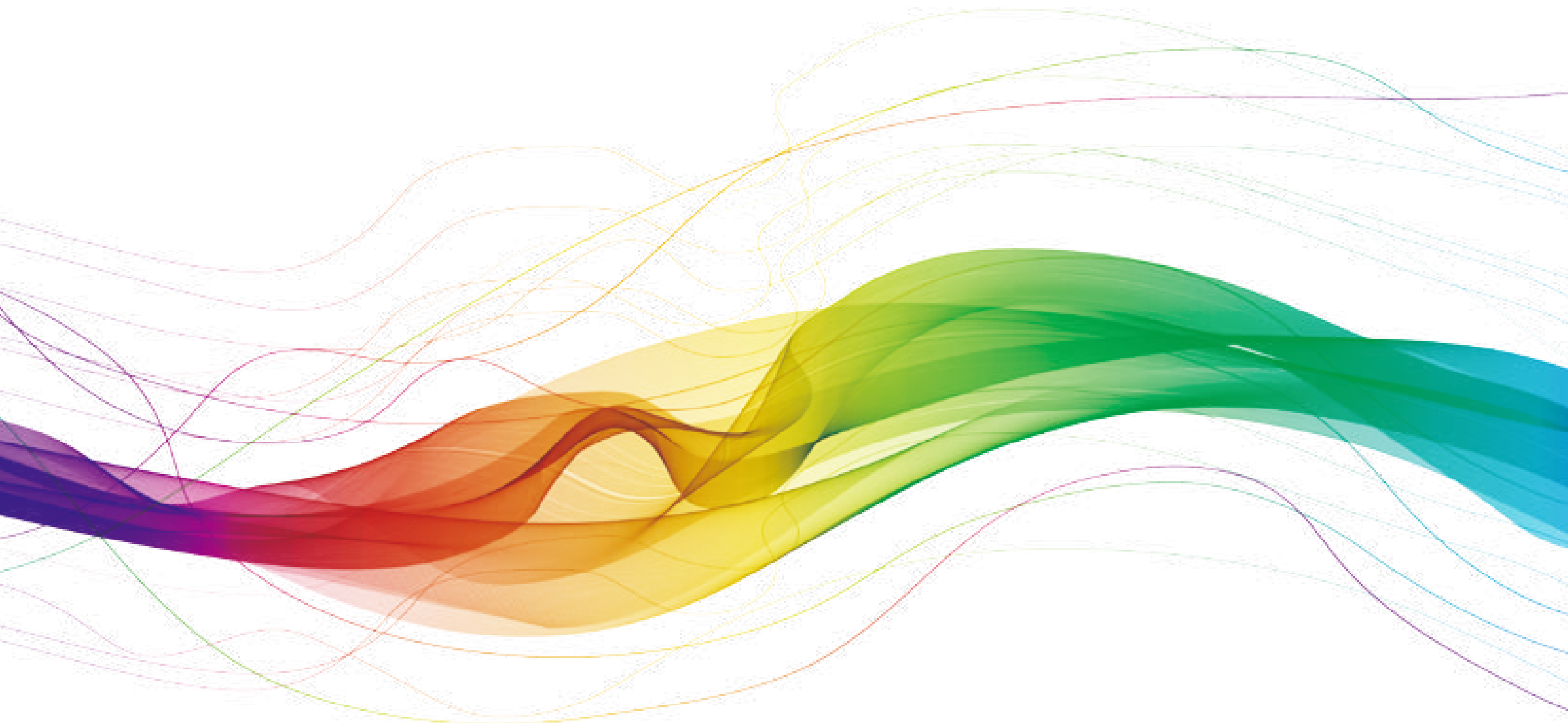
Cradle
MSC Software Company

Thermo-fluid Analysis Software

V13 Product Guide



- scSTREAM
- HeatDesigner
- SC/Tetra
- scFLOW
- PICLS

The Role of CFD in Engineering

One of the foremost expectations of today's successful product driven companies is that they bring high value-added products, that meet customer needs, quickly to the market. In addition, successful companies proactively identify application scenarios that could result in unsatisfactory performance, product failures, customer dissatisfaction and/or develop design solutions that mitigate the potential risks.

Thermo-fluid analysis software

Since software simulation enables predicting performance without creating a hardware prototype, the tools can be used early in the planning state of product development to sift through preliminary design concepts. Simulation can also be used to predict performance of products where it is difficult to make experimental measurements. In addition, simulation software can be used to visualize invisible fluid flow and heat transfer. This results in increased engineering understanding while providing a vehicle for communicating this knowledge to non-experts.

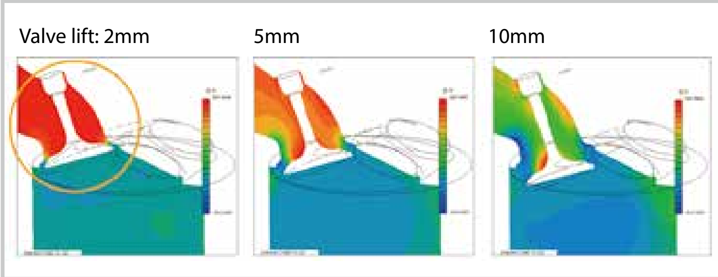


Figure. Example of comparison between analysis cases
Comparison of pressure at an intake port with different engine valve lift

Where does thermo-fluid analysis software come into play?

Thermo-fluid analysis software is indispensable for "Front-loading" product development to ensure the best product concepts that are identified early in the design process. Design quality will be improved during the conceptual design phase by conducting basic studies of fluid and thermal phenomena that directly affect product performance. During the detailed design phase, analyses are conducted under conditions similar to what the actual product will experience. From this work, design engineers can understand the source of problems that limit performance and investigate alternate design solutions before production begins.

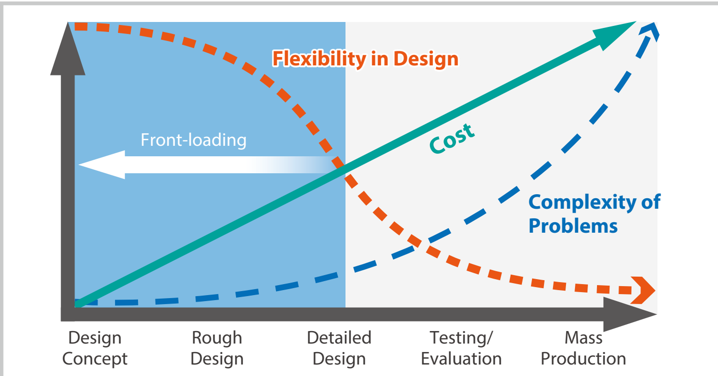


Figure. Product development process

Structured and Unstructured Mesh: The Differences

Software Cradle offers two different types of thermo-fluid analysis tools:
scSTREAM and HeatDesigner with structured mesh,
SC/Tetra and scFLOW with unstructured mesh.

Structured mesh is simple and easy to construct. Structured mesh is comprised of many small cuboids so it can only approximate curved or angled surfaces with stair-case patterns. It is most useful for applications where tiny details and surface curvature or angles do not have a strong effect on the overall results. Examples of applications for structured mesh include electronics cooling, HVAC, and architecture.

Unstructured mesh is created using tetrahedron, pentahedron, hexahedron, and/or polyhedron elements. Mesh is generated such that it fits along the ridge lines of the original geometry. As a result, unstructured mesh is used for applications where precise representation of geometry is crucial. Examples of applications for unstructured mesh include vehicle aerodynamics, fan blade designs, and flows inside ducts.

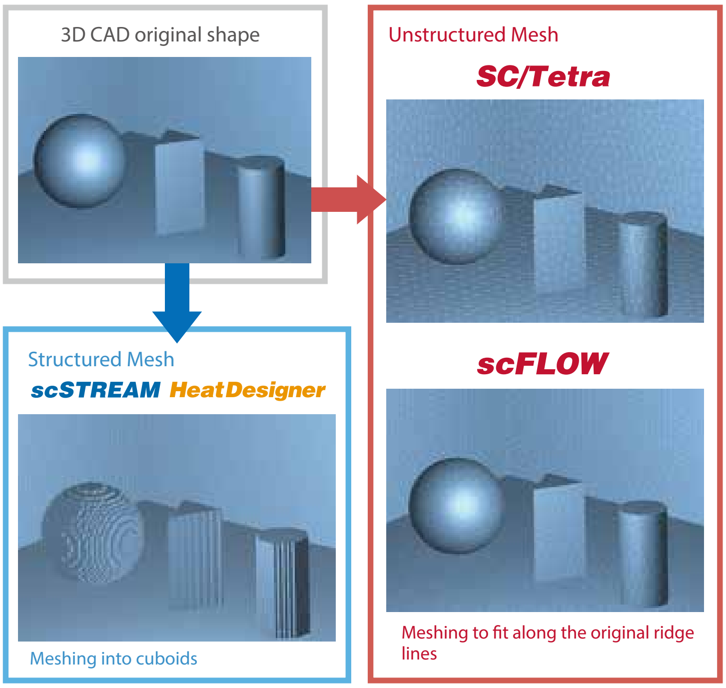


Fig. Differences between meshing methods

Products

Software Cradle develops and provides thermo-fluid simulation software and optional tools that suit various industries and objectives.

Thermo-fluid simulation software and main peripheral tools

scSTREAM P4

Structured mesh
(Cartesian/cylindrical coordinate systems)

- Designing thermal and air flow inside an office
- Evaluating air flow around buildings
- Evaluating heat island effect
- Heat dissipation design of electronics and precision instruments
- Dust-proof and moisture-proof review of electronics and precision instruments
- Multi-phase flow analysis such as mixing, spray, solidification, melting, boiling, and condensation
- Analysis involving moving objects such as cars, controlled equipment, hydraulic and pneumatic equipment, and robots

HeatDesigner P4

Module for electronics

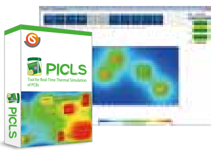
- Designing heat release of a printed circuit board
- Examining heat-releasing fins and the material
- Designing heat release of an enclosure with a fan

ElectronicPartsMaker

Tool for semiconductor package modeling

PICLS P22

Dedicated tool for thermal analysis of printed circuit boards



- Real-time thermal analysis
- Board size design
- Layer composition design
- Parts layout design
- Review of the effects of wiring pattern and thermal vias

Tools for architecture fields

WindTool
Wind environment assessment tool

Launcher (Autodesk® Revit®)
CAD add-in tool

Launcher (ARCHICAD)
CAD add-in tool

Tools for scSTREAM and HeatDesigner

Launcher (SOLIDWORKS®)
CAD add-in tool

Tools for both scSTREAM and SC/Tetra

Optimus® for Cradle
Optional tool for optimum solution search

scWorkSketch
Tool for creating automated workflow

scFLOW P18

NEW

Unstructured mesh

Powered by the new Solver with stability and up to three times faster calculation, and by the new Preprocessor that makes complex modeling and high-quality meshing accessible to entry level users.

SC/Tetra P12

Unstructured mesh
(Tetrahedral, pentahedral, and hexahedral elements)

- Aerodynamic simulation for automobiles
- Evaluation of rotational devices such as fans and pumps
- Prediction of cavitation and erosion
- Design of household electric appliances such as refrigerators and wash machines
- Internal flow analysis of ducts and nozzle
- Analysis involving chemical reactions including reactor, catalyst, furnace, combustor, and CVD
- Multi-phase flow analysis such as mixing, spray, solidification, melting, boiling, and condensation

Tools for SC/Tetra

Structural Analysis
Structural analysis tool (linear static analysis)

SmartBlades
Tool for modeling fan blades

1D/3D Coupling (GT-SUITE)
Tool for two-way coupling

Fluid-Structure Interface (Abaqus®)
Tool for two-way coupling

Fluid Bearing Designer
Tool for analyzing fluid bearing

Is your analysis tool useful in years to come?

scSTREAM and HeatDesigner have proven track records for incorporating the latest leading edge technology

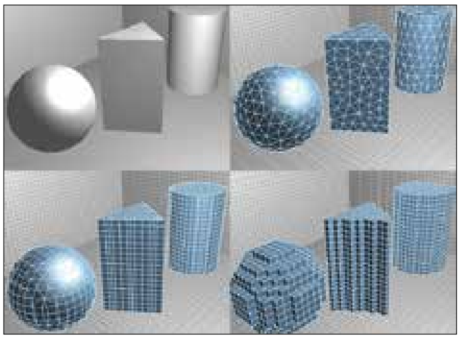
scSTREAM HeatDesigner

scSTREAM thermo-fluid software has serviced the electronics and architectural industries for more than thirty years. The ever-evolving software is characterized by its overwhelmingly user-friendly interfaces and high speed processing. HeatDesigner is based on scSTREAM and is specially developed for thermal design of electronics products. HeatDesigner provides physical functions required only for thermal design with its simple interfaces and powerful computing performance.

[*1] Only for scSTREAM

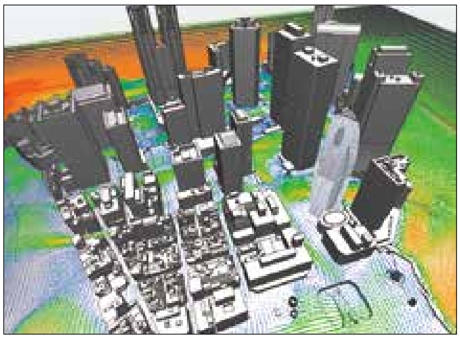
Various methods to represent shapes[*1]

The shape of a model to be analyzed can be represented by using the following methods: voxel method (slanted faces and curved faces are represented in cuboids), cut-cell method (the shape of a model created with a CAD tool can be represented more accurately), and finite element model method (a model of an arbitrary shape defined with unstructured mesh can be overlapped on a model defined with structured mesh to use the shape created with a CAD tool as is).



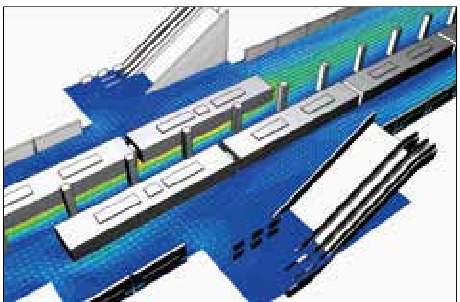
Large-scale calculation

In structured mesh, even a complicated model does not need to be modified almost at all and the shape or the scale of a model does not affect the difficulty of mesh generation. In addition, Solver performs a calculation at a high speed in parallel computing and achieves effective processing as the speed increases depending on the number of subdomains.



Moving objects[*1]

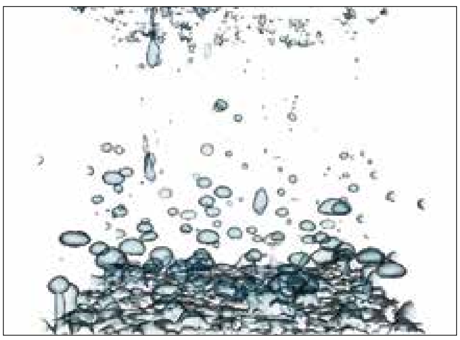
A flow generated by a moving rigid object can be calculated. Conditions including the motions of an object (translation, rotation, and elastic deformation), heat generation/absorption, and air supply/return can be set. The model of a moving object is created on another mesh. In this way, conditions such as the distance that the object moves are limited very little.

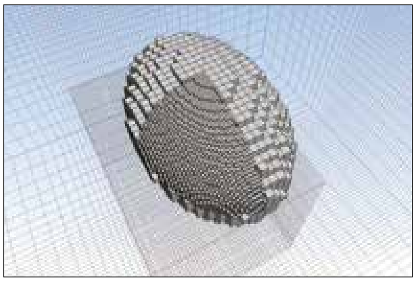


Wind velocity distribution in metro station

Boiling/condensation[*1]

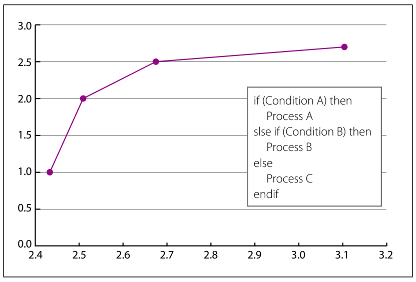
Flow with boiling, which is a gas-liquid two-phase flow due to the temperature difference between liquid and a heating surface, can be analyzed. Flow itself is analyzed by a free surface analysis MARS method, while the phase change of boiling and condensation is modeled by the change in F value (volume fraction of fluid). In addition, latent heat and the change in volume (density difference between gas and liquid) are considered.





Multiblock

Mesh can be refined partially to represent a model shape more accurately and perform a calculation more efficiently.

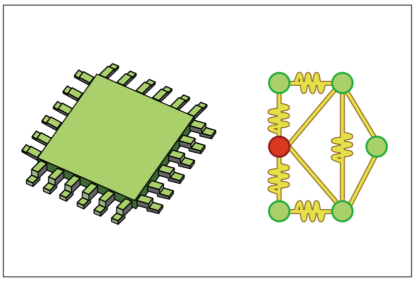


Customizing variables

Complicated conditions including trigonometric functions and conditional branches such as IF statements can be set without compiling.

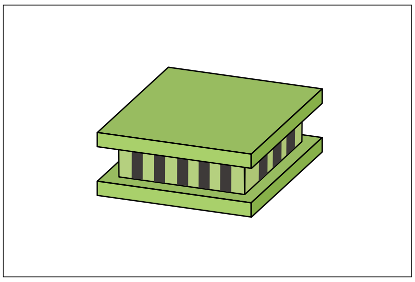
Parts library

The shapes and conditions of frequently used parts can be registered. Conditions include the allocation position, material, and heat generation.



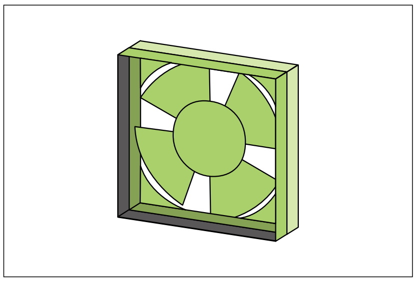
Thermal circuit model

The Delphi model (multiple-resistor model) enables highly accurate calculation.



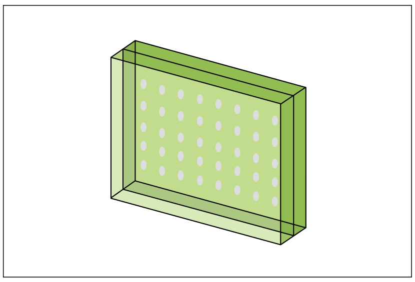
Peltier-device model

The performance characteristics of a Peltier-device model can be considered for calculation.



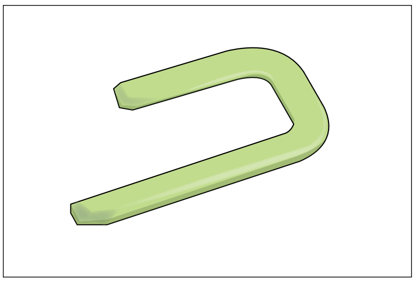
Fan model

P-Q characteristics and swirling components can be considered for calculation without creating the shape of a fan.



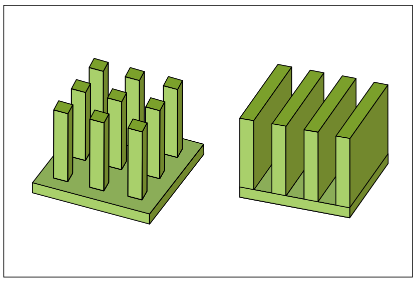
Slit punching model

The pressure loss of a part can be considered for calculation only by setting its opening ratio.



Heat pipe model

Heat transfer from a heat source to a heat-releasing part by using a heat pipe is modeled and the model can be used for calculation.



Heatsink

The shapes of pin fins and plate fins can be created easily by specifying parameters.

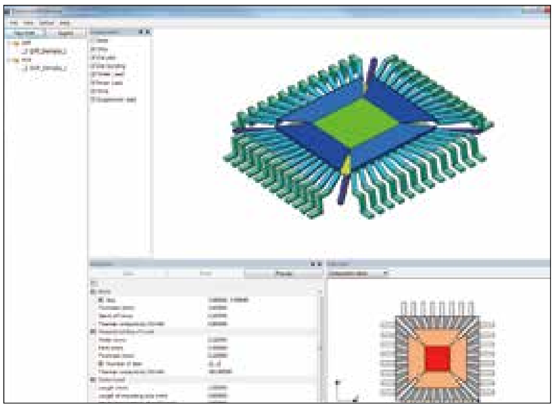
*1 Only for scSTREAM

HeatPathView

The information on temperature of each part and a comprehensive amount of heat release obtained in post-processing of a general CFD analysis is not enough to know the heat path. HeatPathView displays heat paths and the amount of heat transfer in the whole computational domain in a diagram, a graph, and a table, allowing you to find the bottleneck of the heat paths easily.

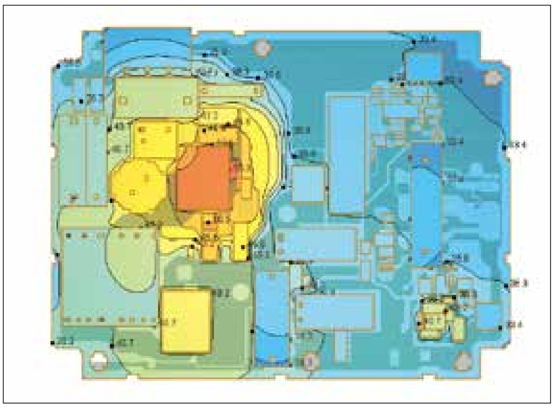
ElectronicPartsMaker

The tool can create detailed models of semiconductor packages including QFP, SOP, and BGA by specifying parameters, and simplified models using thermal resistor models such as Delphi models and two-resistor models. Manufacturers of semiconductor packages can provide the data of semiconductor packages as thermal resistor models without releasing the inside information.



Reading wiring patterns

To calculate heat transfer conditions depending on wiring patterns of a printed circuit board (PCB) in detail, the module can read Gerber data output from an electric CAD tool and import the data as a model for a thermo-fluid analysis. By using Gerber data, a more realistic calculation result can be obtained with the consideration of heat transfer affected by an uneven wiring pattern.



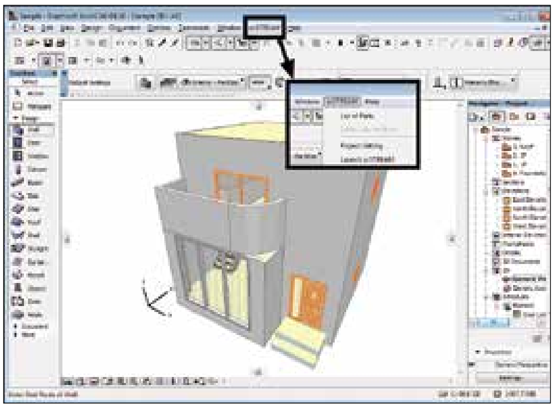
Radiation

By setting temperature difference and emissivity between objects, heat transfer by radiation of infrared rays, for example, can be considered. VF (view factor) method and FLUX method[*1] can be used. Transmission, absorption, diffusion, refraction and reflection of radiant rays can also be considered. The directivity of radiant rays can also be considered in FLUX method.

Comparison of temperatures between LED light globes of different transmittance

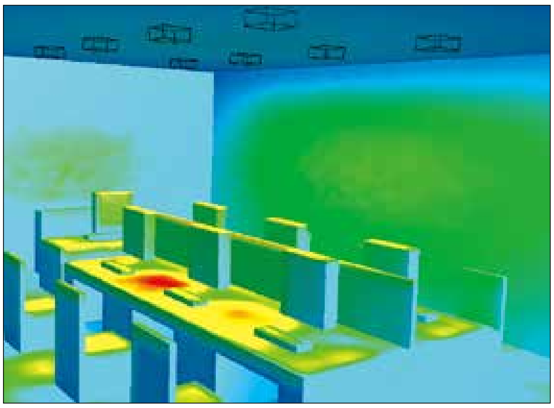
BIM[*1]

The software interface supports BIM 2.0. Autodesk® Revit® and GRAPHISOFT ARCHICAD have a direct interface (optional) through which a target part can be selected and the tree structure can be kept and simplified. In addition, the module can load files in IFC format, which is the BIM-standard format.



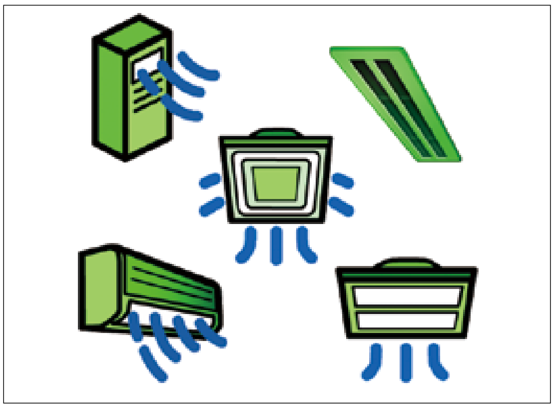
Illuminance analysis[*1]

The software can calculate illuminance of various types of light; for example, daylight through an opening of a building and artificial lighting with consideration of its directivity. Object surfaces such as walls are treated as diffusive reflection surfaces. In general, the larger an opening of a building is, the larger heat loss tends to be. By calculating the illuminance, the balance between heat and light can be examined collectively.



Air-conditioner parts | CFD parts[*1]

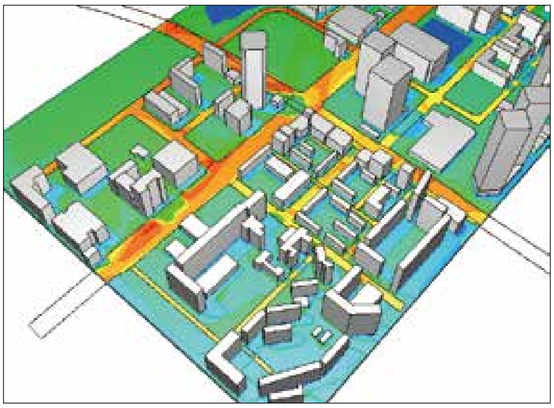
The model shapes of parts frequently used for room air-conditioning can be imported. The models include ceiling cassettes, anemostat models, and linear diffusers. The software can import CFD part data, such as air supply characteristics, provided by SHASE[*]. Various parameters can be set to simulate air-conditioning operation in addition to simple air heating and cooling.



[*] SHASE: Society of Heating, Air-Conditioning and Sanitary Engineers of Japan

Solar radiation | ASHRAE, NEDO[*1]

Climate data published by ASHRAE and NEDO is preset and can be used for condition setting. By entering arbitrary values of longitude, latitude, date, and time, the solar altitude and the azimuth angle of the sun at a specified location and time are calculated automatically. The effect of solar radiation can be examined in detail. Various parameters including absorption and reflectivity of solar radiation and materials which transmit light diffusely, such as frosted glass, can be set.

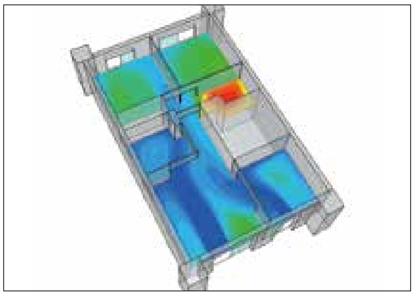


scSTREAM HeatDesigner

[*1] Only for scSTREAM

PMV, SET* Ventilation efficiency[*1]

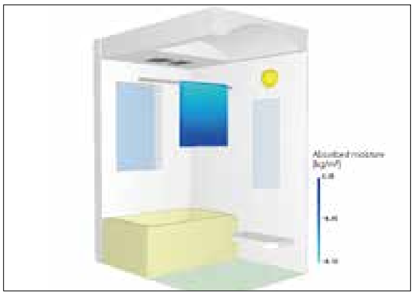
Comfort indices PMV and SET* can be derived from already obtained temperature, humidity, and MRT[*], as one of result-processing functions. The scale for ventilation efficiency (SVE), of which some indices can be converted to a real time, can be set by one click, and the range of calculation area can be selected (for example, either one of two rooms).



[*] MRT: Mean Radiant Temperature

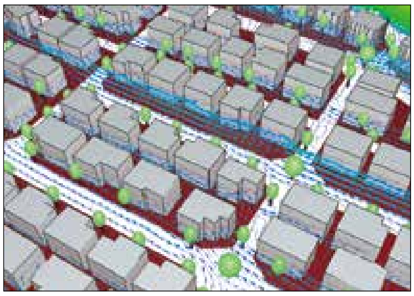
Humidity / dew condensation[*1]

The software can analyze humidity in the air. Dew condensation and evaporation on a wall surface due to temperature change can be considered and the amount of dew condensation and evaporation per time can be obtained. The software supports the analyses of moisture transfer inside a solid, and the function can be used to analyze a permeable object and dew condensation inside a part.



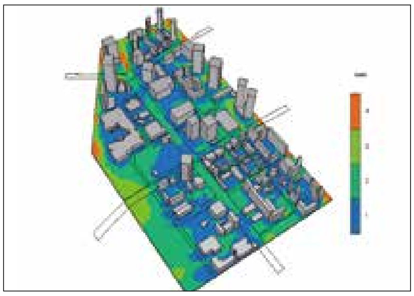
Plant canopy model (flow and heat)[*1]

Air resistance caused by plant canopy can be considered by setting the coefficient of friction and the leaf area density. For frequently used plants such as oak tree, their parameters are preset as the recommended values. The software also simulates the cooling effect by the latent heat of vaporization on a leaf surface by using the fixed temperature and setting the amount of absorbed heat. The function can be used for analyses of outdoor wind environment and heat island effect.



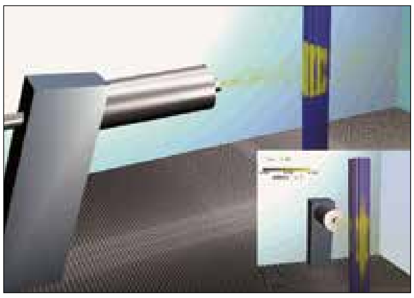
WindTool (outdoor wind environment assessment tool)[*1]

This tool helps assess outdoor wind environment. The assessment criteria can be selected from the ones proposed by Murakami et al. and by Wind Engineering Institute. By specifying a base shape and parameters required for wind environment evaluation, the parameters for 16 directions are calculated and the wind environment is ranked automatically. Detailed distributions of air current and pressure per direction can be visualized.



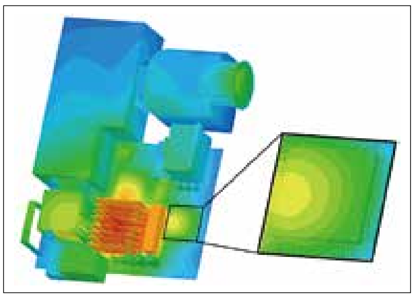
Electrostatic field[*1]

In addition to fluid force, the effect of an electrostatic field, which applies external force to charged particles, can be considered. By setting electric charge of particles and electric potential of a wall surface, the function can be used for analyses to consider area control of electrostatic coating. Velocity at which charged particles do not adhere on a wall surface can also be examined by using the function.



Mapping[*1]

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. To analyze only the inside of an enclosure for an electronic device highly affected by its outside, the analysis results of the outside can be used as boundary conditions.



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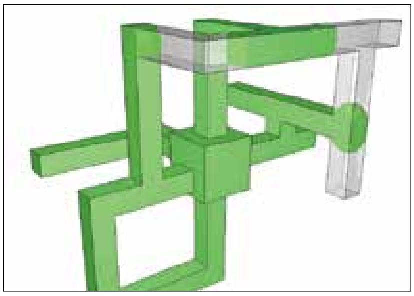
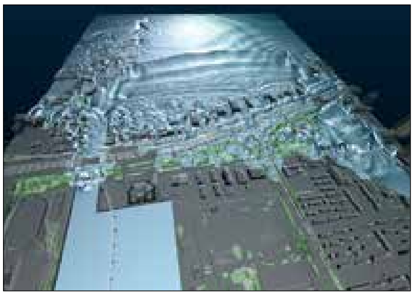
Flow of foaming resin[*1]

The software calculates the behavior of filling up an object with foaming resin, which is used as a heat insulator for houses and refrigerators. To examine speed and pressure of filling-up and the position for injecting the resin, the software simulates the behavior in 3D. The simulation can provide more pieces of information in shorter time than an actual measurement.



Free surface[*1]

The software calculates the shape of an interface between a gas and a liquid. Either MARS or VOF method can be used, and the calculation target phase can be selected: both gas and liquid, only gas, or only liquid. The function is useful in a wide range of fields: from an analysis of tsunami in the civil engineering and construction field to an analysis of soldering in the electronic device field.

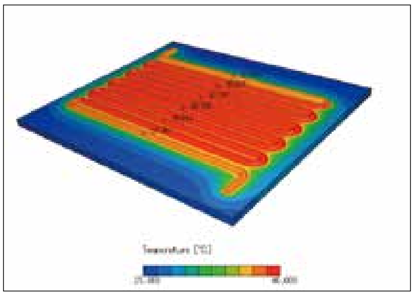


Solidification / melting[*1]

The phase change between fluid and solid, for example, water to ice and ice to water, can be considered. The following phenomena related to solidification/melting can be considered: change of flow affected by a solidified region, change of melting speed depending on the flow status, and latent heat at melting. A phenomenon that water in an ice maker becomes ice can be simulated using the function.

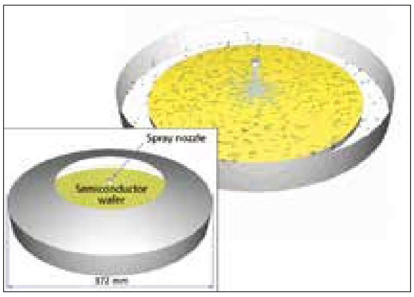
Joule heat[*1]

Joule heat, which is generated when an electric current travels through an object with an electric resistance, can be considered. By setting a wiring of a conductor and specifying values of electric current and voltage, the wiring works as a heat source automatically.



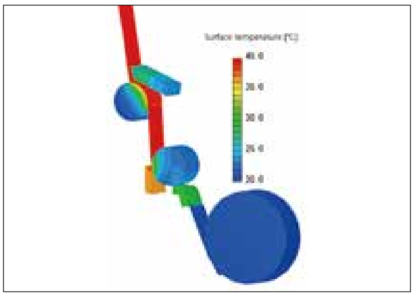
Particle tracking[*1]

The software simulates the behavior of particles depending on their characteristics (diameter, density, and sedimentation speed) and action/reaction between particles and a fluid. This includes sedimentation due to gravity, inertial force for mass particles, and movement due to electrostatic force, liquefaction at adhering on a wall surface, evaporation and latent heat, the behavior as bubbles in a liquid for charged particles.



Panel (heat conduction / transfer[*1]/ conveyor[*1])

Material properties and motion conditions can be applied to a panel having no thickness in model, which allows for heat conduction to other parts and heat dissipation to air. This enables the simulations of paper feeding and film drying processes, where thin objects move and go under heating repetitively.



Functions (scSTREAM, HeatDesinger)

			scSTREAM	HeatDesigner
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 (2D, 3D-face), VDAFS, XGL, IDF, Autodesk Revit, ARCHICAD, NASTRAN, SHAPE, 3DS, SketchUp, IFC, PRE, MDL, NFB, Gerber (RS-274D, RS-274X)	Parasolid, STEP, STL, IGES, ACIS, CATIA V5, CATIA V4, Creo Elements/Pro (Pro/Engineer), SOLIDWORKS, NX, Solid Edge, Inventor, DXF (2D, 3D-face), VDAFS, XGL, IDF, MDL, NFB, Gerber (RS-274D, RS-274X)
		CAD data interface (export)	Parasolid, STL, MDL, NFB	Parasolid, STL, MDL, NFB
		Primitives	Cuboid, hexagon, cylinder, cone, sphere, revolved rectangle, point, panel (orthogonal, quadrilateral), 2.5D solid part, pipe components, fan (flat, axial, blower), electronics (chassis, thermal circuit model (two-resistor, Delphi, multi-resistor), fin, slits, Peltier device, heat pipes), air-conditioning appliances (4 way cassette, 2 way cassette, wall type, floor type, outdoor unit, anemostat, linear diffuser)	Cuboid, hexagon, cylinder, cone, sphere, point, panel (orthogonal, quadrilateral), 2.5D solid part, pipe components, fan (flat, axial, blower), electronics (chassis, thermal circuit model (two-resistor, Delphi, multi-resistor), fin, slits, Peltier device, heat pipes)
		Geometry modification	Boolean operation (sum, subtract,multiply, divide), shape simplification (deformer, filling hole, projection deletion, R fillet deletion), copy, mirror copy, wrapping	Boolean operation (sum, subtract,multiply, divide), shape simplification (deformer, filling hole, projection deletion, R fillet deletion), copy, mirror copy, wrapping
		Registration of parts library	●	●
	Mesh generation	Tetrahedron	● (finite element model)	
		Hexahedron	● (cylindrical coordinate system)	
		Cuboid	●	●
		Cut-cell	●	
	Conditions	Easy set-up through wizard	●	●
		Preset default conditions	●	●
		Unused dialogs hidden	●	●
		Collective settings to undefined regions	●	●
		Material property library (editable)	●	●
		Laminated materials	●	●
	Operation and control environment	VB Interface	●	●
		Selectable mouse operation modes	●	●
		Mapping	●	
Solver	Mesh	Structured mesh	● (Cartesian or cylindrical coordinate)	● (Cartesian coordinate)
		Unstructured mesh	● (finite element model)	
		Multiblock	●	●
		Cut-cell	●	
		Moving objects	●	
	Numerical scheme	Finite volume method	●	●
		Pressure correction	SIMPLEC, SIMPLE	SIMPLEC
		Convection term accuracy	1st / 3rd (QUICK / WENO) upwind scheme	1st / 3rd (QUICK / WENO) upwind scheme
		Matrix	MICCG, ILUCR, ILUCGS, FMGCG, FMGCGS	MICCG, ILUCR, ILUCGS, FMGCG, FMGCGS
		Steady-state / transient calculation	●	●
	Flow types	Incompressible fluid	●	●
		Compressible fluid	●	
		Non-Newtonian fluid	●	
		Buoyancy (Boussinesq approximation)	●	●
		Multiple fluids	●	
		Gas mixing	●	
		Foaming resin model	●	
	Turbulence models		Standard k-ε model, RNG k-ε model, MP k-ε model, AKN linear low-Reynolds-number model, non-linear low-Reynolds-number model, Improved LK k-ε model, two-equation heat transfer (NK) model (high Reynolds number), two-equation heat transfer (AKN) model (linear low-Reynolds-number), LES (Smagorinsky, Dynamic Smagorinsky, WALE, mixed-time scale)	Standard k-ε model, AKN linear low-Reynolds-number model
	Thermal analysis	Heat conduction (fluid/solid)	●	●
		Convective heat transfer	●	●
		Heat radiation (view factor method)	●	●
		Heat radiation (flux method)	●	
		Heat conduction panel	●	●
		Solar radiation	● (direct / sky solar radiation / reflection)	
		Lamp	●	
		Joule heat	●	
		Mean radiation temperature calculation	●	
	Diffusion analysis	Diffusivity	●	
		Sedimentation rate	●	
		SORET effect	●	
	Index for ventilation efficiency	Age of air, life expectancy of air, inlet contribution rate	●	
	Thermal control model	PMV / SET*	●	
	Illumination analysis	Solar radiation / lamp	●	
	Humidity/dew condensation analysis	Relative humidity / absolute humidity	●	
		Dew condensation	●	
		Humidity transfer in solid	●	
	Reaction analysis	Chemical reaction	●	
		Combustion	● Eddy-dissipation model, PDF (Probability Density Function) method	
	Particle analysis	Marker particles	●	
		Mass particles	●	
		Reactant particles	●	
		Charged particles	●	
		Spray model	●	
		Transforming dew condensation	●	
		Transforming fluid / volume rate	● (MARS method)	
	Multiphase flow analysis	Free surface	● (VOF method, MARS method)	
		Solidification / melting	● (VOF method, MARS method)	
		Evaporation / condensation	● (MARS method)	
	Current analysis	Conductor current	●	
		Conductor potential	●	
		Braking effect of static magnetic field	●	
	Electric field analysis	Electrostatic field	●	
	Thermal circuit model	2-resistor / DELPHI model / multi-resistor	●	●
	Flow conditions	Velocity	●	●
		Power-law velocity	●	
		Volume flow rate	●	●
		Radial volume flow rate	●	
		Pressure (static, total)	●	●
		Natural inflow / outflow	●	●
		Air-conditioner model	●	
		Fan model	●	●
		Wave generation, wave dissipation	● (MARS method)	
	Thermal conditions	Fixed temperature	●	●
		Amount of heat generation	●	●
		Heat transfer coefficient	●	●
		Contact heat transfer coefficient	●	●

Cradle
MSC Software Company

Functions (scSTREAM, HeatDesinger)

			scSTREAM	HeatDesigner
Solver	Wall conditions	No-slip (stationary wall)	●	●
		Free-slip (symmetry wall)	●	●
		Log-law condition	●	●
		Power-law condition	●	●
		Surface roughness	●	●
	Pressure conditions	Fixed pressure	●	●
		Pressure loss	●	●
		Porous media	●	
	Source conditions	Volume force / pressure loss	●	●
		Heat source	●	●
		Smoke source (diffusing materials)	●	
		Turbulence generation	●	
		Humidification	●	
		Grass establishment	●	
	User-defined conditions	Variables table / functions	●	●
		Scripts (JavaScript)	●	●
		User-defined function (compilation required)	●	
	Calculation control environment	Job management	●	●
		Monitoring the calculation status	●	●
		E-mail notification of the calculation	●	●
		VB interface	●	●
	Output post files		Software Cradle post files (FLD, iFLD)	Software Cradle post files (FLD, iFLD)
	Output for third party software		Abaqus, NASTRAN, I-DEAS, ANSYS, Femtet, ADVENTURECluster, JMAG-Designer, EMSolution, Optimus, Isight, modeFRONTIER Autodesk Revit, ARCHICAD, ThermoRender EnSight, FieldView	Optimus, Isight, modeFRONTIER EnSight, FieldView
Postprocessor	Drawing functions	Mesh, vector, contour plots	●	
		Isosurface, streamline, pathline, 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	● (only SC/Tetra and scFLOW)	
		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 sweeping	●	
		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 (function 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)
scSTREAM HeatDesigner	Windows 10 Windows 8.1 Windows 7 Windows Vista *1 Windows Server 2012 R2 Windows Server 2012 Windows Server 2008 R2 RedHat Enterprise Linux 6 *2 RedHat Enterprise Linux 5 *2 *3 SUSE Linux Enterprise Server 11 *2	**[Memory]** 2GB or more **[Hard disk]** 10GB or more free capacity recommended	**[Memory]** 10 million mesh elements / 5.5GB **[Max. number of mesh elements]** 2 billion **[Max. number of parallel processing]** 4096	● Windows version Intel Parallel Studio XE 2015 Composer Edition for Fortran Intel Parallel Studio XE 2016 Composer Edition for Fortran ● Linux version GFortran (GNU Fortran compiler) (Linux standard)

* Note: Software is compliant with 64 bit only for the entire OS from V12 onward.

*1 Will not support after April 12, 2017.

*2 Only compliant with Solver and Monitor. Itanium 64-bit version will not be supported.
Not compliant with HeatDesigner.

*3 Will not support Monitor after March 31, 2017.

Alleviating the stress of numerical analysis?

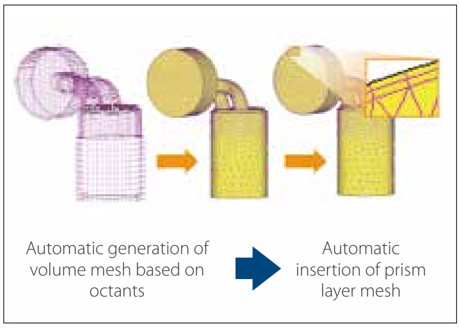
Focusing on stability and speed, SC/Tetra generates solutions faster and gives you more time for innovation

SC/Tetra

SC/Tetra is general purpose thermo-fluid simulation software using hybrid mesh to represent the surface shape with high accuracy. Its characteristics include sophisticated mesh generation system, high speed computing, low memory consumption, and user-friendly features throughout the operation. You can obtain simulation results in a short time without stress.

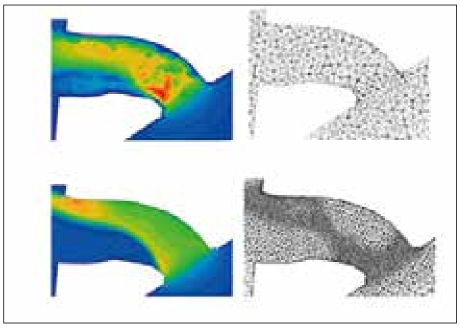
High-speed automated mesh generation

High quality mesh is automatically generated at a high speed by creating the octree and using the Advancing Front method. Prism layer elements affecting the calculation accuracy can also be created automatically and the layer thickness can be set to link with the width of a flow channel. The software enables faster mesh generation in parallel computing and supports large scale mesh.



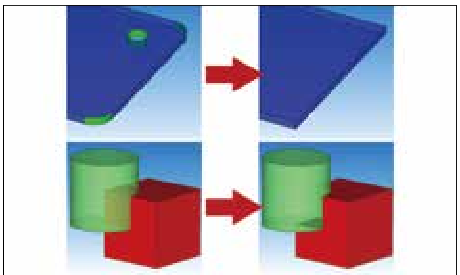
Mesh adaptation analysis

With this function in a steady-state analysis, mesh will be automatically refined at an area where the flow or pressure changes greatly. After Solver completes the calculation, Preprocessor is automatically launched and remeshing is executed based on the calculation result. You can generate a coarse mesh first and refine the mesh automatically to suit for that particular calculation with an input of the target number of mesh elements. The function is useful for an analysis of flows in a tube of a complicated shape.



Modifying CAD data

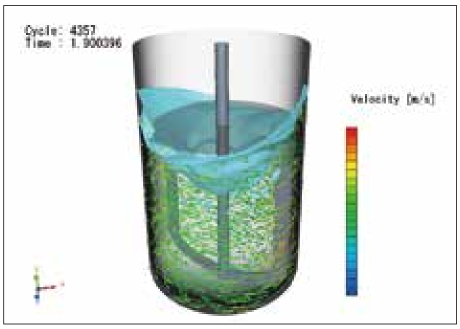
When CAD data to be used for simulation has a problem, the data can be modified in SC/Tetra. Boundary conditions can be set based on the part names and color information set in the CAD data. When some regions are missing in the model, shapes such as cuboids and cylinders can be added.



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

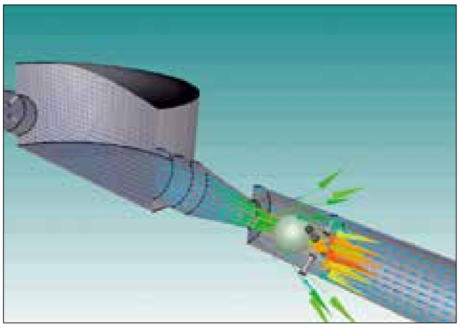
Free surface

The function is used to calculate the shape of an interface between a gas and a liquid. VOF method (Interface Capturing Method) enables high-speed calculation with high-accuracy. The function can be used with other functions such as moving boundary, overset mesh, and particle tracking. The function is useful to analyze the effect of waves to a ship and the effect of shaking to a gasoline tank, and various other analyses.



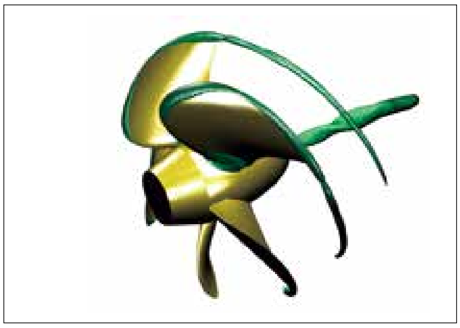
Dynamical function

Passive translation and rotation of a rigid object receiving a fluid force can be analyzed. The function enables an analysis of a ball valve with consideration on the elasticity of the spring (1D translation), and an analysis of paper plane with 6 degree of freedom (3D translation + 3D rotation). In addition, the function is used for analyzing check valves, wind power generators, and blades of wave power generators.



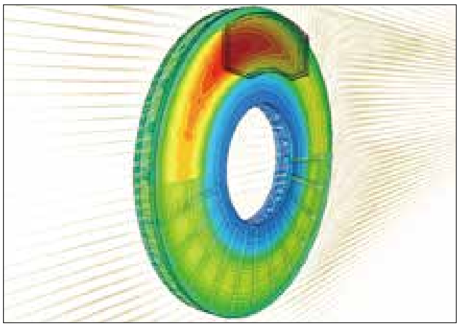
Cavitation

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 the one around 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.



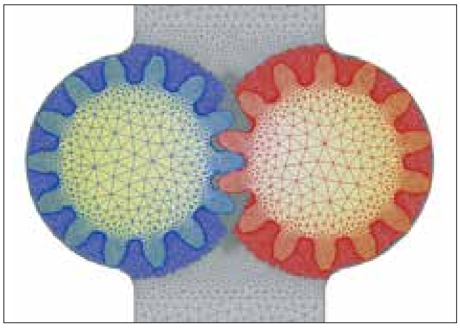
Discontinuous mesh

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.



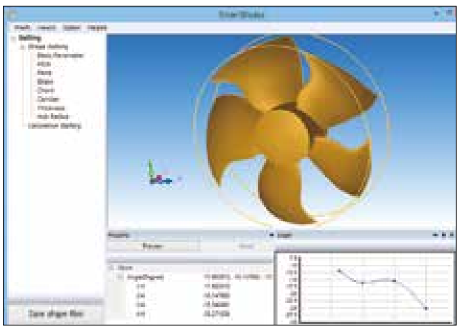
Overset mesh

By overlapping mesh for a stationary region with mesh for a moving region, a motion which was not able to be simulated using the existing functions such as deformation or rotation can be simulated. In addition, contact of objects and overlap of multiple moving regions are supported. This function is useful to analyze opening and closing of a valve of an engine port, and a gear pump that works with its gears.



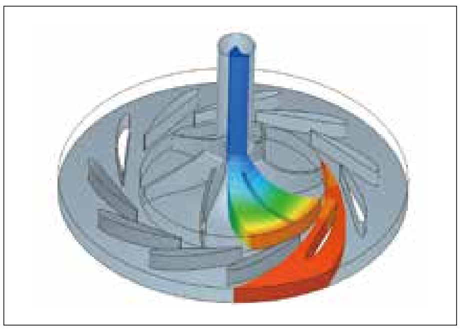
SmartBlades

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

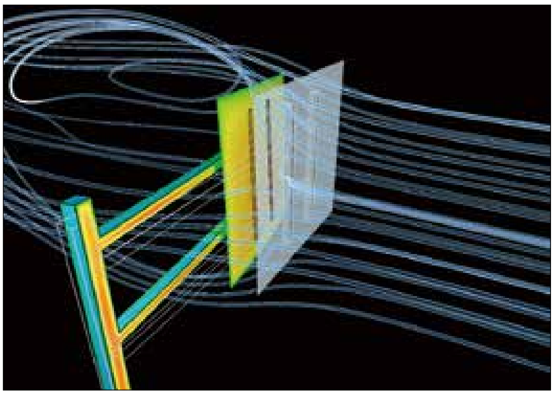
One-pitch shape can be extracted from a periodic model such as an impeller or a vane of turbomachinery. The analysis result of the one-pitch model can be checked in the meridian plane. Two regions whose pitches are different can also be analyzed. The calculation load will be reduced by using this function.



SC/Tetra

Fluid-structure interface (Abaqus®)

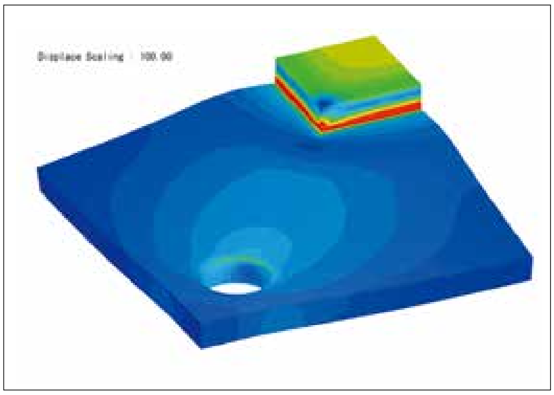
This option is used for coupled simulation that involves fluid-structure interface (FSI) by SC/Tetra and Abaqus (structural analysis software)*. Deformation of an object caused by a fluid force and the change of fluid caused by deformation of the object can be analyzed.



* Abaqus is structural analysis software provided by SIMULIA

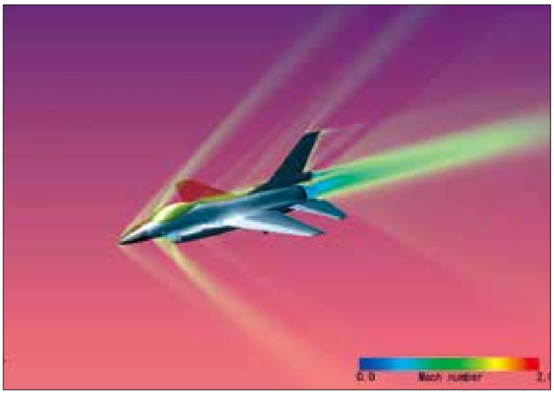
Structural analysis option

By using the analysis results including values of pressure and temperature, deformation and thermal stress of an object can be calculated. The target of the structural analysis software bundled with SC/Tetra is within the range of linear static analyses.



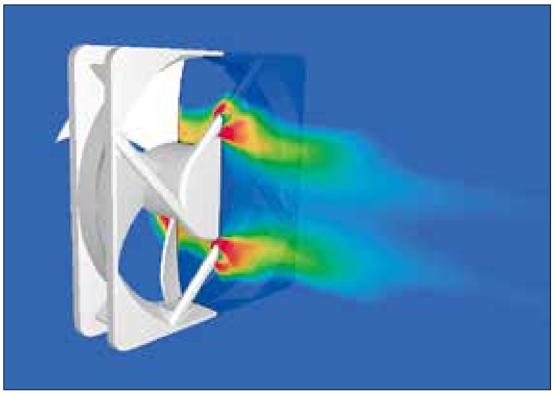
Compressible fluid

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.



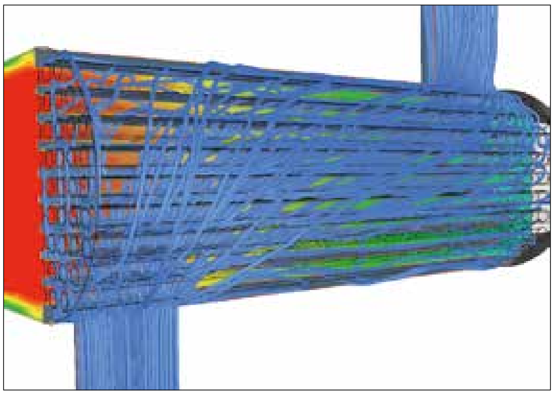
Aerodynamic noise analysis

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.



Boiling model

Boiling heat transfer on walls can be analyzed. Boiling heat transfer on walls change depending on temperature or the state of air bubbles and is not constant. Simulating small air bubbles requires large calculation load. The boiling model, which simulates air bubbles caused by boiling, can be used to analyze complicated phenomena of heat transfer with small calculation load.

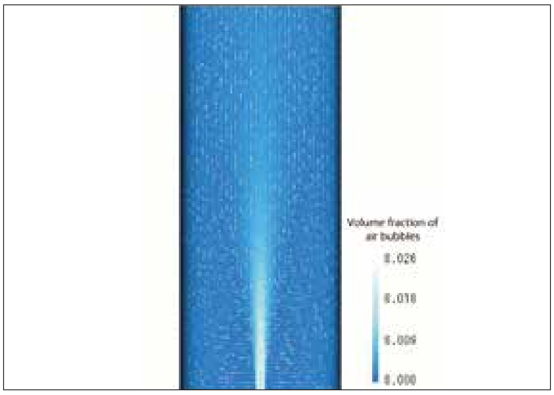


Solidification / melting

The phase change between fluid and solid, for example, water to ice and ice to water, can be considered. The following phenomena related to solidification/melting can be considered: change of flow affected by a solidified region, change of melting speed depending on the flow status, and latent heat at melting. In this way, simulations closer to real phenomena can be done.

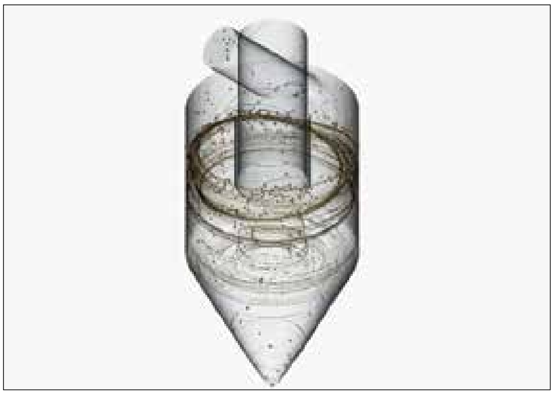
Dispersed multi-phase flow

You can analyze multi-phase flows containing many air bubbles, liquid droplets, or particles (dispersed phase) such as the bubble jet effect and an aeration tank. The dispersed multi-phase flow model regards the dispersed phase as a fluid (continuous phase). You can output distributions of volume fraction and velocity of each phase by using the model.



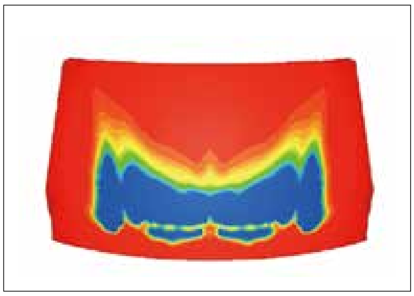
Particle tracking

The software simulates the behavior of particles depending on their characteristics (diameter, density, and sedimentation speed) and action/reaction between particles and a fluid. This includes sedimentation due to gravity, inertial force for mass particles, and movement due to electrostatic force, liquefaction at adhering on a wall surface, evaporation and latent heat, the behavior as bubbles in a liquid for charged particles.



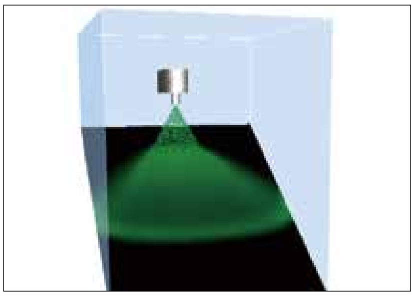
Humidity dew condensation

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.



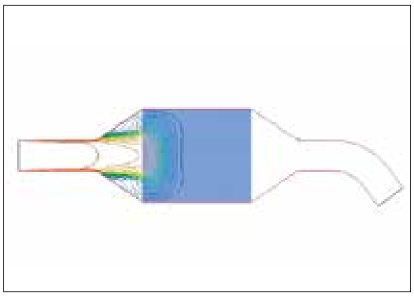
Liquid film model

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



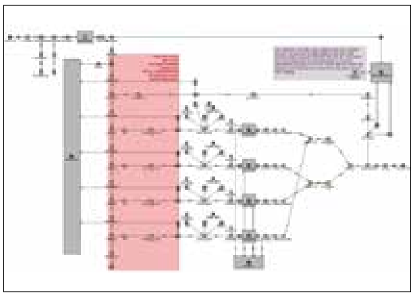
Pressure loss model

A pressure loss model of a fluid passing through porous media such as punching metal, a slit, or a sponge can be used to ease the geometry representation. The pressure loss can be arbitrarily set by the power law of velocity. The opening ratio and the direction that pressure loss affects can also be considered.



Coupled analysis with GT-SUITE

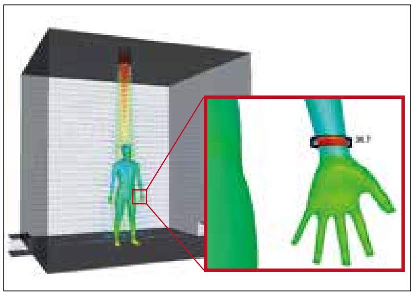
Coupled analysis between SC/Tetra and GT-SUITE* is available. The entire flow in an intake and exhaust system is calculated with GT-SUITE and small flows of each part are interpolated with SC/Tetra. This will improve calculation accuracy of the whole system.



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

Thermoregulation-model (JOS)

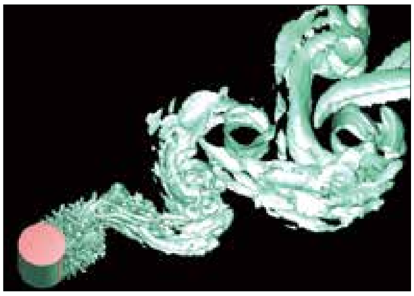
Combination use of the thermoregulation-model (JOS)* and a fluid analysis provides the surface temperature of the human body. You can consider age, clothes, and physiological phenomena of the human body such as heat transport by blood flow in addition to surrounding environment of the human body such as temperature and velocity.



*SC/Tetra adopts JOS and JOS-2 developed by Waseda University Tanabe Laboratory et al. as thermoregulation models

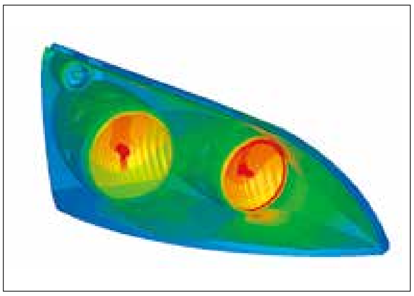
LES

LES is one of turbulent flow models. It models small eddies and directly calculates others. 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. You can use the hybrid model with RANS, a turbulent model of small calculation load.



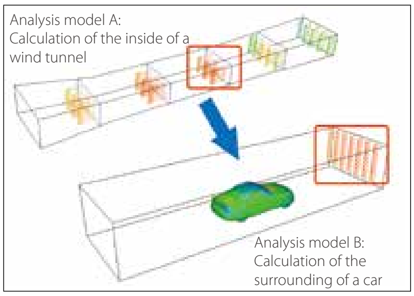
Radiation

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



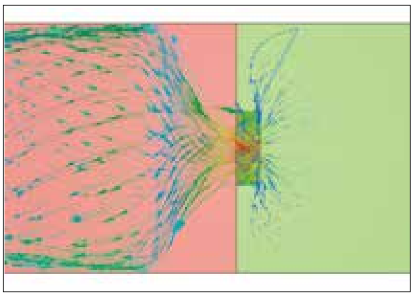
Mapping

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

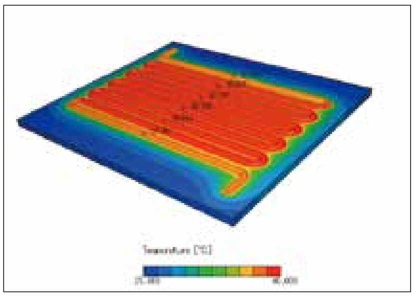
You can set conditions considering P-Q characteristics of fans without creating the shape of fans. For swirling components which are not obtained from P-Q characteristics of axial flow fans, non-dimensional swirl coefficient model suggested by JSME* research sub-committee has been adopted.



* JSME: The Japan Society of Mechanical Engineers

Joule heat

Joule heat, which is generated when an electric current travels through an object with an electric resistance, can be considered. By setting a wiring of a conductor and specifying values of electric current and voltage, the wiring works as a heat source automatically.

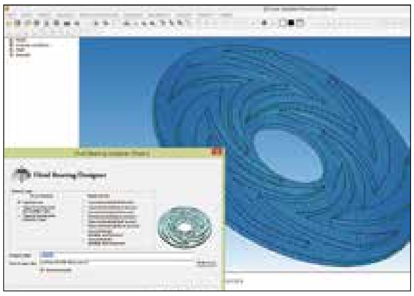


HeatPathView

The information on temperature of each part and a comprehensive amount of heat release obtained in post-processing of a general CFD analysis is not enough to know the heat path. HeatPathView displays heat paths and the amount of heat transfer in the whole computational domain in a diagram, a graph, and a table, allowing you to find the bottleneck of the heat paths easily.

FluidBearingDesigner

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.



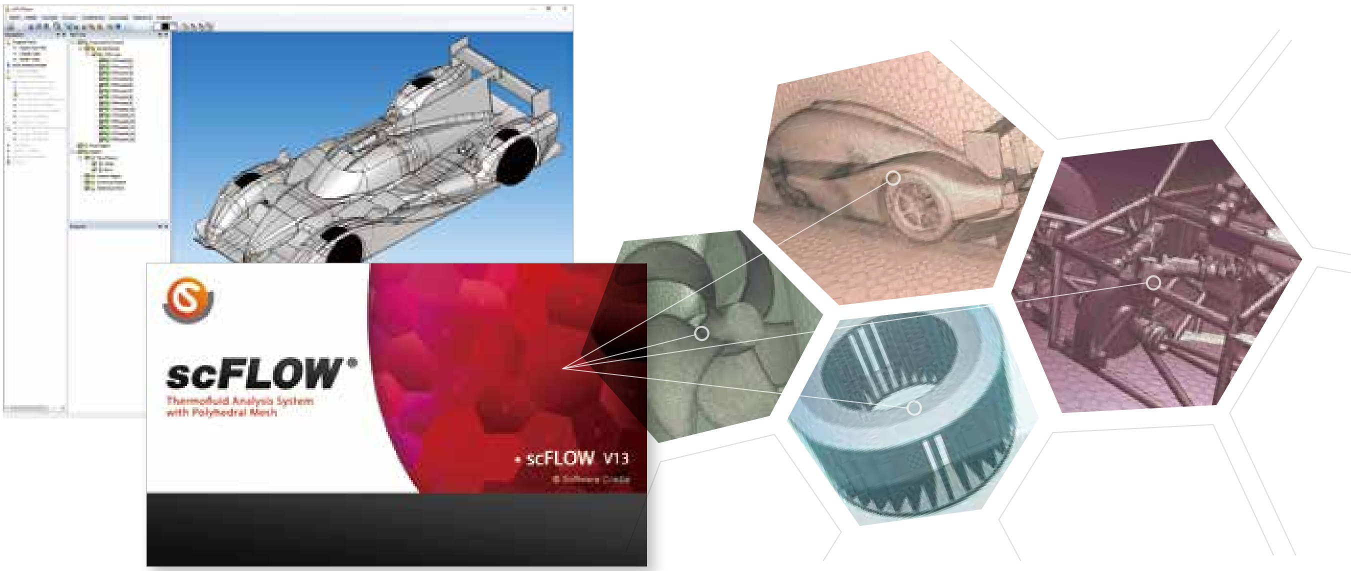
What do you want from your CFD tool?

The answer is here: [State-of-the-art & Practical]

scFLOW

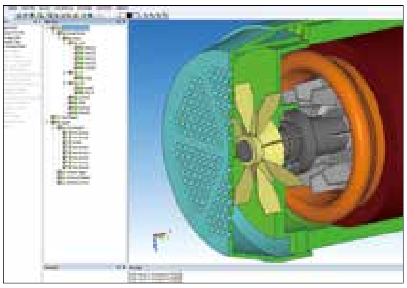
New Release !!

The new generation CFD software, scFLOW, has been developed to become the state-of-the-art tool with the breadth of new technologies and simple, practical features. The software is currently equipped with the new Solver with stability and three times faster calculation speed (at maximum) than before, as well as the new Preprocessor which helps entry-level users build complicated models and high-quality mesh. The software keeps on evolving.



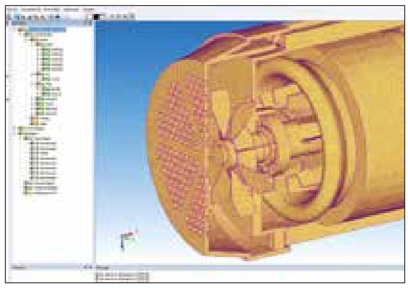
Simplification of Preprocessor operations

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.



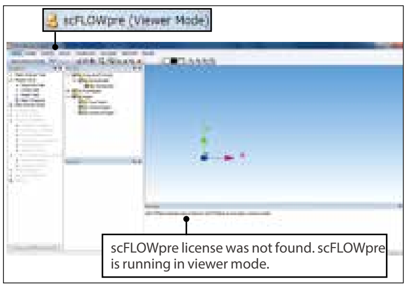
Polyhedral mesher

Roughness/refinement distribution function of the automatic mesher has been improved. Polyhedral mesh can be generated with the sizes that are best suited for the geometry.



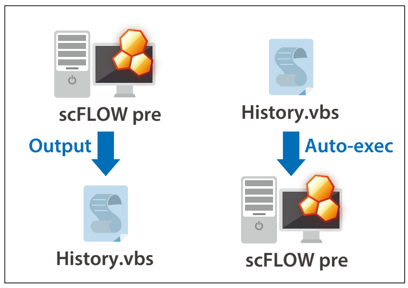
Viewer mode

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.



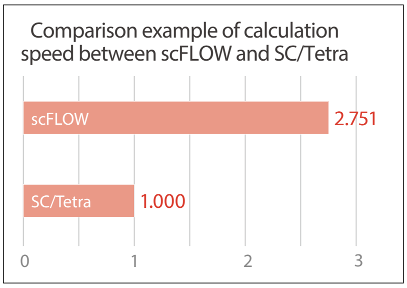
Operation logging by VB interface

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.



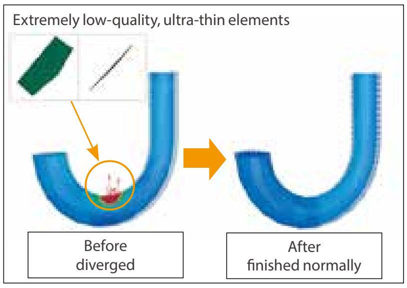
Speedup of steady-state analysis

Convergence performance has been improved and calculation time per cycle has been shortened for steady-state calculations by means of optimization of the calculation algorithm with the latest matrix Solver.
Steady-state calculation speed can be doubled or tripled compared to before.



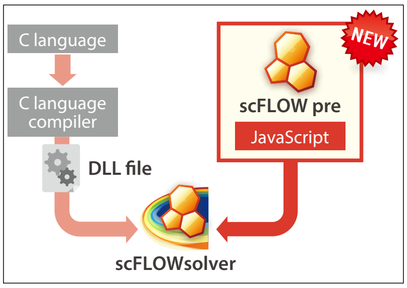
Stabilization of calculation

Even for a mesh data with elements of extremely low quality, the calculation can be stabilized by the automatic process for avoiding divergence.



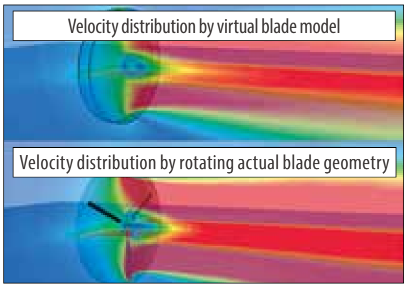
Script functions

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.



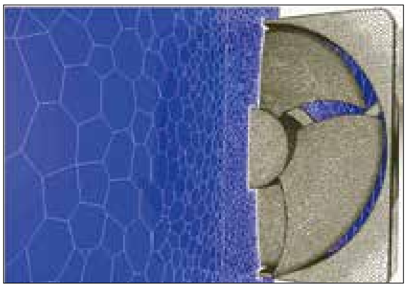
Virtual blade model

Average flow field of a rotating blade (propeller) can be reproduced not by using the actual geometry but by setting some relevant parameters: Lift curve, drag curve, pitch angle, etc. This can be utilized, for example, in an average flow field analysis with axial windmills or waterwheel.



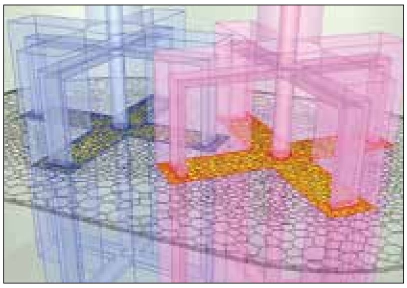
Moving elements (discontinuous mesh)

Calculations with moving objects can be performed: Rotation such as a fan, and translation such as cars passing each other. The calculation accuracy of element connections has been improved by revising the algorithm. For the HPC edition of Solver, memory consumption efficiency has been improved, which is expected to bring considerable effects in a multi-core calculation of large-scale data.



Overset mesh

Motions with high degree of freedom can be set up compared to stretching or rotating motions by oversetting multiple mesh grids (static and moving regions).

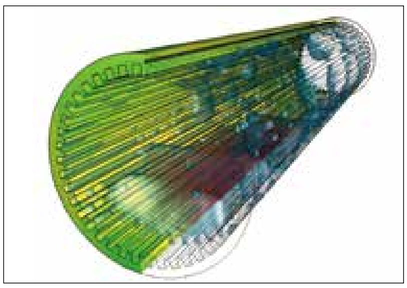


Free surface (steady-state / transient)

Shape of interface between gas and liquid can be simulated. Calculations by VOF method (Interface Capturing Method) are fast and accurate, and moving boundary function, overset mesh, particle tracking, etc. can be used in combination. For a phenomenon where the phase interface becomes stable, a steady-state calculation is possible, and the result can be obtained in a shorter amount of time than before.

Phase change

As an extension function of free surface analysis (VOF method), phase change such as evaporation and condensation can be simulated. This can be used for an analysis of the coolant in a heat exchanger.



Functions (SC/Tetra, scFLOW)

			SC/Tetra	scFLOW
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, Abaqus, NASTRAN, I-DEAS, Design Space, Plot3D, CGNS	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
		CAD data interface (export)	STL, NASTRAN, CGNS, Parasolid, MDL	Parasolid, MDL
		Primitives	Cuboid, cylinder, sphere, rectangle (panel)	Cuboid, cylinder, sphere
		Geometry modification	Data cleaning, editing solid, editing sheet, cross-section and extraction, coordinate conversion, turbomachinery (single-pitch extraction), wrapping	Data cleaning, editing solid, editing sheet, cross-section and extraction, coordinate conversion, 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)	●	●
		Dynamical moving element	●	● (rotation only)
		Mixing plane	●	
		Shape optimization (Adjoint)	●	
	Numerical scheme	Finite volume method	●	●
		Pressure correction	SIMPLEC, SIMPLE, revised SIMPLEC	SIMPLEC, SIMPLE, PISO
		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, AMG, AMGCG-STAB, CGCCG-STAB	MILUCG-STAB, AMGCG-STAB, CGCCG-STAB
		Density based	● (approximate Riemannian solution, Rotated-RHLL, Roe, HLL)	
		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, 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 three equation model, SST-SAS model, LES, DES, VLES	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
	Thermal analysis	Heat conduction (fluid / solid)	●	●
		Convective heat transfer	●	●
		Heat radiation (view factor)	●	●
		Heat radiation (flux method)	●	●
		Heat conduction panel	●	●
		Solar radiation	●	
		Joule heat	●	●
		Mean radiation temperature calculation	●	●
	Diffusion analysis	Diffusivity	●	●
		SORET effect	●	
	Index for ventilation efficiency	Passive scalar		●
	Thermal control model	PMV / SET*	●	
	Humidity / dew condensation analysis	Relative humidity / absolute humidity	●	●
		Dew condensation	●	●
	Reaction analysis	Chemical reaction	●	●
		Combustion reaction	● Eddy-dissipation model	
		Thermal CVD analysis	●	
	Particle analysis	Marker particles	●	●
		Mass particles	●	●
		Reactant particles	●	
		Charged particles	● (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, transient)	● (VOF method, steady-state/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	● (VOF method)	● (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	●	●

Cradle
MSC Software Company

Functions (SC/Tetra, scFLOW)

			SC/Tetra	scFLOW
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	●	
		Propeller model (infinitely bladed propeller theory)	●	
		Virtual blade model		●
	User-defined conditions	Variables table / functions	●	●
		Script functions (JavaScript)		●
		User-defined function (compilation required)	●	●
	Calculation control environment	Job management	●	●
		Monitoring the calculation status	●	●
		E-mail notification of the calculation	●	●
		VB interface	●	●
	Output post files		Software Cradle post files (FLD, iFLD)	Software Cradle post files (FPH)
	Output for third party software		Abaqus, NASTRAN, I-DEAS, ANSYS, Femtet, ADVENTURECluster, JMAG-Designer, EMSolution, Optimus, Isight, modeFRONTIER, LMS Virtual.Lab, ACTRAN, FlowNoise, GT-SUITE, KULI, Flowmaster, LOGE, EnSight, FieldView, AVS	Abaqus, NASTRAN, I-DEAS, ANSYS, Femtet, JMAG-Designer, EMSolution,
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	●	

System Configuration

Product	Compliant OS*	Recommended environment	Approx. measure of analysis size	Compiler environment (User-defined function)
SC/Tetra scFLOW	Windows 10 Windows 8.1 Windows 7 Windows Vista *1 Windows Server 2012 R2 *2 Windows Server 2012 *2 Windows Server 2008 R2 *2 RedHat Enterprise Linux 6 *3 *4 RedHat Enterprise Linux 5 *3 *5 SUSE Linux Enterprise Server 11 *3 *4	**[Memory]** 2GB or more **[Hard disk]** 10GB or more free capacity recommended	●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 ●scFLOW **[Memory]** 1 million mesh elements / 2.0GB **[Max. number of mesh elements]** 40 million **[Max. number of parallel processing]** 192	●Windows version Microsoft Visual Studio 2013 Microsoft Visual Studio 2015 ●Linux version GCC (GNU Compiler Collection) (Linux standard)

* Note: Software is compliant with 64 bit only for the entire OS from V12 onward.

*1 Will not support after April 12, 2017.
*2 Fluid-Structure Interface (Abaqus®) is not supported for HPC Pack.
*3 Only compliant with Solver and Monitor. Itanium 64-bit version will not be supported.
*4 Only compliant with SC/Tetra Preprocessor. Itanium 64-bit version will not be supported.
*5 Will not support Monitor after March 31, 2017.

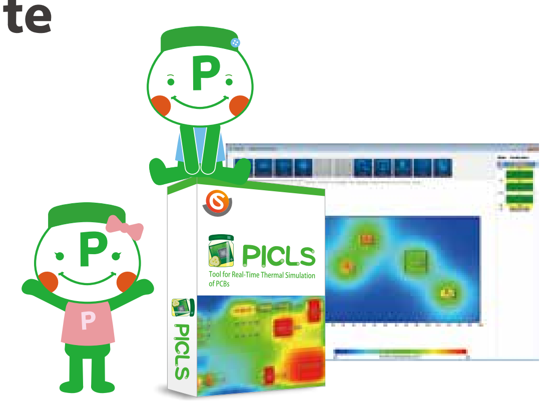
Wow! Was it this easy?!

Non-experts can start thermal analysis right away with easy operation in 2D and real-time results

PICLS PICLS Lite

http://www.cradle-cfd.com/picls/

PICLS is a thermal simulation tool which helps designers easily perform thermal simulation of PCBs. Even if you are unfamiliar with thermal simulation, you will obtain a simulation result without stress through the tool's easy and quick operation in 2D. You can import the data of a PCB created in PICLS to scSTREAM and HeatDesigner, that is, you can pass the analysis data seamlessly from the PCB design stage to the mechanical design stage.

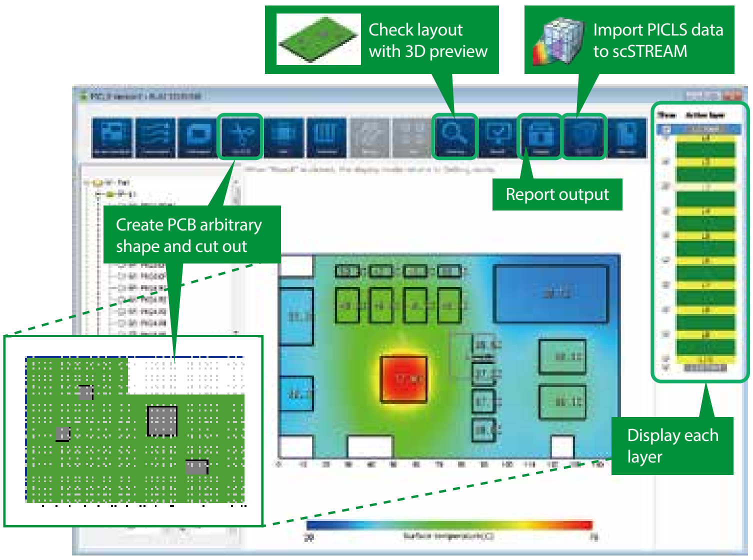


Advantages

- Easy to use
  (Operation in 2D, integrated GUI for pre- and post-processing)
- Inexpensive
- Capable of real-time analysis

Thermal countermeasures using PICLS

- Checking the layout of components to avoid interference of heat between them
- Troubleshooting thermal issues of current products
- Examining thermal interferences of part layouts
- Considering heat release depending on a wiring pattern (coverage ratio)
- Examining the location and the number of thermal vias
- Examining the performance of a heatsink
- Examining the size of a PCB
- Examining the number of layers and the thickness of copper foil
- Considering natural/forced air cooling
- Considering radiant heat
- Considering heatsinks (number of fins, size)
- Examining heat dissipation performances by connection to enclosure
- Considering PCB mounting environment



Functions available in PICLS and PICLS Lite

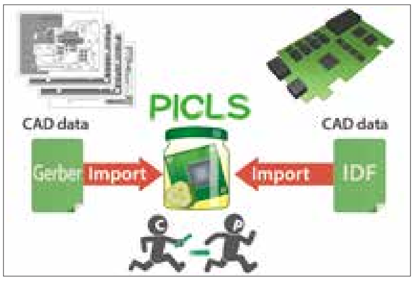
* PICLS Lite is provided online

○ …PICLS and PICLS Lite ● …PICLS only

○ Multiple layers
○ 3D preview
○ Real-time display
○ Radiation
● IDF3.0 interface
● Library
○ Wiring area specification
○ Displaying each layer
○ Automatic report output
○ Contact thermal resistance
● Considering a heatsink
● Wiring data (Gerber) import
○ Thermal via
○ Cutting out a PCB
○ Forced air cooling
○ Temperature margin, alert function
● Consideration of simple enclosure
● Drill data import

Main features of PICLS and PICLS Lite

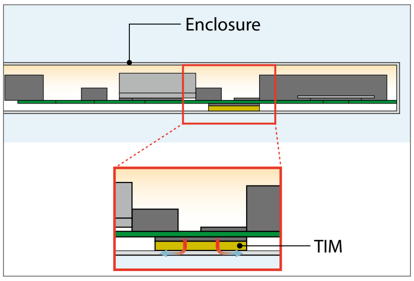
Modeling



External file interface

PICLS

You can import IDF 3.0 and Gerber data



Consideration of simple enclosure

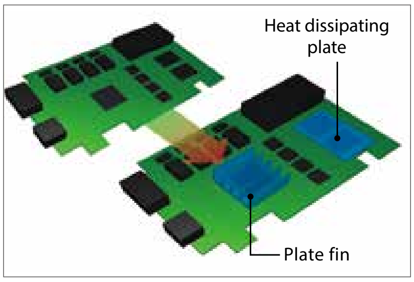
PICLS

You can consider heat dissipation by connection to enclosure

Cutting out a PCB

PICLS
PICLS Lite

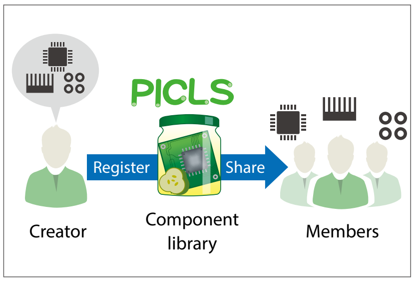
You can create a PCB of arbitrary shape using cut-out function.



Heatsink

PICLS

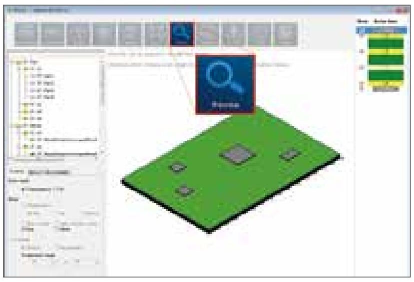
You can allocate and display parts such as plate fins and heat dissipation plates



Library

PICLS

You can register and reuse created parts to the library



Preview

PICLS
PICLS Lite

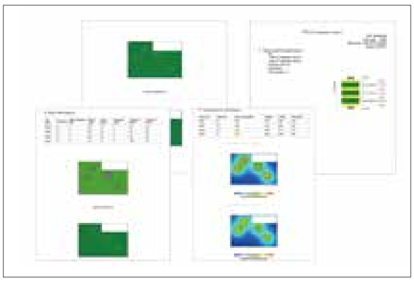
You can check the layout of components in the 3D image.

Calculation and Post-Processing

Real-time display

PICLS
PICLS Lite

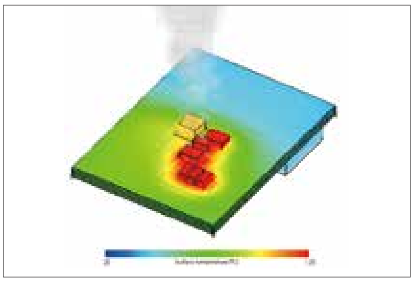
The translation of components is displayed in real time.



Report output

PICLS
PICLS Lite

You can output analysis results as reports.



Alert function

PICLS
PICLS Lite

You can check parts whose temperature
is higher than threshold

System Configuration

Compliant OS	Recommended environment
Windows 10 Windows 8.1 Pro (32bit) Windows 8.1 Pro (64bit) Windows 7 (Professional / Ultimate / Enterprise) (32bit) Windows 7 (Professional / Ultimate / Enterprise) (64bit) Windows Vista*1 (Business / Ultimate / Enterprise) (32bit) Windows Vista*1 (Business / Ultimate / Enterprise) (64bit) RedHat Enterprise Linux5*2, 6 (64 bit) *3 SUSE Linux Enterprise Server 11 (64 bit) *3	[Memory] 2.0 GB or more [Hard disk] 0.5 GB or more free capacity recommended [Display resolution] 1920 x 1080 or more

*1 Will not support after April 12, 2017.
*2 Will not support after March 31, 2017.
*3 Supports license manager only.

Analysis Procedure

–scSTREAM (HeatDesigner), scFLOW and SC/Tetra

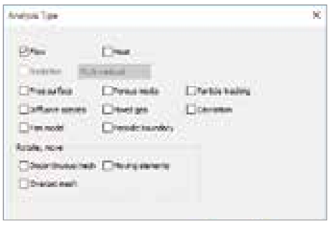
There are three major steps in the workflow for obtaining simulation results.

User input | Auto-run

STEP.1 Preprocessor

With Preprocessor, create or import analysis models, set analysis conditions, and generate mesh.

Create model
Import CAD data
Create model geometry



Set conditions
Specify properties, steady-state / transient, heat, boundary conditions, etc

Set mesh density

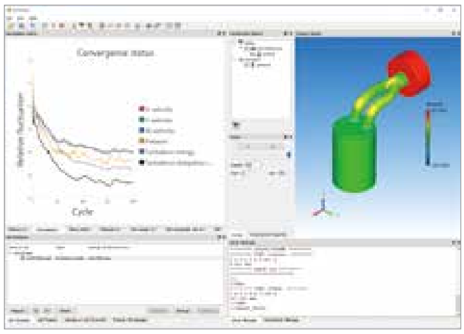
Generate mesh

STEP.2 Solver

Flow/thermal calculations are performed using input data created in the Preprocessor. During the computation, calculation status can be monitored. The amount of time required for the computation depends on the size of the model (number of mesh elements), quality of the model, and hardware. A parallel Solver is available for reducing the computational time of large-scale models.

Calculate

• Solver features (examples)
- Setting the degree of parallelism
- Monitoring job status
- Visualizing results in real-time



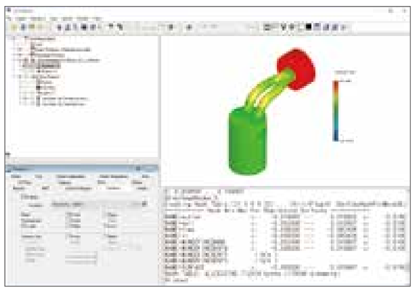
* See page 25 (HPC Solution) for more information about parallel calculation

STEP.3 Postprocessor

The Solver outputs field data for visualization using the Postprocessor. This permits examining flow, temperature, pressure, and other analysis results. Visualized results can be converted to images, animations and/or CradleViewer files for later use.

Visualize results

• Various drawing functions
- Vector plot
- Contour map
- Streamline
- Oil flow
- Isosurface
- Pathline (available only in SC/Tetra)
- CradleViewer file output
- Still image and animation output



Main Mutual Features

CAD Interface

ST: scSTREAM, HD: HeatDesigner, SCT: SC/Tetra, FLOW: scFLOW

Software Cradle analysis software can import native data from major 3D CAD software as well as import most generalized intermediate data formats (some option is for a fee). This eliminates the cumbersome process of data conversion.

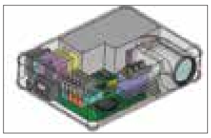
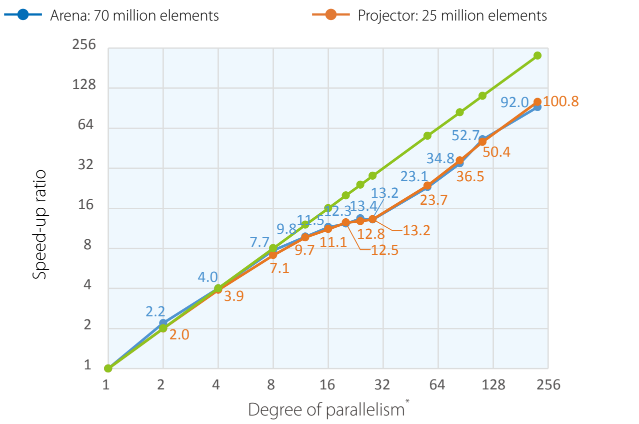
	CAD / geometry data	Compliant software	Format	V13 compliant versions
Import	CATIA V5	ST HD SCT FLOW	CATPart, CATProduct	R10~R26
	CATIA V4	ST HD SCT FLOW	model, exp, session, dlv, dlv3	4.1.5~4.2.4
	Creo Elements/Pro(Pro/E)	ST HD SCT FLOW	prt, asm, xpr, xas	13 - Creo/Parametric 3.0
	SOLIDWORKS	ST HD SCT FLOW	sldprt, sldasm (2008-2014 include add-in support)	95~2016
	UG NX	ST HD SCT FLOW	prt	11~NX10
	SolidEdge	ST HD SCT FLOW	par, psm, asm	10~ST8
	Autodesk® Inventor®	ST HD SCT FLOW	ipt,iam	V9~V2017
	Autodesk® Revit®	ST	Compliant with Lancher	2011~2016
	ARCHICAD	ST	Compliant with Lancher	15~19
	IGES	ST HD SCT FLOW	iges,igs	All
	VDAFS	ST HD SCT FLOW	vda	All
	ACIS	ST HD SCT FLOW	sat, sab, asat, asab	R1~2016 1.0
	Parasolid	ST HD SCT FLOW	x_t,xmt_txt, (x_b, xmt_bin: SCT only)	V7.1~V28
	STEP	ST HD SCT FLOW	stp,step	AP203, AP214
	IFC	ST	ifc	-
	SHAPE	ST	Shp (Polyline , polygon)	-
	3ds	ST	3ds	-
	STL	ST HD SCT FLOW	stl	All
	NASTRAN	SCT FLOW	nas (mesh for SCT only)	-
	Abaqus®	SCT	inp	-
	DesignSpace	SCT	dat	-
	Plot3D	SCT	fmt,p2dfmt,p3dfmt,dat	-
	CGNS	SCT	CGNS	-
	DXF	ST HD SCT FLOW	dxf (3D-face) , (Polymesh, 2D: ST only)	-
	IDF	ST HD	brd,emn	IDF2.0, IDF3.0
	GERBER	ST HD	gbr, drl, ECAD native (CR5000, Allegro, OrCAD)	RS274D, RS274X, Excellon
Export	Parasolid	ST HD SCT FLOW	x_t, xmt_txt, (x_b, xmt_bin: SCT only)	ST: V22~V28, SCT : V28, FLOW : V28
	STL	ST HD SCT	stl	All
	NASTRAN	SCT	nas	-
	CGNS	SCT	cgns	-

HPC (High Performance Computing) Solution

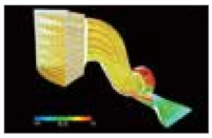
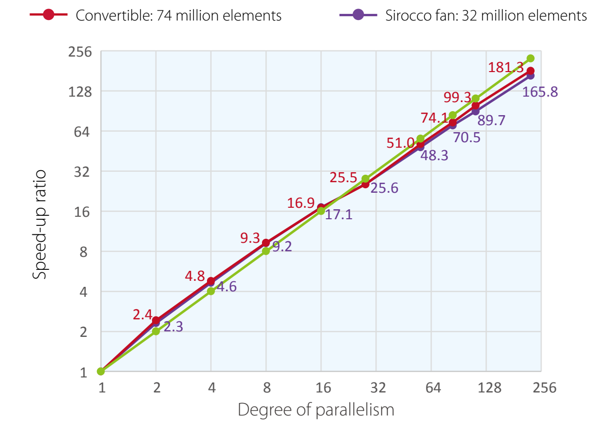
Large-scale, high-speed simulation with parallel computing technologies

Parallel computing makes possible solving existing models faster, conducting more analyses, and/or solving more detailed models with a greater number of mesh elements.

scSTREAM V12

SC/Tetra V12

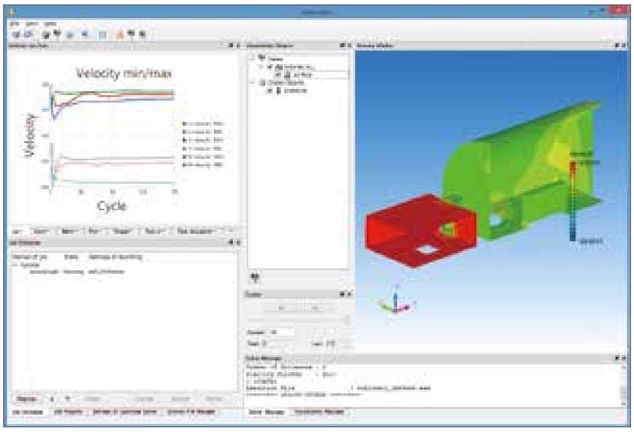




*Parallel when number of Subdomain is 1

Main Mutual Features

scMonitor

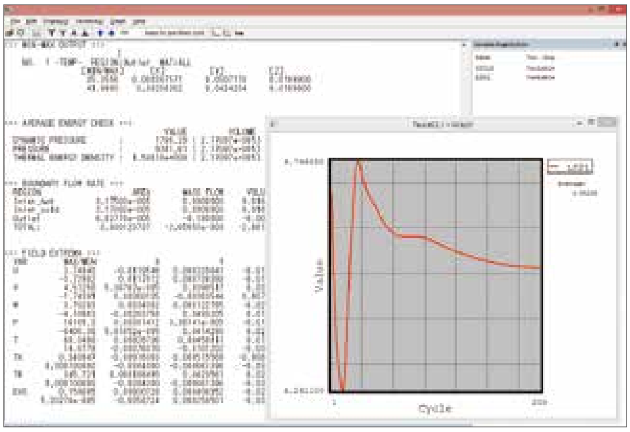
You can visualize the progress of the simulations in scMonitor during the Solver calculations. You can check, for example, pressure contour of a registered surface and temperature contour and flow vector on axial planes.



* To use this function, a Postprocessor license is required.

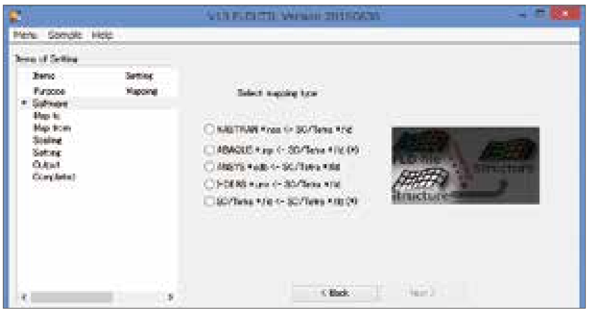
LFileView

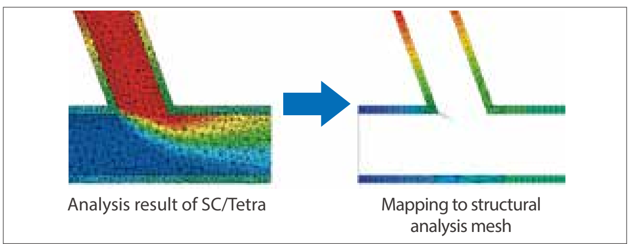
LFileView is a dedicated viewer for L files, which are output during the simulations automatically. You can check the progress of the simulations numerically with variable values for each cycle and the maximum/minimum/average values for the specified output.



FLDUTIL

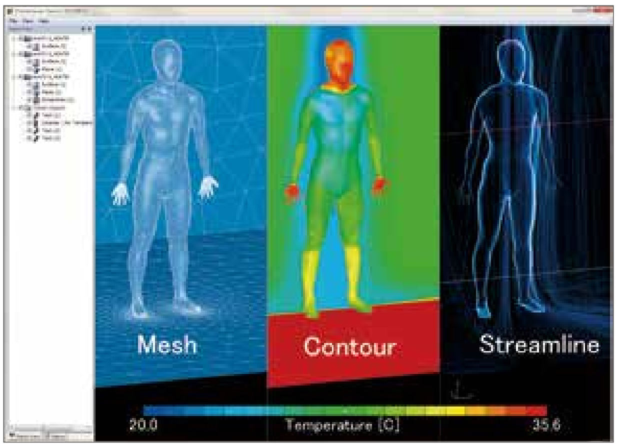
You can map the simulation results of pressure, temperature, and heat transfer coefficient onto the input data of structural analysis software (Abaqus®, I-DEAS, NASTRAN). You can also convert the input data of structural analysis software into FLD files.





CradleViewer

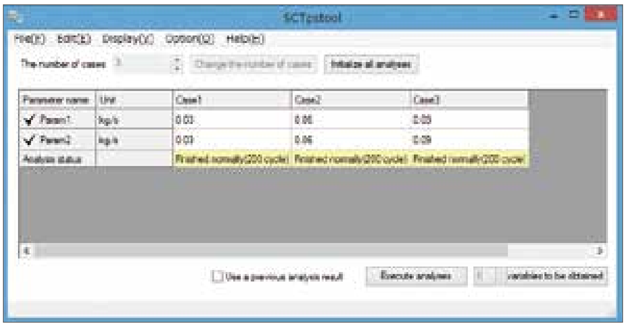
The simulation result visualized in Postprocessor can be saved in a file and the file can be opened in a simple viewer. In the viewer, the viewpoint ant the distance can be changed with the mouse and by touch operation*. CradleViewer is provided free of charge. You can share the simulation result even in an environment without Postprocessor installed.



* Operation using two fingers is supported on a multitouch-compatible screen in a Windows 10 or Windows 8.1 environment.

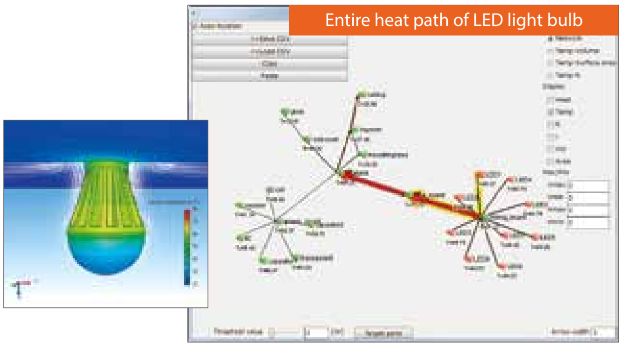
Parametric Study Tool

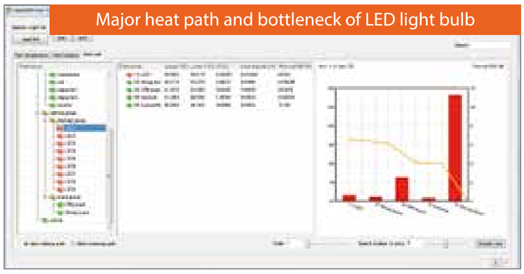
Using the parametric study tool, you can set analysis conditions to multiple cases all at once - for instance, when you run several calculations with modified parameters such as flow rate or amount of heat. The interface is user-friendly with spreadsheet-like settings. You can check, in the same interface, the status of each case and the output parameters such as the maximum/minimum temperature or average pressure on a specified plane.



HeatPathView

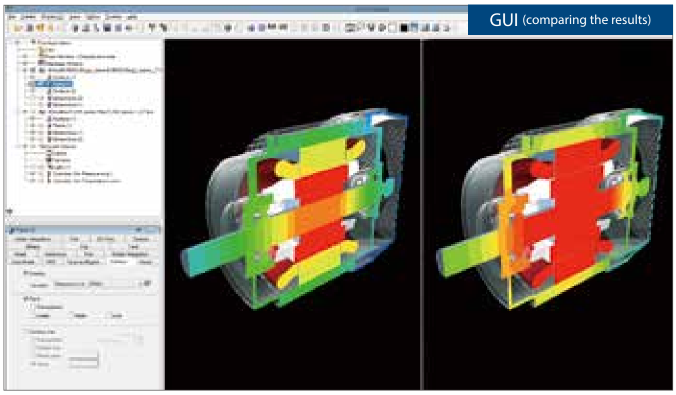
Using HeatPathView, you can review heat dissipation measures with focus on each component. The tool enables the intuitive and comprehensive evaluation of heat balance and search of heat dissipation paths. By understanding the flow of heat, you can make your heat dissipation designs more reliable.





Postprocessor

In Postprocessor, you can visualize the simulation results calculated in Solver. It is effective for product design reviews because in Postprocessor, you can check, for example, temperature distribution at the places that cannot be measured or observed in the actual products. You can output not only still images but also animations, as well as output files for CradleViewer.

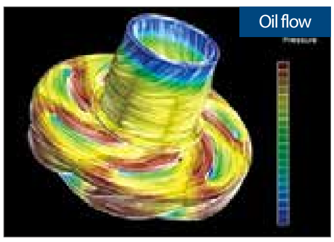


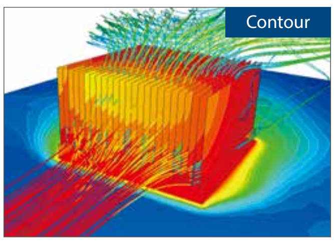
• Versatile visualization functions (example)

- Vector plot
- Contour plot
- Streamline plot
- Isosurface
- Oil flow
- Volume rendering
- Pathline plot (SC/Tetra, scFLOW only)

• Useful functions (example)

- Creates animation automatically
- Saves display status
- Develops the image on the meridian plane
- Compares results
- Calculates (integral, registering functions)





Introducing Optimus®

Optimus is an integration platform of simulation tools with optimization and automation as its cores.

* Software Cradle handles Optimus® only in Japan

Design for real

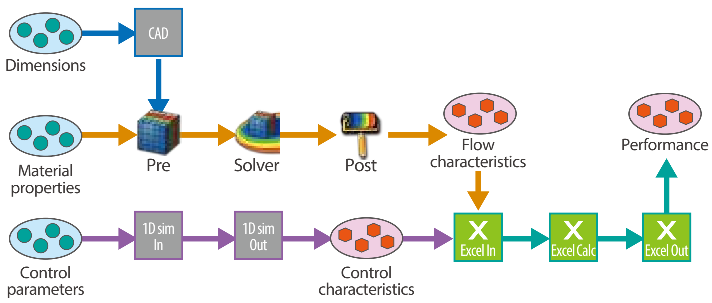
Optimus®

1. Optimus®

Optimus is an integration platform of simulation tools with optimization and automation as its cores. It has a direct interface with scSTREAM and SC/Tetra, and the optimization can be performed without any additional customization. It also supports a creation of an original GUI using API and an optimization using Quality Engineering (Taguchi Method).

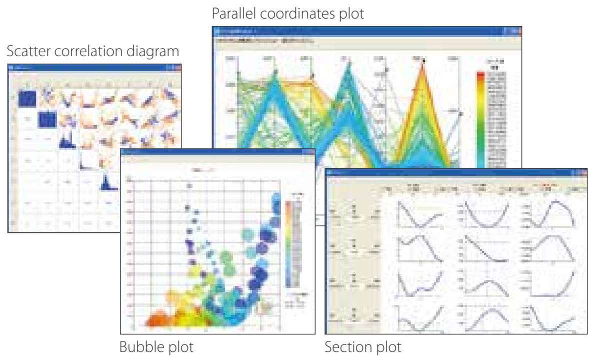
Automation/Integration

Executes the processes automatically just by constructing a simulation workflow with icons.



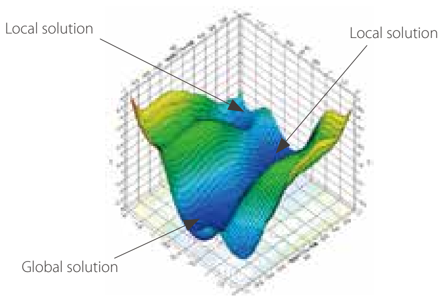
Data Mining

Visualizes data immediately. Relationships between the parameters can be grasped easily from sensitivity and correlation analyses.



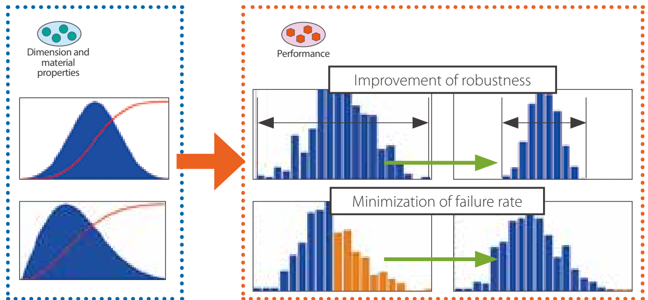
Optimization

Optimization algorithm automatically searches the parameters yielding the best performance.



Robustness, Reliability

Predicts the variations in performance from the variations of parts. This enables the design with consideration on the variations in advance.



2. Optimus® for Cradle

Optimus® for Cradle is an optional tool which allows for the uses of optimization functions of Optimus directly on Software Cradle products. Optimization can be performed with ease, by inputting design variables and other parameters from the dedicated GUI.

Comparison Table: Optimus® and Optimus® for Cradle

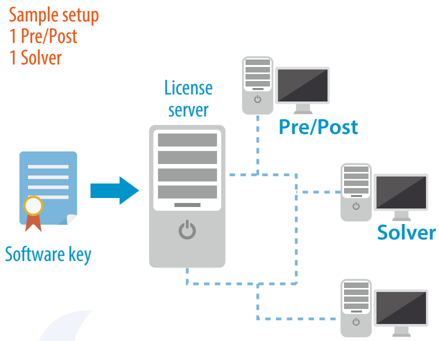
		Optimus®	Optimus® for Cradle
Linkage to Software Cradle products	Condition setting	● (Direct interface)	● (Own GUI)
Linkage to third party products	Shape modification using CAD	● (Direct Interface)	–
	Simulation linkage	●	–
Calculation method	DOE	Total 23 methods	Central Composite (inscribed), Latin-Hypercube
	Response surface	All 5 + Optional 11 methods	Least squares, RBF (cubic)
	Single-objective optimization	Local: Total 5 methods Global: Total 7 + Optional 5 methods	NLPQL (local optimization)
	Multi-objective optimization	Total 11 + Optional 5 methods	NSEA+
	Robustness / Reliability / Quality Engineering	Total 7 methods, orthogonal table L4-512, static/dynamic characteristics	–
Postprocessing	Method	Total 23 types	Correlation diagram / scatter diagram / optimum solution / Pareto optimality
	Model	Total 13 types	Contour, contribution rate

License type

We provide various license types based on customer operations, from on-premise to cloud.

1. On-premise license: Features

- Underpriced
- Internally manageable machines
- Existing hardware resources
- No data transfer
- Internally controlled security
- In-house tools (e.g. automation)
- Multiple tools in combination

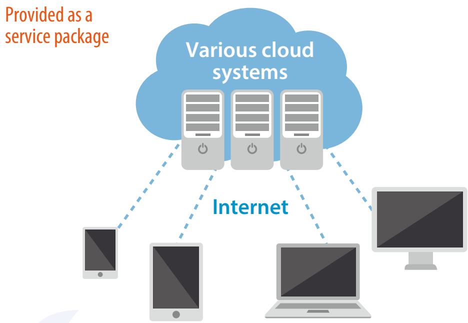


Recommended for customers who want to…

- Incorporate analysis into design workflow constantly and reduce cost
- Elaborate a combinational use of multiple analysis tools with a simple system
- Simplify analysis operations for obtaining design pointers and allow several users short-term uses

2. Cloud license: Features

- On-demand offer*1
- No hardware required
- Large-scale calculations
- Support for sudden need
- No maintenance required
- Underpriced for infrequent users
- Not an asset



Recommended for customers who want to…

- Finish large-scale calculations in a short time although ordinary calculations can be performed with on-premise licenses
- Use outside resources temporarily because in-house resources is insufficient at the time
- Handle intensive calculation jobs efficiently for one project without placing burden on in-house resources

License type lookup table

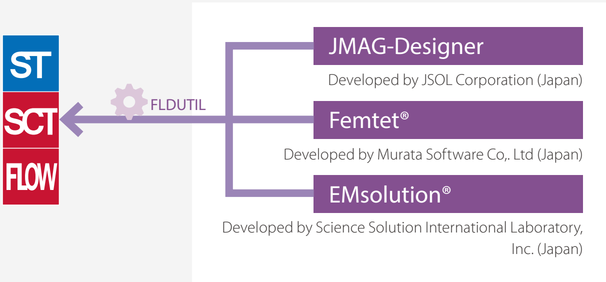
			License	Agreement type, period					
			Floating	Lump-sum	Annual	Altair*2	Cloud service*1 Monthly	Cloud service*1 Daily	Cloud service*1 Hourly
scSTREAM SC/Tetra	Pre/Post	Standard edition	•	•	•	•	•	•	•
		HPC edition	•	•	•		•	•	•
	Solver	Standard edition	•	•	•	•			
		HPC edition	•	•	•	• SC/Tetra only	•	•	•
HeatDesigner	Pre/Solver/Post	Standard edition	•	•	•				
scFLOW	Pre/Post	Standard edition	•	•	•		•	•	•
	Solver	Standard edition	•	•	•				
		HPC edition	•	•	•		•	•	•
PICLS			•		•	•			
Optimus® for Cradle			•		•				

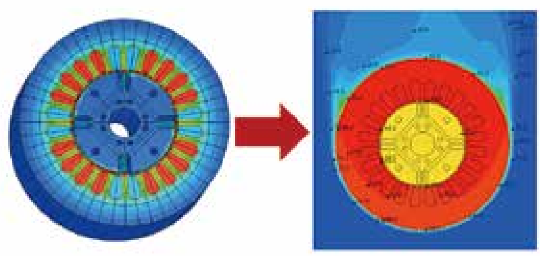
*1 Only available in a certain region
*2 Agreement type available with Altair Partner Alliance (APA) provided by Altair Engineering, Inc. For details, go to the official website of APA.

Links with other software

1. Electromagnetic Field Analysis Software

Using the data output from the electromagnetic analysis software, the effect of heat source distribution due to an electromagnetic field can be analyzed.



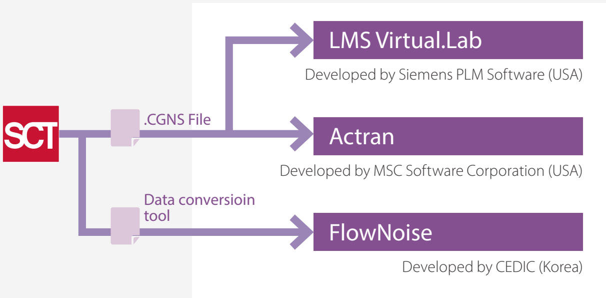


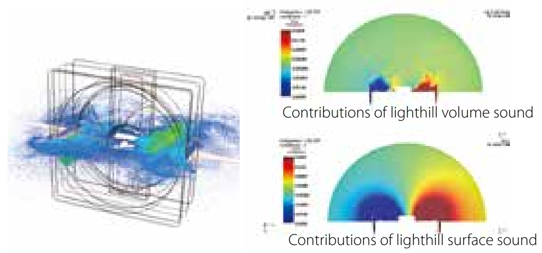
Heat source distribution calculated by using EMsolution

Analysis results obtained by using SC/Tetra

2. Acoustic Analysis Software

The acoustics of aerodynamic noise can be analyzed using SC/Tetra output data.



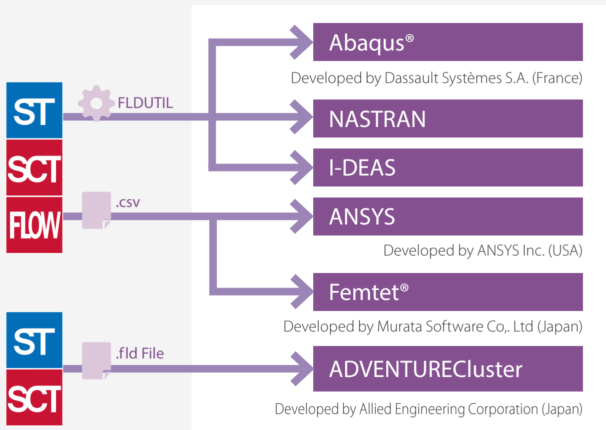


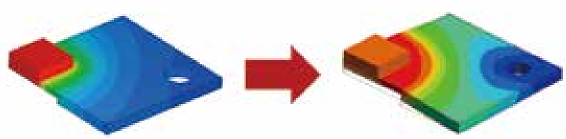
CFD analysis results using SC/Tetra (velocity vector)

Analysis results using Actran

3. Structural Analysis Software

Using the output data from SC/Tetra, structural analysis can include the influence of heat transfer and other fluid interactions.





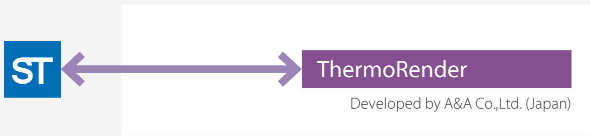
Analysis results obtained by using SC/Tetra (temperature contour map)

Results of thermal stress analysis obtained by using Femtet (displacement distribution)

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

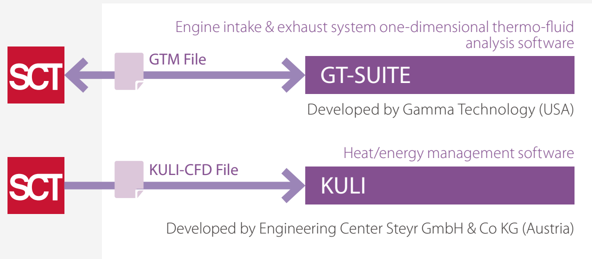
4. Thermal Environment Simulation Software

The surface temperature distribution is output from the thermal environment simulation software. The output data can be used as boundary conditions for scSTREAM calculation to analyze the distribution of wind velocity and temperature.



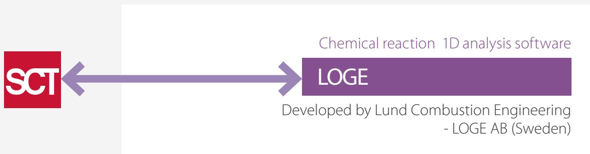
5. One-Dimensional Analysis Software

Computational load can be reduced by not solving all of the thermo-fluid analysis in three dimensions but using one-dimensional analysis software for some part.



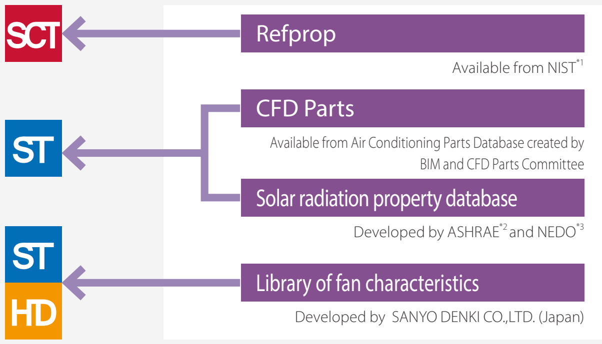
6. Chemical Reaction Analysis Software

Using material property parameters and chemical reaction database of LOGE, coupled analysis with SC/Tetra can be performed. This enables analysis of overall chemical reactions and detailed chemical reactions, which could not be analyzed by SC/Tetra alone.



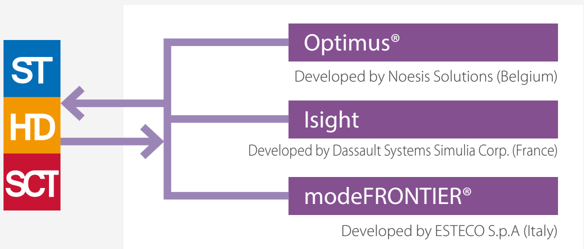
7. Material Property Library

Analysis conditions can be imported from the material property library for use in Software Cradle products.



8. Optimization Software

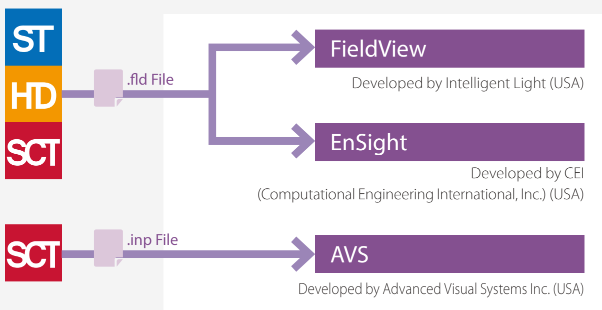
Software Cradle products can be used in conjunction with optimization software for automation and/or optimizing product design.



Optimus and modeFRONTIER have direct interface with SC/Tetra

9. Visualization Software

Read, visualize and edit FLD data (analysis results file from Software Cradle products) using other visualization software.



*1 National Institute of Standards and Technology
*2 American Society of Heating, Refrigerating and Air-Conditioning Engineers
*3 New Energy and Industrial Technology Development Organization


Osaka Head Office


Tokyo Office

About Software Cradle

Software Cradle Co., Ltd. is an innovative provider of computational fluid dynamics (CFD) simulation software. Established in 1984, the company has pursued to offer unique, innovation focused, and highly reliable CFD solutions that enhance customers' product quality and creativity. In 2016, the company has joined MSC Software Corporation (headquartered in Newport Beach, California, US), the worldwide leader in the field of multidiscipline simulation. Now as a truly global company, Software Cradle delivers all-inclusive multi-physics solutions.

For more information about MSC Software Corporation, please visit:
http://www.mscsoftware.com.

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MSC Software Company