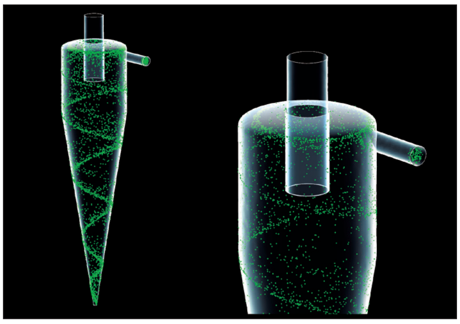
This function can simulate flows containing many bubbles, droplets, or particles (dispersed phase), which are difficult to be analyzed using free surface. This function is a multi-fluid model that can predict volume fraction distribution and velocity distribution of each phase by solving the governing equation under the assumption that the dispersed phase is a fluid (continuous phase). The function is useful to analyze the bubble jet effect and aeration tanks.



Particle tracking

FLOW SCT

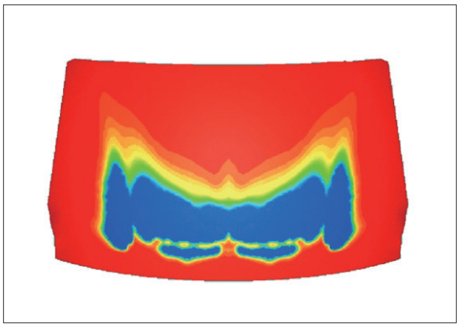
Particle tracking function enables analyzing behavior of particles in flow. When analyzing small particles that follow the fluids movement (such as steam and dust), marker particle function can be used to evaluate particles in flow that change over time, which assumes that particle movement is in accordance with fluid velocity.



Humidity dew condensation

FLOW SCT

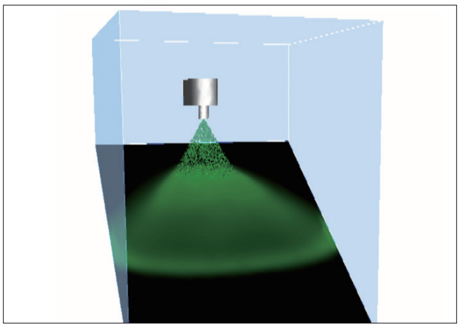
The amount of dew condensation on an object surface can be calculated from the surface temperature and water vapor in the air. You can output the amount of dew condensation per unit time in a steady-state analysis and the accumulated dew condensation in a transient analysis. Evaporation from a surface where dew condensation occurs can be calculated simultaneously, and this is useful for an analysis of a windshield defroster.



Liquid film model

FLOW SCT

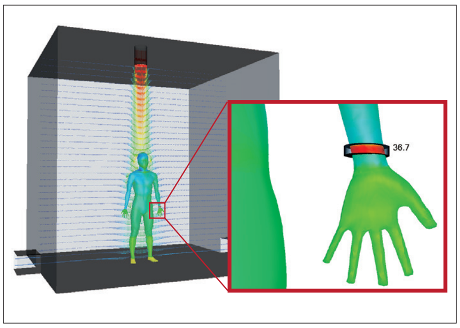
The liquid film model is an extended function of the particle tracking function. By using the model, you the user can simulate the phenomenon that liquid particles change to a liquid film (water on a wall) when they reaching on the a wall. A liquid film on a wall flows with the influence of gravity and a gas-phase flowdown depending on an angle of the wall and collects in at a certain position.
The analysis results are output as the thickness of a liquid film.



Thermoregulation-model (JOS)

FLOW SCT

Combination use of the thermoregulation-model (JOS) and a fluid analysis enables analyses of the surface temperature of a human body under a certain thermal environment. It can also be used to analyze temperature and humidity changes in the surrounding environment of a human body. The user can consider age, clothes, and physiological phenomena of the human body such as heat transfer by blood flow in addition to the surrounding environment of a human body such as temperature and velocity.

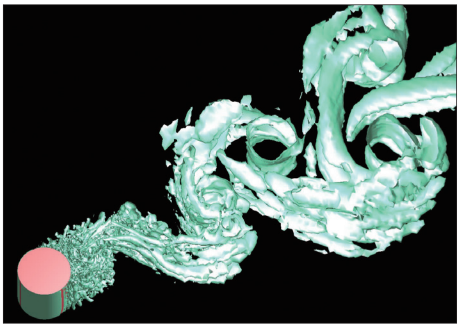


*JOS and JOS-2 developed by Tanabe laboratory at Waseda University, et al. are introduced for the thermoregulation model.

LES

FLOW SCT

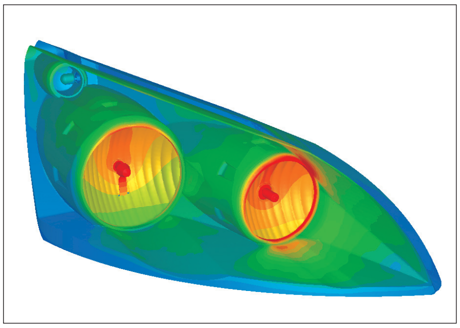
LES is one of the turbulent flow models. It models eddies smaller than the mesh element in size and directly calculates other eddies. Although calculation load is large, LES enables simulations closer to real phenomena. LES is often used in noise analyses, significantly affected by time variation, to simulate the behavior of small eddies. The user can use the hybrid model with RANS, a turbulent model of small calculation load.



Radiation

FLOW SCT

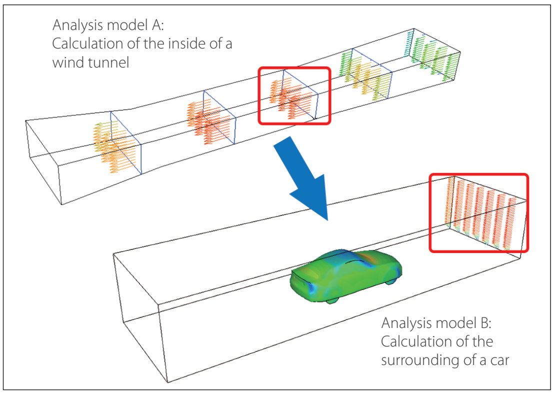
Heat transfer by infrared-ray radiation can be considered by setting emissivity and temperature difference between objects. The user can choose VF (view factor) method or FLUX method as a calculation method. The user can also consider wavelength dependence, transmission, absorption, refraction, diffusion, and reflection of radiation. In FLUX method, the user can also consider directionality.



Mapping

FLOW SCT

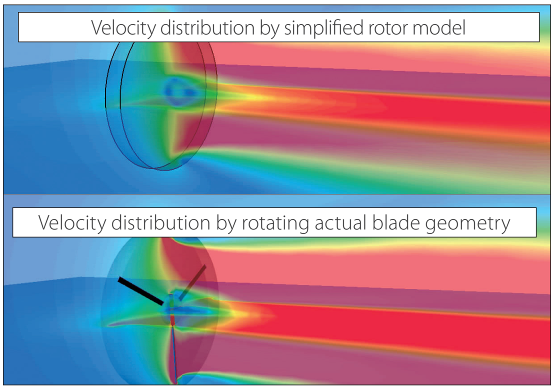
When a target phenomenon is in a small range and the phenomenon is affected by a wide range of its surrounding area, analysis results of the surrounding area can be used for an analysis of the target phenomenon as boundary conditions to decrease the calculation load.



Fan model (rotating blades)

FLOW SCT

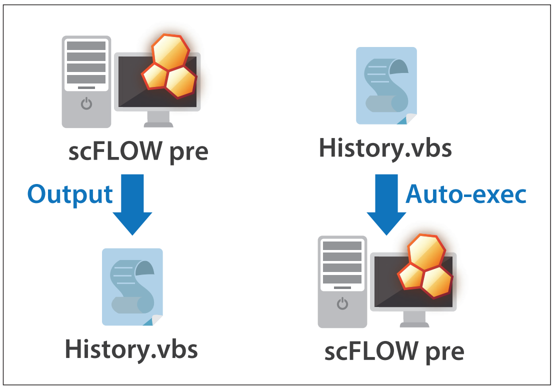
With this model, an average flow field around rotating blades can be simulated only by entering characteristic properties regardless of real shapes of fans or propellers. The user can use the non-dimensional swirl coefficient model, the simplified propeller model, and the simplified rotor model. This model is useful to analyze axial-flow windmills and waterwheels.



Operation logging by VB interface

FLOW

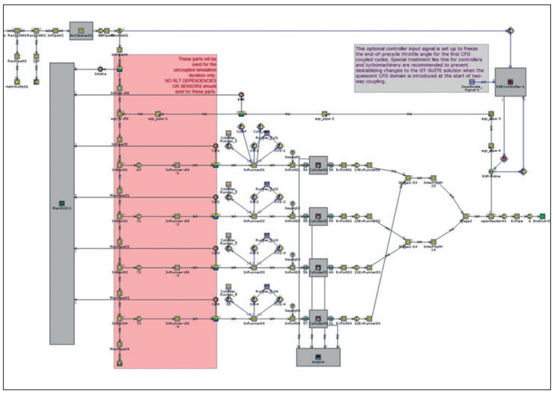
The operations in Preprocessor can be saved as a log file using the VB interface. Making the user scripting unnecessary, this makes the construction of an automated system affordable in a short period of time based on the files storing the operation logs.



Coupled analysis with GT-SUITE

FLOW SCT

Coupled analysis with GT-SUITE is available. The entire flow in an intake and exhaust system is calculated with GT-SUITE and small flows of each part are interpolated with scFLOW or SC/Tetra. This will enhance calculation accuracy of the whole system.

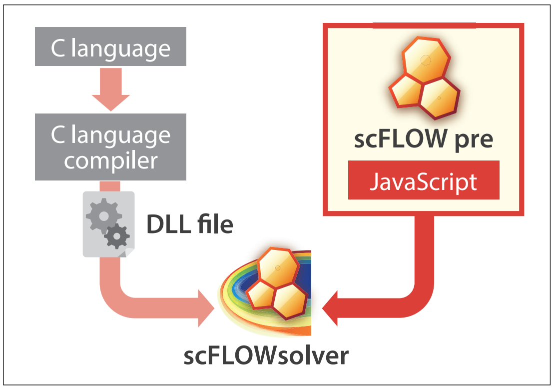


*GT-SUITE is engine intake & exhaust system one-dimensional thermo-fluid analysis software provided by Gamma Technology

FLOW : scFLOW SCT : SC/Tetra

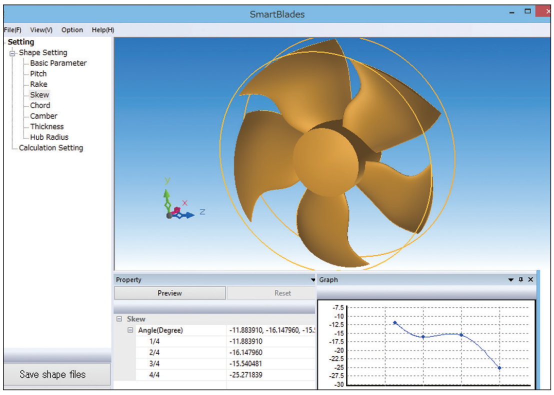
Script functions FLOW

Before, complicated settings, including time-/coordinate-dependent material properties or boundary conditions, required a coding and compilation of user-defined function in C language. With the script functions, compilation is not required. Functions can be written in Preprocessor based on JavaScript.



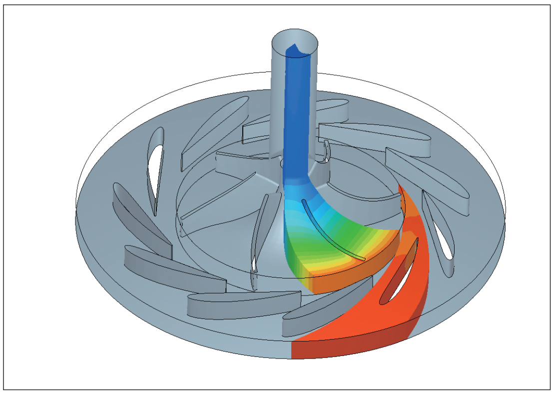
SmartBlades SCT

This function is useful for analyzing the shape of a fan automatically throughout creating the shape of a fan (CAD data), calculating the flow, and post-processing. The shape of a fan can be created easily by specifying parameters including the number of blades, fan diameter, rake angle, and skew angle.



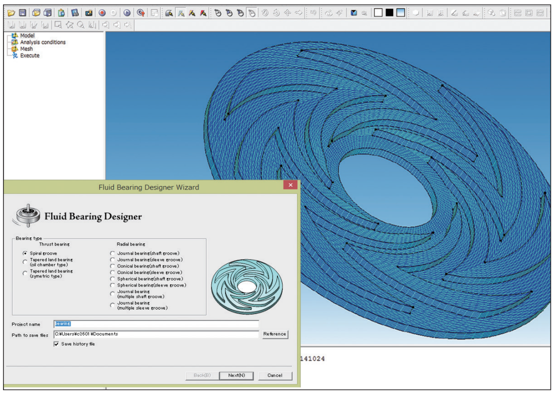
Functions for turbomachinery SCT

One-pitch shape can be extracted from a periodic model such as an impeller or a vane of turbomachinery. The analysis result of the one-pitch model can be checked in the meridian plane. Two regions whose pitches are different can also be analyzed. The calculation load will be reduced by using this function.



FluidBearingDesigner SCT

The function creates groove patterns of fluid bearings (dynamic-pressure bearing) and generates mesh. You can select the shape of grooves such as journal and thrust and materials such as porous material. From calculation results, you can obtain parameters for designing fluid bearings such as axial force and drag coefficient.



Functions (scFLOW, SC/Tetra)

			scFLOW	SC/Tetra
Preprocessor	Modeling	CAD data Interface (import)	Parasolid, STEP, STL, IGES, ACIS, CATIA V5, CATIA V4, Creo Elements/Pro (Pro/Engineer), SOLIDWORKS, NX, Solid Edge, Inventor, DXF (3D-face), VDAFS, Nastran, MDL	Parasolid, STEP, STL, IGES, ACIS, CATIA V5, CATIA V4, Creo Elements/Pro (Pro/Engineer), SOLIDWORKS, NX, Solid Edge, Inventor, DXF (3D-face), VDAFS, Abaqus, Nastran, Design Space, Plot3D, CGNS
		CAD data interface (export)	Parasolid, MDL	STL, Nastran, CGNS, Parasolid, MDL
		Primitives	Cuboid, cylinder, sphere	Cuboid, cylinder, sphere, rectangle (panel)
		Geometry modification	Data cleaning, editing solid, editing sheet, cross-section and extraction, coordinate conversion, wrapping	Data cleaning, editing solid, editing sheet, cross-section and extraction, coordinate conversion, turbomachinery (single-pitch extraction), wrapping
	Mesh generation	Tetrahedron		●
		Pentahedron (prism, pyramid)		●
		Hexahedron		● (manual setting)
		Cuboid	● (when internal hexahedron elements are used)	● (when internal hexahedron elements are used)
		Polygon (polyhedron)	●	
	Conditions	Easy set-up through wizard	●	●
		Unused dialogs hidden	●	●
		Collective settings to undefined regions	●	●
		Material property library (editable)	●	●
		Laminated materials		● (laminated panel)
	Operation and control environment	VB Interface	●	●
		Selectable mouse operation modes	●	●
		Mapping	●	●
Solver	Mesh	Unstructured mesh	●	●
		Overset mesh	●	●
		Mesh adaptation	●	●
		Discontinuous mesh interface	●	●
		ALE (rotation, translation, stretch)	●	●
		6-degree-of-freedom motion (6DOF)	●	●
		Mixing plane		●
	Numerical scheme	Finite volume method	●	●
		Pressure correction	SIMPLEC, SIMPLE, PISO	SIMPLEC, SIMPLE, revised SIMPLEC
		Convection term accuracy	1st/2nd order (MUSCL/QUICK) upwind scheme, 2nd-order central difference (LES)	1st/2nd order (MUSCL/QUICK) upwind scheme, 2nd-order central difference (LES)
		Matrix	MILUCG-STAB, AMGCG-STAB, CGCCG-STAB	MILUCG-STAB, AMG, AMGCG-STAB, CGCCG-STAB
		Density based	● (defect correction method, JFNK method)	● (defect correction method)
		Steady-state / transient calculation	●	●
	Flow types	Incompressible fluid	●	●
		Compressible fluid	●	●
		Non-Newtonian fluid	●	●
		Buoyancy (Boussinesq approximation)	●	●
		Multiple fluids	●	●
		Gas mixing	●	●
	Turbulence models		Standard k-ε model, RNG k-ε model, MP k-ε model, AKN linear low-Reynolds number k-ε model, realizable k-ε model, SST k-ω model, MPAKN linear low-Reynolds number k-ε model, Spalart-Allmaras one equation model, SST-SAS model, LES	Standard k-ε model, RNG k-ε model, MP k-ε model, AKN linear low-Reynolds number k-ε model, GPC linear low-Reynolds number k-ε model, non-linear low-Reynolds number k-ε model, realizable k-ε model, SST k-ω model, MPAKN linear low-Reynolds number k-ε model, Spalart-Allmaras one equation model, LKE k-kL-ω model, SST-SAS model, LES, DES, VLES
	Thermal analysis	Heat conduction (fluid / solid)	●	●
		Convective heat transfer	●	●
		Heat radiation (view factor)	●	●
		Heat radiation (flux method)	●	●
		Heat conduction panel	●	●
		Moving heat conduction panel	●	
		Solar radiation		●
		Joule heat	●	●
		Mean radiation temperature calculation	●	●
	Diffusion analysis	Diffusivity	●	●
		SORET effect	●	●
		Passive scalar	●	
	Index for ventilation efficiency / thermal comfort	PMV / SET*	●	●
	Humidity / dew condensation analysis	Relative humidity / absolute humidity	●	●
		Dew condensation	●	●
	Reaction analysis	Chemical reaction	●	●
		Combustion reaction	● Eddy-dissipation model	● Eddy-dissipation model
		Thermal CVD analysis		●
	Particle analysis	Marker particles	●	●
		Mass particles	●	●
		Charged particles	● (user-defined function)	● (user-defined function)
		Spray model	●	●
		Liquid film	●	●
		Transforming dew condensation	●	●
		Transforming fluid / volume rate	● (VOF method)	● (VOF method)
	Multiphase flow analysis	Free surface	● (VOF method, steady-state/transient)	● (VOF method, transient)
		Solidification / melting analysis	●	●
		Evaporation / condensation	● (VOF method)	● (VOF method)
		Cavitation model / erosion index	●	●
		Dispersed multiphase flow		●
	Aerodynamic noise analysis	Ffowcs Williams & Hawkings' equation		●
		Weak compressible flow model		●
		Sound source detection model	●	●
	Current analysis	Conductor current	●	●
		Conductor potential	●	●
	Thermo-regulation model	JOS, JOS-2	●	●
	Flow conditions	Velocity	●	●
		Volume flow rate	●	●
		Mass flow rate	●	●
		Pressure (static pressure / total pressure)	●	●
		Natural inflow / outflow	●	●
		Fan model	●	●
		Wave generation, wave dissipation	● (wave dissipation only)	● (VOF method)
	Thermal conditions	Fixed temperature	●	●
		Amount of heat generation	●	●
		Heat transfer coefficient	●	●
		Contact heat transfer coefficient	●	●
	Wall conditions	No-slip (stationary wall)	●	●
		Free-slip (symmetry wall)	●	●
		Log-law condition	●	●
		Low-Re-number adaptive wall function	●	●
		Surface roughness	●	●

Functions (scFLOW, SC/Tetra)

			scFLOW	SC/Tetra
Solver	Pressure conditions	Fixed pressure	●	●
		Pressure loss	●	●
		Porous media	●	●
	Source conditions	Volume force / pressure loss	●	●
		Heat generation	●	●
		Smoke source (diffusing materials)	●	●
		Turbulence generation	●	●
		Solid shear heating		●
		Simplified propeller model	●	●
		Simplified rotor model	●	
	User-defined conditions	Variables table / functions	●	●
		Script functions (JavaScript)	●	
		User-defined function (compilation required)	●	●
	Calculation control environment	Job management	●	●
		Monitoring the calculation status	●	●
		Email notification of the calculation	●	●
		VB interface	●	●
	Output post files		Software Cradle post files (FPH)	Software Cradle post files (FLD, iFLD)
	Output for third party software		Abaqus, Nastran, Femtet, JMAG-Designer, EMSolution	Abaqus, Nastran, Femtet, ADVENTURECluster, JMAG-Designer, EMSolution, Optimus, Isight, modeFRONTIER, LMS Virtual.Lab, Actran, FlowNoise, GT-SUITE, KULI, Flowmaster, LOGE, EnSight, FieldView, AVS
Postprocessor	Drawing functions	Mesh, vector, contour plots	●	
		Isosurface, streamline, pathlines, volume rendering	●	
		Geometry display	● (STL file, NFB file, Wavefront OBJ file)	
		2D graph	●	
		Mirror / periodical copy	●	
		Vortex center	●	
	Drawing position / orientation	Arbitrary plane, surface, entire volume, cylinder	●	
		Streamlines, isosurface	●	
		Pathlines	●	
		Arbitrary scaling	●	
		Arbitrary pick	● (scalar / vector value)	
	Special effects	Oil flow	● (on plane / surface)	
		Texture mapping	● (on plane / surface)	
		Lighting, luster, gradation	● (preset, arbitrary)	
		Transparency, water-like expression, shadow	●	
	Animation	Vector animation	●	
		Flow line animation	●	
		Cut-plane weeping	●	
		Marker particle	● (turbulent diffusion effect)	
		Automatic translation of view point	● (view / focus points can be set)	
		Key-frame animation	●	
		Animation interpolated between cycles	●	
	Analysis results	Variable registration	●	
		Integral (surface / volume)	● (scalar / vector integration)	
		Comparison	● (clipping function)	
		Projected area calculation	●	
		Automatic search of the local max / min positions	●	
		Import of CSV data	●	
		Automatic change of colorbar	● (preset, arbitrary)	
	Data image output	Microsoft BMP, JPEG, PNG	● (size, resolution adjustable)	
		CradleViewer®	● (support steady-state / transient animation, attach to Office applications)	
		AVI, WMV	●	
		VRML	●	
	Operation and control environment	Selectable help function	●	
		OpenGL emulation	●	
		VB interface	●	
		Selectable mouse operation modes	●	
		Stereoscopic view (side by side)	●	

System Configuration

Product	Compliant OS	Recommended environment	Approx. measure of analysis size	Compiler environment (User-defined function)
scFLOW SC/Tetra	Windows 10 Windows 8.1 Windows 7 Windows Server 2016 Windows Server 2012 R2 *1 Windows Server 2012 *1 Windows Server 2008 R2 *1 RedHat Enterprise Linux 7 *2 RedHat Enterprise Linux 6 (6.1 onward) *2 SUSE Linux Enterprise Server 12 *2 SUSE Linux Enterprise Server 11 (SP 3 onward) *2	**[Memory]** 8GB or more **[Hard disk]** 10GB or more free capacity recommended	● scFLOW **[Memory]** 1 million mesh elements / 2.0GB **[Max. number of mesh elements]** 180 million **[Max. number of parallel processing]** 1000 ● SC/Tetra **[Memory]** Approx. 1 million nodes / 1.5GB (5 million mesh elements) **[Max. number of mesh elements]** 1.5 billion **[Max. number of parallel processing]** 4096	● Windows version Microsoft Visual Studio 2017 Microsoft Visual Studio 2015 ● Linux version GCC (GNU Compiler Collection) (Linux standard)

*1 Fluid-Structure Interaction (Abaqus®) is not supported for HPC pack.
*2 Only compliant with partial functions in Solver, Monitor and Preprocessor.