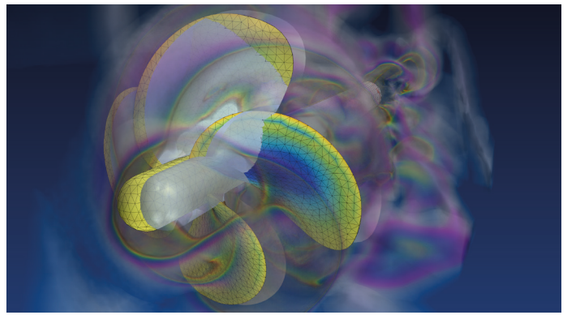
SOLID MECHANICS: BRIDGE THE GAP BETWEEN FLUIDS AND SOLIDS

STAR-CCM+ offers both finite volume (FV)-based Computational Fluid Dynamics and finite element (FE)-based Computational Solid Mechanics (CSM) from 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.
- Static, quasi-static and dynamic analysis including non-linear 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.

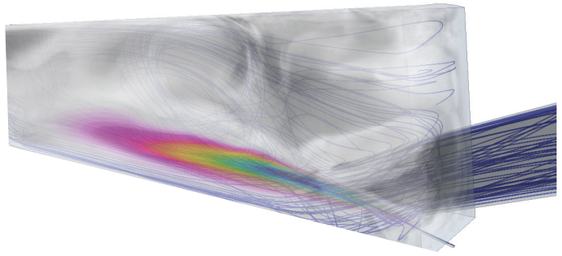


Fluid-structure interaction on a ship's propeller

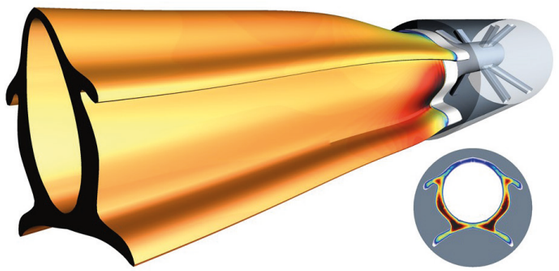
REACTING FLOWS: PREDICT COMBUSTION AND EMISSION PRODUCTION

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

- Explore combustion behavior and emission production through the efficient flamelet-based combustion models (FGM, PPDF, CFM, TFC).
- Analyze gas and surface species and reaction rates using the complex chemistry solver.
- Simulate coal combustion, polymerization and steam reformation in tubular reactors through tailor-made models.
- Applications include design of gas turbines, aftertreatment systems, catalysts, polymerization reactors, crackers, chemical vapor deposition, heaters, coal furnaces, combustors, jet engines, etc.



Mass fraction of CO in a glass furnace simulation

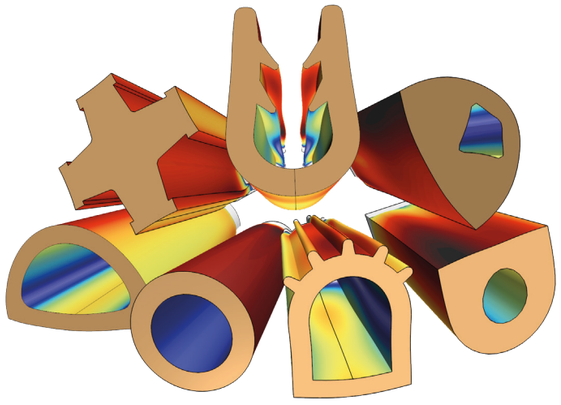


Rubber seal extrusion from a die

RHEOLOGY: MODEL NON-NEWTONIAN/ VISCOELASTIC MATERIALS IN INDUSTRIAL PROBLEMS

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

- Accurately model very complex viscoelastic materials using one of three standard viscoelastic constitutive equations (Oldroyd-B, Giesekus-Leonov and PPT 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 user interface integrated for geometry through data analysis.
- 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.



Multiple extrudate cases with various die cross sections

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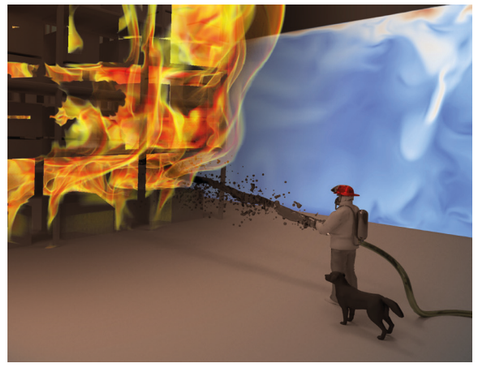
STAR-CCM+
ENGINEERING DISCIPLINES

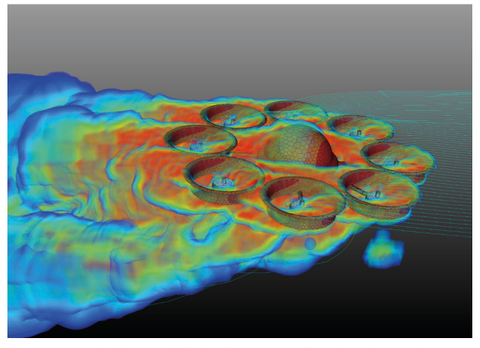
FLUID · STRUCTURE · PARTICLES · ACOUSTICS · THERMAL · RHEOLOGY · REACTIONS · ELECTROCHEMISTRY

"STAR-CCM+ gives us the ability to run multidisciplinary simulations from a single tool. This makes it ideal for a wide range of applications involving a lot of physics without having to worry about coupling different tools together."

Simone Ferrari
Bottero S.p.A.



Fire accident within a warehouse (Courtesy: Bureau of Technics)



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

MODERN CHALLENGES IN ENGINEERING SIMULATION

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 and cross multiple disciplines. To accomplish this, you often have to spend a lot of your engineering time scripting various codes together so they can work in unison, leaving you with less time to analyze results and often keeping automated design exploration out of reach.

MULTIDISCIPLINARY SIMULATIONS YOU CAN TRUST

STAR-CCM+® delivers accurate and efficient multidisciplinary technologies from a singe 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.

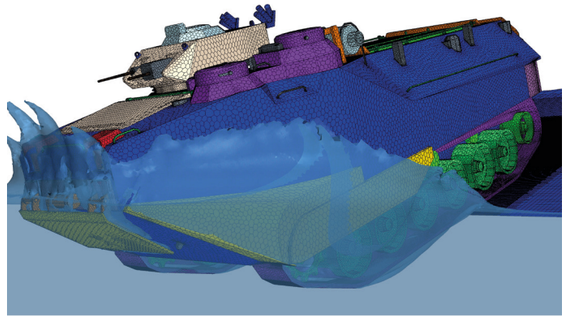
FLUID DYNAMICS: SIMULATE FLOW AT THE MACRO & MICRO LEVEL

The Computational Fluid Dynamics (CFD) capability in STAR-CCM+ provides an efficient and accurate set of models, and solvers with excellent parallel performance. This builds a solid foundation for you to tackle your multidisciplinary design exploration studies:

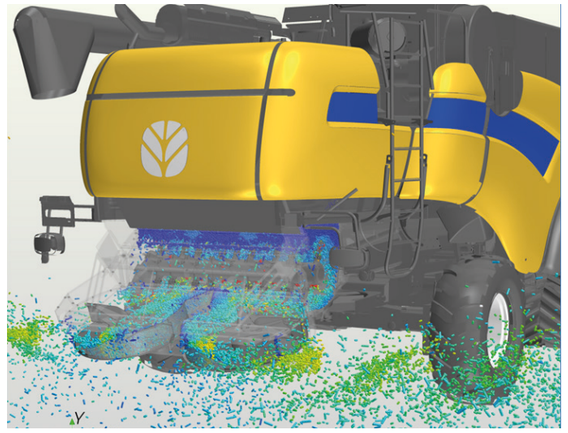
- Coupled and segregated flow/energy solvers covering your full range of applications from subsonic to hypersonic.
- Steady and unsteady implicit and explicit formulations allowing you to pick the right solver for the right application.
- Wide range of turbulence models, from RANS to DES/LES, helping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

"STAR-CCM+ has very strong and robust turbulence solvers compared to other software I have seen out there."

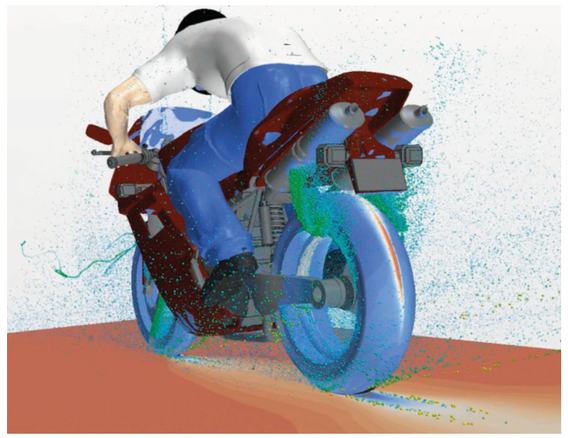
Scott Reynolds
M/E Engineering



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

MULTIPHASE FLOW: PREDICT THE REAL-WORLD BEHAVIOR OF YOUR DESIGNS

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 the different fluid and solid phases. STAR-CCM+ offers:

- **Eulerian Description:**
  - **Eulerian Multiphase (EMP):** Core model for fluids that can be considered continuous, interpenetrating and reacting. 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):** Lightweight model unique to STAR-CCM+, used to simulate impinging droplets often in conjunction with the Fluid Film model.
  - **Large Scale Interface Model:** Combines the benefits of Eulerian Multiphase and Volume of Fluid 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 where particle-particle contact and particle shape are of interest or to analyze the collision behavior of large numbers of densely packed particles. Can be used with overset meshing to simulate particle flow with motion, such as particle hoppers and conveyors.

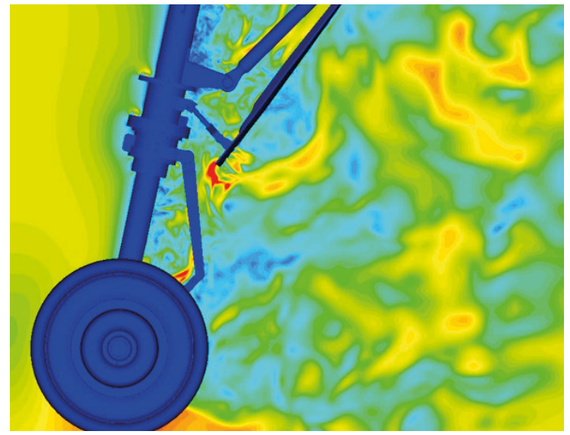
"One of the most important features of STAR-CCM+ is the Volume of Fluid method, which I use to capture and track the interfaces between the different polymer melt layers. Setting up an application which requires use of the VOF method is very easy and straightforward."

James Champion
DuPont Teijin Films

ACOUSTICS: PREDICT NOISE IN UNSTEADY FLOWS WITH A WIDE RANGE OF MODELS

STAR-CCM+ has an extensive library of accurate models for predicting aeroacoustics noise sources including:

- **Steady State Models:** Quickly identify sources of noise in RANS simulation and estimate mesh cut-off 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 inbuilt time domain methods. Functionality can be extended for aero-vibro-acoustics using frequency domain methods (with Wave6®).
- **Acoustic Perturbation Equations (APE) Solver**: Hybrid approach to improve accuracy and reduce spurious effects compared to compressible solutions.
- Applications include HVAC, external aerodynamics, engine powertrain, aircraft noise, fan cooling, etc.



Landing gear aeroacoustics

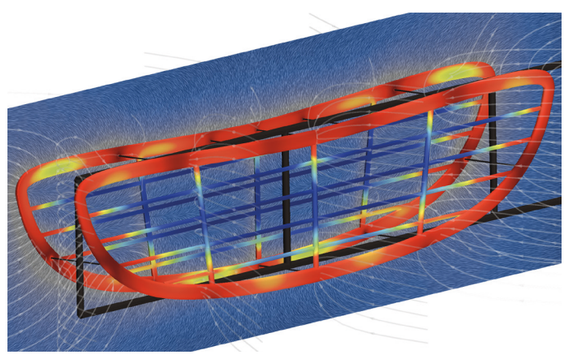
HEAT TRANSFER: DESIGN COMPLEX THERMAL SYSTEMS IN LESS TIME

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

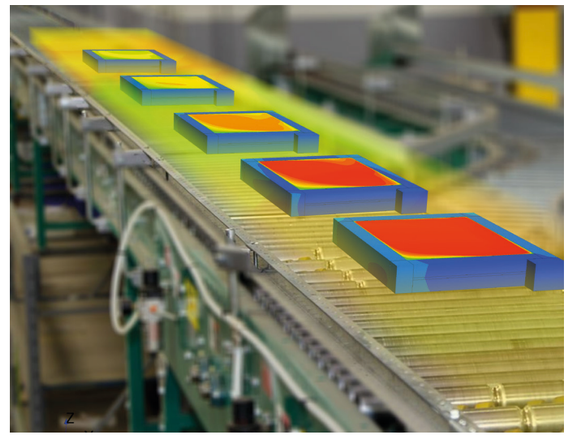
- Analyze conjugate heat transfer (heat transfer from both solid and fluid) within a single simulation.
- Model convection, conduction and radiation (surface-to-surface radiation, solar radiation and complete discrete ordinate modeling for participating media).
- Replace solids with zero-thickness shells on thin components to save meshing and computational time.
- Applications include thermal comfort, vehicle thermal management, electronics cooling, gas turbine cooling, etc.

"STAR-CCM+ has a lot of capabilities and it is continuously growing. It is growing as we speak. This is critical in terms of solving our complex problems involving heat transfer. The models we require have become progressively better, resulting in more accurate warm up and pull down predictions."

Karamjit Sandhu
Jaguar Land Rover Limited



Automotive grille electroplating



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

ELECTROCHEMISTRY: SIMULATE WITH FEWER RESTRICTIONS THAN EVER BEFORE

Increasingly engineers 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)

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