FLOW-3D Cast is a simulation software designed specifically for modeling casting processes. It combines an easy-to-use interface with powerful solver capabilities.

FLOW-3D Cast provides engineers and designers with highly-accurate flow and solidification results. With FLOW-3D Cast, quality and productivity issues can be solved in less time and with lower costs by evaluating alternative concepts with simulation before die steel is cut or molds are modified. And, the effectiveness of new tool development can be improved by solving problems before production begins.

FLOW-3D Cast is available in three packages: BASIC, EXTENDED and ADVANCED and has been translated into multiple languages.

WHAT IS FLOW-3D CAST?

PACKAGES
**GRAPHICAL USER INTERFACE**

**Design Flow**
*FLOW-3D Cast*’s intuitive interface lets users create accurate simulations quickly and correctly.

**Clear Model Input & Interpretation**
The top-down workflow ensures that all aspects of model setup are addressed. Models and parameters are defined using casting terminology.

**Fast Meshing**
*FLOW-3D Cast*’s meshing captures complex parts and molds with minimal user input required. Casting designs can be imported and meshed in minutes.

**Powerful Solver**
*FLOW-3D Cast* has a wide range of integrated physical models capable of modeling most casting processes and providing solutions to the common defects found in castings relevant to both filling and solidification.

**Material Database & Geometry Library**
Access information for alloys, molds, cores, filters and add your own materials to the database. Import risers, runners, filters or import designs from CAD packages in the Geometry Library.
**Meshing**

*FLOW-3D Cast* uses an approach to meshing that combines the advantages of simple structured rectangular grids with the flexibility of deformed, body-fitted grids using our unique methodology known as FAVOR™. Fixed grids of rectangular control elements are simple to generate and possess many desirable properties (e.g., improved free-surface flow accuracy, smaller demands on memory, and simpler numerical approximations). The FAVOR™ method enables *FLOW-3D Cast* to maintain accurate flow calculations around complex geometries by alleviating momentum losses typically found in a structured grid.

This technique is referred to as ‘free-gridding’ because the mesh and geometry can be changed independently of each other, greatly simplifying the meshing process and saving significant time in setting up a simulation. Once the computational domain is defined, the imported geometry is quickly embedded in the mesh. Another strength of this approach is in the ability to easily interchange geometry to test different design variations without the need to change the mesh.
POST-PROCESSING WITH FLOWSIGHT™

FlowSight is an integrated state-of-the-art post-processing tool based on the industry leading Ensight, which has been highly customized for FLOW-3D Cast. Its capabilities include:

- Multiple iso-surfaces
- 2D clips with FAVOR™ geometry
- Animated streamlines
- Multiple viewpoints of simulation results
- Simultaneous view of FSI/TSE and fluid flow results
- Extensive annotation capabilities
- Read/plot data from external source
- Interactive queries
- Texture mapping
- 3D stereo
- Definable viewpoints
- Volume rendering
- Flipbook
- Portable Results
- Defects toolbar: oxides, entrained porosity, early solidification, last location to fill, hot spots, tracers, and volume rendering
- Vent flow rates
DEFECT PREDICTIONS

**Oxide Formation**

FLOW-3D Cast's defect tracking capabilities help predict where oxides are most likely to occur during the filling process. Oxides form due to an exposed molten metal surface to air and can end up in undesirable locations. The final location of the defects depends on the overall flow conditions, turbulent mixing, fluid jetting and impingement. FLOW-3D Cast accurately tracks these oxides and their final locations.

**Air Entrainment**

The air entrainment model in FLOW-3D Cast is used to estimate the amount of entrained air that occurs in metal casting systems during filling. This model is based on simple physical mechanisms, and is an excellent predictor of porosity.

**Microporosity**

FLOW-3D Cast has a model specially designed to predict the occurrence and location of microporosity occurring late in the solidification stage. With this information, you can make design adjustments and avoid critical defects.

**Solidification and Shrinkage**

FLOW-3D Cast has a complete suite of tools for modeling solidification and pinpointing areas of excessive shrinkage or porosity, allowing you to determine placement of risers to assure such defects are alleviated.

**Thermal Stress**

FLOW-3D Cast's thermal stress model enables you to predict precisely where stresses will occur and how a casting distorts. Stresses are simultaneously computed in the mold and in solidifying metal with simple options for the interaction between them.
**DEFECT PREDICTIONS**

**FOUNDRY APPLICATIONS**

**IRON SOLIDIFICATION**
The iron solidification model describes the eutectic and near-eutectic solidification of cast irons capturing the formation of austenite, graphite and carbide and the density variations that occur during the cooling process as these different phases form.

**CORE GAS GENERATION**
The core gas model predicts the effects of gas generation during the pouring and solidification process for resin-bonded cores. Chemical binders in sand can produce gas when heated by the molten metal and, if not vented adequately, the gas may flow into the casting resulting in porosity defects. The core gas model predicts the location and quantity of these gas defects and helps to design core venting that will effectively evacuate all the binder product gas from the cores.

**DIE CASTING APPLICATIONS**

**COOLING CHANNELS**
Cooling channels are used in die casting and permanent mold casting for thermal management to prevent the overheating of the die and to control solidification. FLOW-3D Cast’s cooling channel model includes time-dependent temperature and heat transfer coefficients and thermocouple-controlled activation for cooling and heating.

**DIE EROSION**
One of the causes of die erosion is cavitation, which occurs when metal pressure drops below a critical level due to flow separation and high velocities. This unsteady flow can be very damaging to dies. FLOW-3D Cast’s cavitation potential model helps you determine where cavitation-induced die erosion might occur and make adjustments before the actual casting.
Oxide films form when metal is exposed to air. With mixing, the oxides can fold, entrapping them in the part, which reduces the structural integrity of castings.

The engineering team at Hellebusch Tool & Die ran several high pressure die casting filling simulations to look at possible defects in a steering wheel casting to see whether they needed to change the casting design. Their simulation results show that the majority of the oxides were trapped in the overflows. However, the top and bottom of the back of the steering wheel indicate locations where overflows could be placed in order to capture oxides to further improve the casting quality.
**DIE CASTING**

*FLOW-3D Cast* is well suited for simulating die casting processes such as low pressure die casting and both hot and cold chamber high pressure die casting. *FLOW-3D Cast* can model the entire process, from thermal die cycling and shot sleeve optimization to filling and solidification-related defects to thermal stress evolution.

**THERMAL DIE CYCLING**

Die cycling simulations are essential for high pressure die casting since the same die is used repeatedly to produce many thousands of castings. These simulations must provide accurate temperature distributions in a die throughout multiple die cycles. With *FLOW-3D Cast* the temperature distributions for thermal die cycles are calculated for solidification, die opening, spray, air blow, and die closing.

**LADLE POURING & SHOT SLEEVE**

Help determine the optimum shot profile to fill your die by modeling the interaction between the moving piston and the metal in the shot sleeve, minimizing the amount of air entrainment. Test designs quickly by changing only a few parameters and see results easily.
Filling of a gravity casting using the General Moving Objects model to simulate a moving ladle with a prescribed motion that matches the actual machine setup. Filters are also used in the runners in order to control the flow. The small viewport on the top left shows a vertical section of the mold.
FOUNDRY

FLOW-3D Cast accurately models foundry processes such as sand casting, investment casting, lost foam casting, permanent mold casting and centrifugal casting.

Gravity Pour Casting
Casting processes, using both sand casting and permanent molds, can be modeled with FLOW-3D Cast. Although less violent in its filling process than high pressure die casting, part quality can be affected by entrainment of air from overly-turbulent filling and by shrinkage-induced defects. FLOW-3D Cast can accurately track the movement of the metal front, as well as the location of potential defects and the evolution of temperatures during the filling process. After the filling is complete, the solidification of the metal, and its resulting shrinkage, can also be modeled.

Lost Foam Casting
FLOW-3D Cast has special models to simulate the lost foam process. With these models, a user can simulate the filling of a lost foam mold as well as the subsequent solidification of the metal. FLOW-3D Cast enables the user to predict where folds or other defects associated with trapped foam products are likely to be located. FLOW-3D Cast provides engineers with the insight necessary to determine filling process parameters, such as pour temperature and pressure, gate sizes and locations.

Investment Casting
FLOW-3D Cast’s powerful numerical models can simulate the complex investment casting process, allowing users to analyze wax injection, metal filling, and the metal solidification process as well as accurately predict defects. This analysis can help casting companies better understand the investment casting process, improve component design, reduce defects, and shorten development time.

Centrifugal Casting
In centrifugal casting, a mold is rotated at high speed while the molten metal is poured into it. The molten metal is thrown radially outwards to the interior of the mold, where it solidifies as it cools. The higher pressure associated with the centripetal acceleration, forces defects towards the rotational axis. FLOW-3D Cast’s non-inertial reference frame model can prescribe this rotation with the ability to modify its speed. The location of defects can be visualized and modified easily.
NEW ALL-ELECTRIC CAR BMW i3

BMW GROUP

Previously, structural parts in cars were made of steel sheet metal. Several advanced auto manufacturers have now succeeded in manufacturing these parts as complex thin-walled light metal castings which are considerably lighter than the steel designs. This reduction in weight is especially important for electric cars that have to carry heavy batteries.

Casting such complex and large parts is a very demanding task and requires fine tuning of many parameters such as location and dimension of ingates, vents, overflows, shot curve, casting and die temperatures. The use of simulation early on in development enables BMW engineers to optimize the HPDC process so that they can produce premium quality parts according to the specification of their new car designs.
There are three FLOW-3D Cast packages with escalating levels of modeling power: BASIC, EXTENDED and ADVANCED.

**BASIC**
- Multi-block meshing, up to 5 mesh blocks
- Ladle pouring with rotational capability about an axis
- Filling, including viscous, turbulence and surface tension effects
- Solidification & heat transfer
- Expandable database for cast alloys, molds, etc.
- Chills and isolating sleeves
- Temperature-dependent properties
- Filters for flow control
- Track oxide formation and defects
- Identify filling & solidification-related porosity
- Natural convection of molten metal before solidification
- Cast iron solidification
- Flow tracers
- Particle modeling

**EXTENDED**
- All BASIC features, PLUS
- Unlimited mesh blocks for accurate and efficient simulations
- Filling and solidification analysis for high pressure die castings
- Trapped gases and venting effects
- Thermal die cycling to determine mold temperature distribution and cooling line optimization of cooling lines for temperature control
- Optimize shot sleeve performance and apply motion to simulations
- Lost foam castings and foam defects
- Locate cavitation to determine where die erosion may occur
- Permeable mold model for modeling air escape during filling
- Six-degrees-of-freedom motion for prescribed shot sleeve and complex ladle pouring motion

**ADVANCED**
- All BASIC & EXTENDED features, PLUS
- Binary segregation
- Capture core gas release and associated defects
- Sand core blowing
- Model moisture drying in molds and cores
- Enhanced viscous effects including non-Newtonian viscosity, shear thinning/thickening and thixotropic flows
- Heating due to viscous shear
- Thermal and mechanically induced stresses and distortions
A variety of technical support packages are available to streamline your modeling process. Flow Science’s support staff is comprised of engineers with industry experience who understand the needs and problems facing users in competitive professional environments. Flow Science prides itself on offering timely and courteous support from our expert applications engineers for the metal casting industry.

**USERS SITE**

Explore a variety of resources on the Users Site such as:

- Metal casting CFD checklists
- Live chat
- Example simulations
- Software updates
- FAQs, validations and hints & tips
- Presentations, workshops and tutorials

In order to gain access to these pages, you must have an active license and be under a maintenance contract.

**TRAINING**

Flow Science offers comprehensive training classes for **FLOW-3D Cast** in Santa Fe, New Mexico. The classes are aimed at giving attendees a solid understanding of the software as well as hands-on experience with problem solving in cases relevant to them. Existing and new users, as well as those interested in evaluating the software, are invited to attend.

In 1963, while at the Los Alamos National Laboratory, Dr. C. W. “Tony” Hirt pioneered several landmark fluid dynamics methods, stability enhancing procedures and a unique free surface tracking technique - the “Volume of Fluid” or VOF method. In 1980, Dr. Hirt left LANL to form Flow Science, Inc., with the mission to develop a new generation of fluid dynamics modeling capabilities for industrial and scientific applications.

Flow Science now supports a worldwide customer base of commercial, academic and government users. Our staff of scientists and engineers constantly strives to make innovative and useful improvements to our product suite. We take pride in the level of customer support we provide. In 2010, Flow Science celebrated its 30th year of improving the world through accurate flow modeling.