STAR-CCM+ engineering disciplines

Delivering effective multidisciplinary technologies in a single integrated environment

Benefits

- Enables you to predict the real-world performance of your products earlier in the design cycle
- Reduces time-to-market and costly failures
- Covers a wide range of physics, including fluid dynamics, solid mechanics, multiphase flows, acoustics, heat transfer, reacting flows, electrochemistry and rheology

Summary

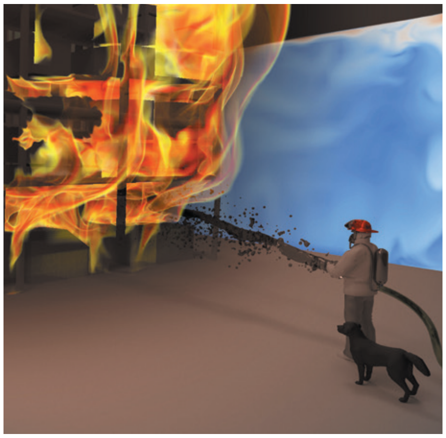
In today's competitive landscape, you must be able to quickly predict the real-world performance of your products. To be successful, your engineering simulations must take into account a broad range of physical phenomena across multiple disciplines. To accomplish this, you often have to spend a lot of your engineering time scripting together codes so they can work in unison, leaving you with less time to analyze results and implement automated design exploration.

Multidisciplinary simulations you can trust

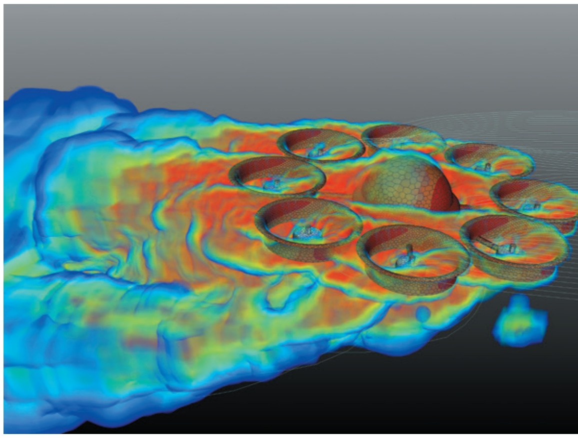
STAR-CCM+ software delivers accurate and efficient multidisciplinary technologies in a single integrated user interface. This enables you to study sophisticated industrial problems with complex physical phenomena in a fully coupled manner. This increases accuracy and helps you discover better designs faster. Our solutions cover a wide range of physics and engineering disciplines, including fluid dynamics, solid mechanics, multiphase and particle flow, acoustics, heat transfer, reacting flow, electrochemistry and rheology.

Fluid dynamics

The computational fluid dynamics (CFD) capability in STAR-CCM+ includes an efficient and accurate set of physics models and solvers with excellent parallel performance. This provides a solid foundation for you to tackle your multidisciplinary design exploration studies:



Fire accident in a warehouse. (Courtesy: Bureau of Technics)



Octocopter in forward flight. (Courtesy: Design, Analysis and Research Corporation)

STAR-CCM+ engineering disciplines

- Coupled and segregated flow/energy solvers covering your full range of applications from subsonic to hypersonic
- Steady and unsteady implicit and explicit formulations, allowing you to pick the right solver for the right application
- Wide range of turbulence models, from Reynolds-averaged Navier-Stokes (RANS) to detached/large eddy simulations (DES/LES), helping you to account for turbulence on any scale
- In-built porous media, fan and heat exchanger models for multi-domain applications

Multiphase flow
Multiphase flow problems are encountered in almost every industry and cover a broad range of applications. The key to capturing the real-world performance of your product is having the right modeling capabilities to accurately represent the physical behavior of different fluid and solid phases. STAR-CCM+ offers:

- Eulerian description:

> Eulerian multiphase (EMP): A core model for continuous, interpenetrating and reacting fluids

> Applications include bubble columns, fluidized beds, mixing vessels, etc.

> Mixture multiphase: Lightweight model that is faster than EMP for applications such as steam generators, boilers, steam turbines, etc.

> Volume of fluid (VOF): Used to track the motion of the interfaces between immiscible fluids; well suited for marine hydrodynamics and seakeeping applications

> Fluid film: Ideal for modeling thin films on surfaces. Applications include vehicle soiling, icing, fuel sprays, etc.

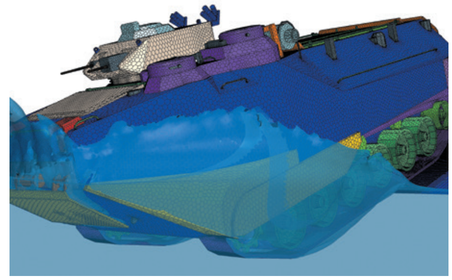
> Dispersed multiphase (DM): It is a lightweight model unique to STAR-CCM+, and is used to simulate impinging droplets, often in conjunction with the fluid film model

> Large scale interface model: Combines the benefits of Eulerian multiphase and VOF for applications such as free surfaces and sprays

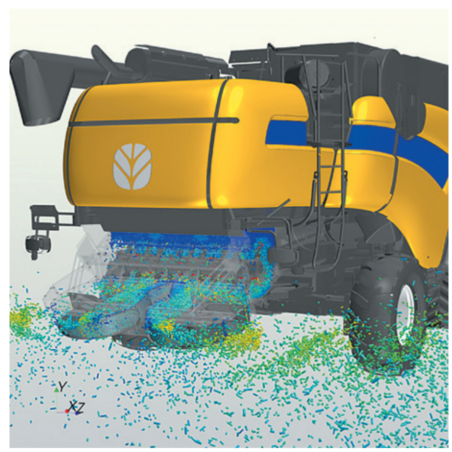
- Lagrangian description (particle dynamics):

> Lagrangian multiphase: Used to study flow with a high number of dispersed particles. Applications include spray coating, erosion, aerosol coating, etc.

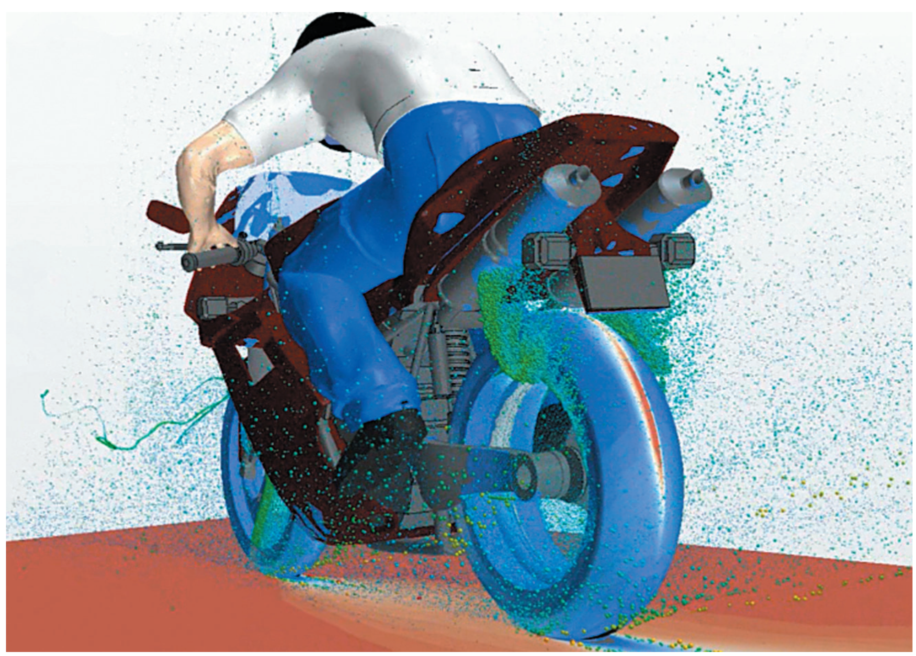
> Discrete element method (DEM): Used for solid particle flows in which particle-particle contact and particle shape are of interest, or to analyze the collision behavior of large numbers of densely packed particles. It can be used with overset meshing to simulate particle flow with motion, such as particle hoppers and conveyors



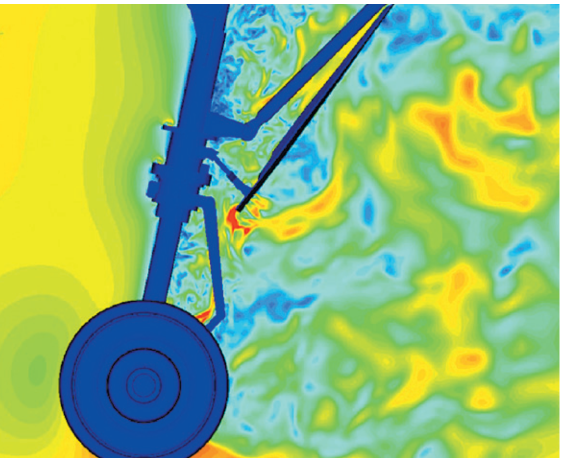
Water entry analysis of an assault amphibious vehicle (AAV7) with overset mesh.



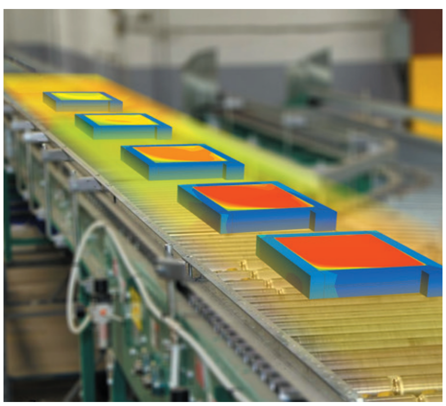
Combine harvester DEM simulation. (Courtesy: CNH Belgium N.V.)



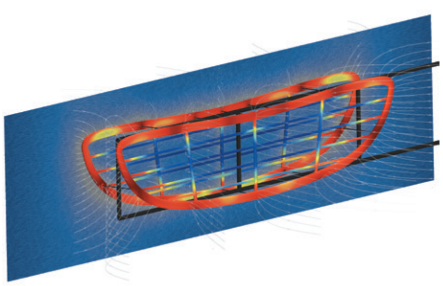
Lagrangian multiphase and fluid film interaction for water management of a motorcycle.



Landing gear aeroacoustics.



Evaporator exiting from brazing furnace. (Courtesy: Denso Subros Thermal Engineering Center, India)



Automotive grill electroplating.

Acoustics

There is an extensive library of STAR-CCM+ models for predicting aeroacoustics noise sources, including:

- Steady-state models: Quickly identify sources of noise in RANS simulation and estimate mesh cutoff frequencies for mesh refinement
- Direct models: Accurately model sources of noise with DES/LES, including prediction of convective turbulence and methods for propagating noise in the near field
- Propagation models: Model propagating aeroacoustic noise sources using in-built time domain methods. Functionality can be extended for aero-vibro-acoustics using frequency domain methods with Wave6 software
- Acoustic perturbation equations (APE) solver: Hybrid approach to improve accuracy and reduce spurious effects compared to compressible solutions
- Applications include heating, ventilation and air conditioning (HVAC), external aerodynamics, engine powertrain, aircraft noise, fan cooling, etc.

Heat transfer

With STAR-CCM+ you can accurately predict heat transfer in fluids and solids, and reduce turnaround time for thermal applications:

- Analyze conjugate heat transfer (heat transfer from both solid and fluid) within a single simulation
- Model convection, conduction and radiation (surface-to-surface radiation, solar radiation and complete discrete ordinate modeling for participating media)
- Replace solids with zero-thickness shells on thin components to save meshing and computational time

Applications include thermal comfort, vehicle thermal management, electronics cooling, gas turbine cooling, etc.

Electrochemistry

Engineers increasingly need to simulate complex electrochemically-driven processes involving ion and electron exchange between fluid and solid phases. Previously, academic codes or specialized modules were used for modeling these problems, and constrained you to two dimensions and simplified physics or geometries.

STAR-CCM+ offers a general-purpose electrochemistry approach:

- Harness the power of existing geometry, meshing and physics capabilities in STAR-CCM+
- Simulate flow, energy and electrochemistry together and open the door to real-world chemistry applications in 3D
- Applications include:

> Energy security (fuel cells and flow batteries)

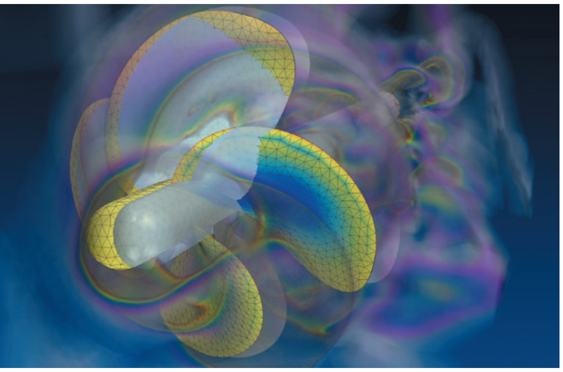
> Asset integrity (corrosion and cathodic protection)

> Manufacturing optimization (electroplating, electrochemical machining, electrolysis, aluminum, smelting and wet etching)

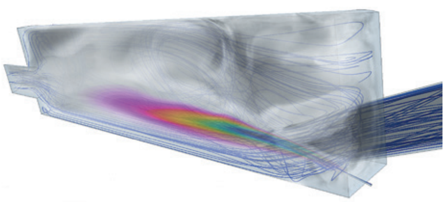
Solid mechanics

STAR-CCM+ offers both finite volume-based CFD and finite element-based computational solid mechanics (CSM) in an easy-to-use single integrated user interface. This allows engineers to expand their simulation scope to include fluid-structure and fluid-thermal-stress interactions. CSM in STAR-CCM+ allows for:

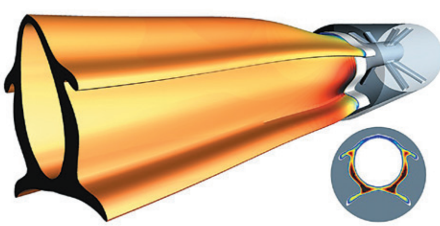
- 3D solid elements, including linear and quadratic hexahedra, tetrehedra, wedge and pyramids



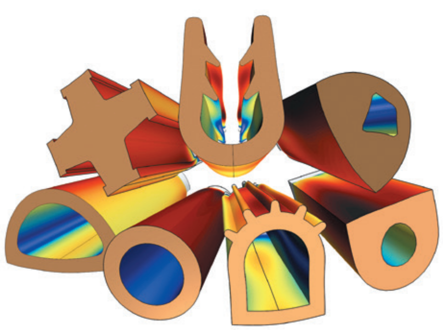
Fluid-structure interaction on a ship's propeller.



Mass fraction of carbon monoxide in a glass furnace simulation.



Rubber seal extrusion from a die.



Multiple extrudate cases with various die cross sections.

- Static, quasi-static and dynamic analysis, including nonlinear geometry and multiple parts with bonded and small sliding contacts
- Simulation of linear elastic materials, thermal strain and Rayleigh damping for dynamic analysis

Applications include heat exchangers, turbo chargers, exhaust manifolds, nuclear fuel rods, stents, fans, marine propellers, etc.

Reacting flows

Using STAR-CCM+, you can understand the interaction of the turbulent flow field with the underlying chemistry to improve the tradeoff between the performance and emissions of your device for different operating conditions as well as variations in fuel:

- Explore combustion behavior and emission production with efficient flamelet-based combustion models: flamelet-generated manifold (FGM), presumed probability density function (PPDF), coherent flamelet model (CFM), turbulent flame closure (TFC)
- Analyze gas and surface species and reaction rates using the complex chemistry solver
- Simulate coal combustion, polymerization and steam reformation in tubular reactors with tailor-made models

Applications include the design of gas turbines, after-treatment systems, catalysts, polymerization reactors, crackers, chemical vapor deposition, heaters, coal furnaces, combustors, jet engines, etc.

Rheology

Using STAR-CCM+ enables the study of complex rheological material flow behavior, providing solver tools to accurately resolve the dominant physics:

- Accurately model complex viscoelastic materials using one of four standard viscoelastic constitutive equations (Oldroyd-B, Giesekus-Leonov, Phan Thien-Tanner and extended pom-pom for up to eight viscoelastic modes) and use non-Newtonian models for solvent
- Take advantage of novel numerical stabilization techniques to significantly speed convergence and improve accuracy
- Leverage the STAR-CCM+ single integrated process from preparing the geometry to analyzing the data

Applications include static mixers (bread dough, food, etc.), flow-into containers (toothpaste, shampoo, etc.), pumping slurries with significant heat generation, extrusions (foam rubber insulation for door seals, rubber tires, etc.) and material processing.

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