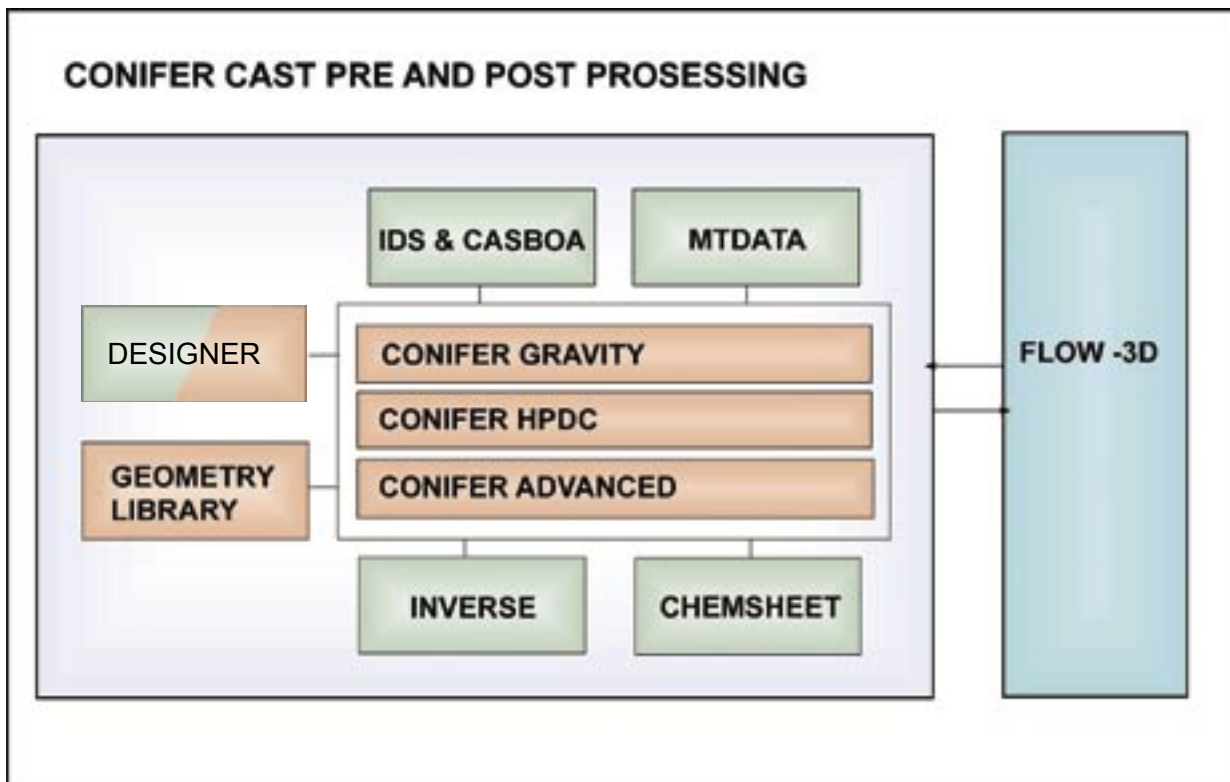
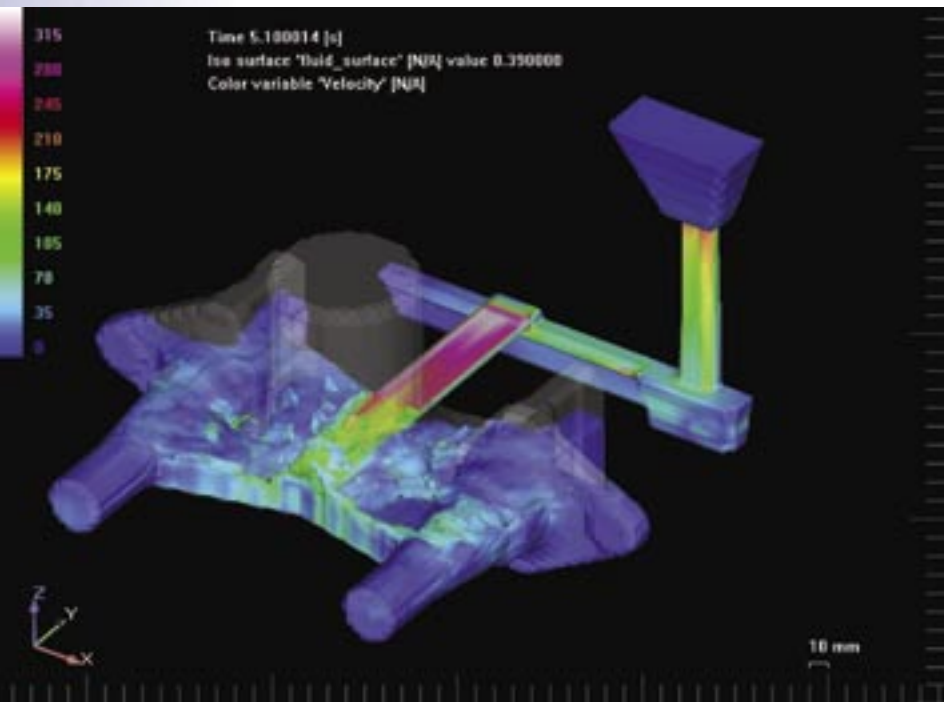


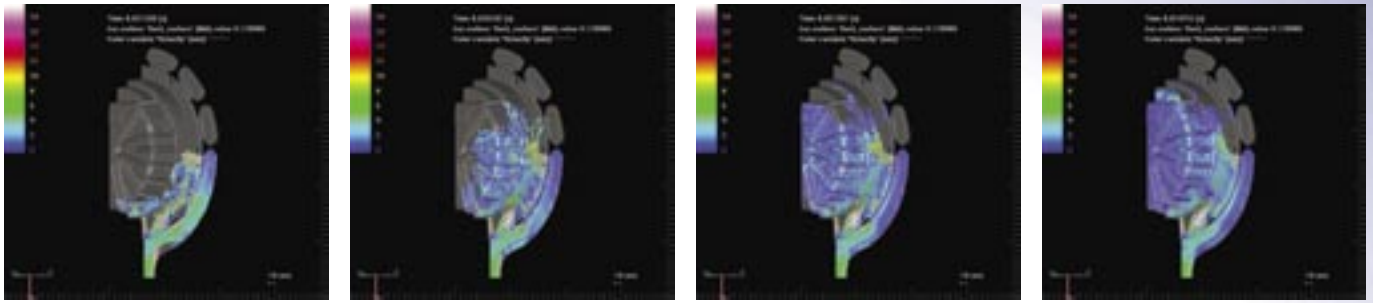
ConiferCast®

- SIMULATION SOFTWARE FOR FOUNDRIES

ConiferCast® is a computer program for simulating casting processes that involve metal flow and solidification. It has been divided into different solver modules with increasing capabilities according to the process. **ConiferCast®** also offers accessory modules for e.g. materials data and designing. It uses world famous **FLOW-3D®** fluid simulation software as a calculation engine. The program is based on the fundamental laws of mass, momentum and energy conservation. **FLOW-3D®** has been supplied with a large variety of auxiliary physical models. This allows the user to simulate an extremely wide range of physical phenomena taking place during processing of metals from liquid state down to room temperature.



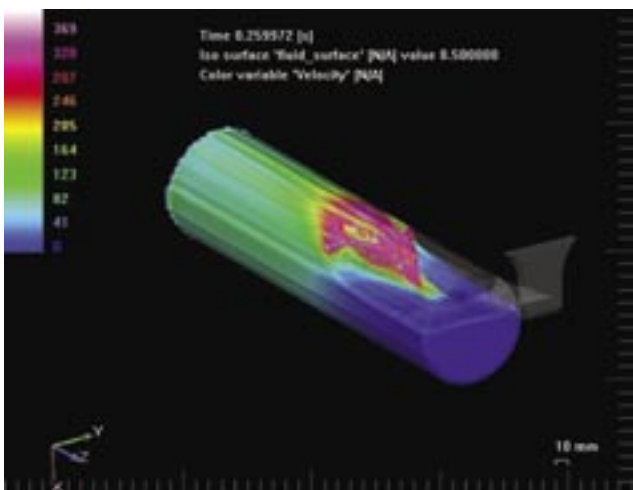
ConiferCast® is a powerful software bundle with a possibility to include all the necessary tools for casting simulations. Basic version consist of a riser library and a light version of the designer module.



Courtesy by IDMAN-Philips Lighting and Specialvalimo J. Pap Finland

SHOT SLEEVE Simulation

In the cold chamber die casting process molten metal is injected into the die cavity by means of a plunger which forces the metal flow through a horizontally mounted cylindrical shot sleeve. Usually, the shot sleeve is only partially filled with molten metal. The remaining volume of the shot sleeve is filled with air. With **ConiferCast®** possible air entrapment can be simulated and the simulation results can be used as boundary condition for filling simulation.



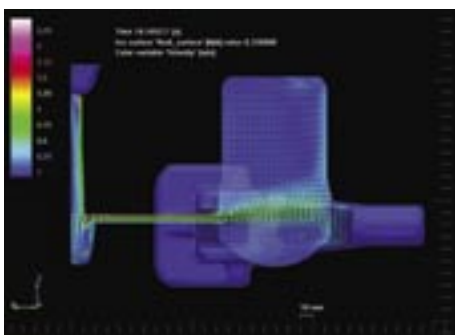
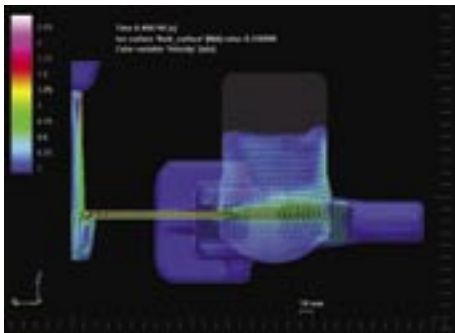
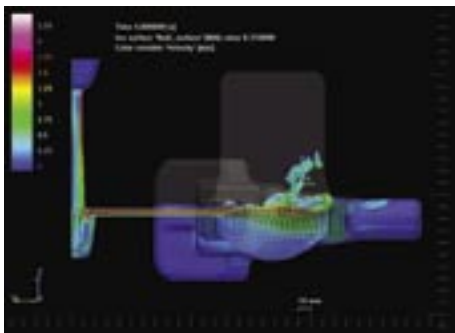
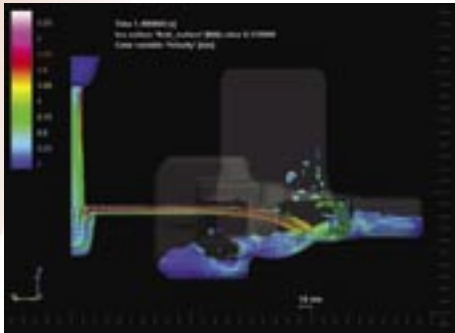
HIGH PRESSURE DIE CASTING

Together with adiabatic module and free surface modeling it is possible to simulate air entrapment during the filling process.

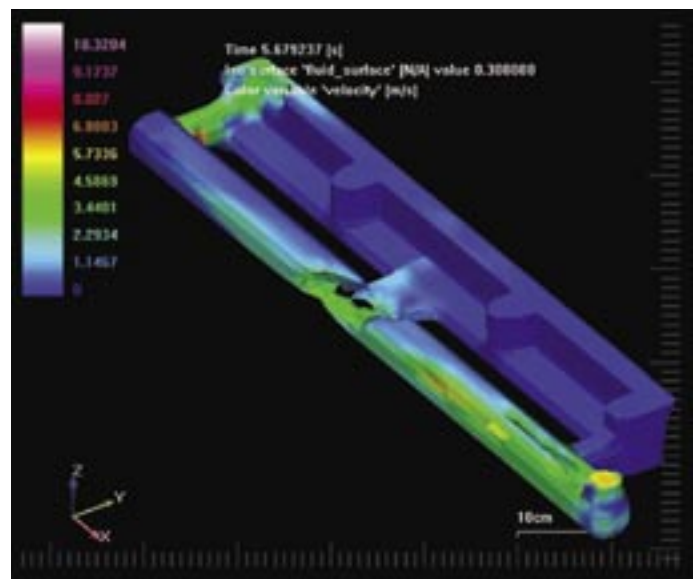
WHAT CAN BE SIMULATED

- Steel, iron, aluminium, magnesium, copper and other metals
- Sand Casting
- High and low pressure die casting
- Lost foam casting
- Tilt pour casting
- Centrifugal casting
- Semi-solid and thixocasting
- Composite matrix inserts and filters
- Location of inclusion, folds and laps
- Sand core blowing
- Hot cracking criterion
- Deformation and stresses
- Inverse module to calculate material parameters from experimental data
- IDS-program to calculate material parameters for steels
- Design Expert for creating a casting system for a product by utilising STL-files

Solver levels GRAVITY

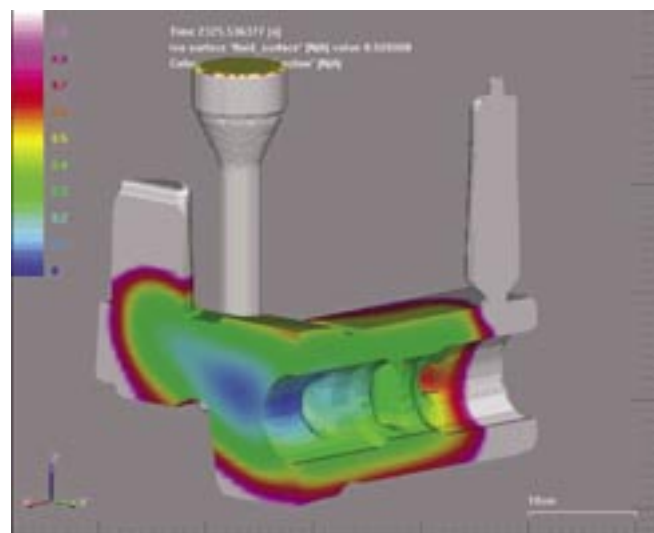


With **ConiferCast**[®] gravity it's possible to simulate sand castings from filling to fully solidified product. Problems associated with entrapped air, oxidation inclusions, folds, laps and wearing of the mould during filling and prediction of hot spots, hot cracking and macrosegregation during solidifying can be estimated from the simulation results.



Flow and heat transfer in the channels affects the quality of the cast product significantly. With **ConiferCast**[®] simulation of fluid flow and heat transfer in the channels is easy to simulate and use the information in optimization of the process.

Solidification simulations alone can reduce the need for experimental castings significantly. Problems arising from unsuccessful solidification e.g. hot spots and hot cracking can easily be estimated from the results.

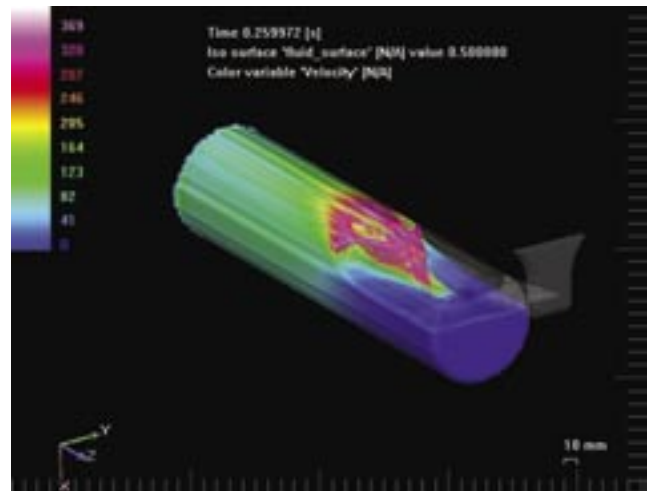


Solver levels

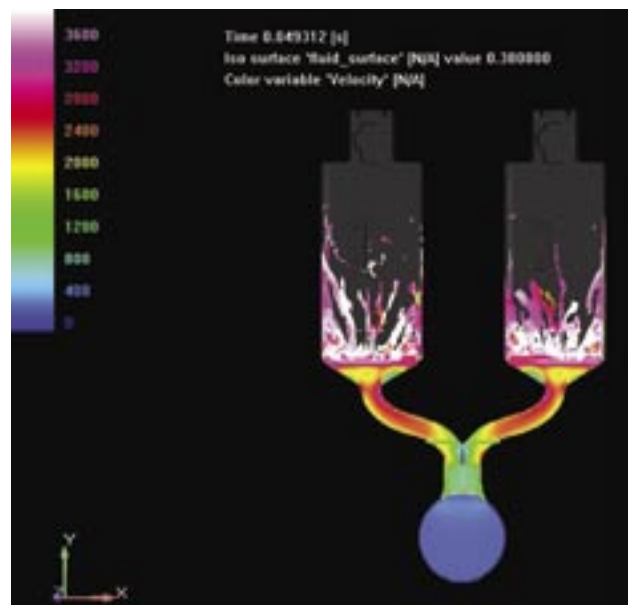
HPDC



High Pressure Die Casting is a very demanding process to simulate because of the high velocities and thin walls. **ConiferCast**[®] HPDC offers an efficient tool for simulating the whole High Pressure Die Casting process. It can be used for the simulation of the filling and solidification but also for simulating the shot sleeve process that injects the metal into the mould.



*Air entrapment and cavitation are difficult problems in High Pressure Die Casting process. With **ConiferCast**[®] it is possible to optimise the shot sleeve process to minimise cavitation and the amount of trapped air.*

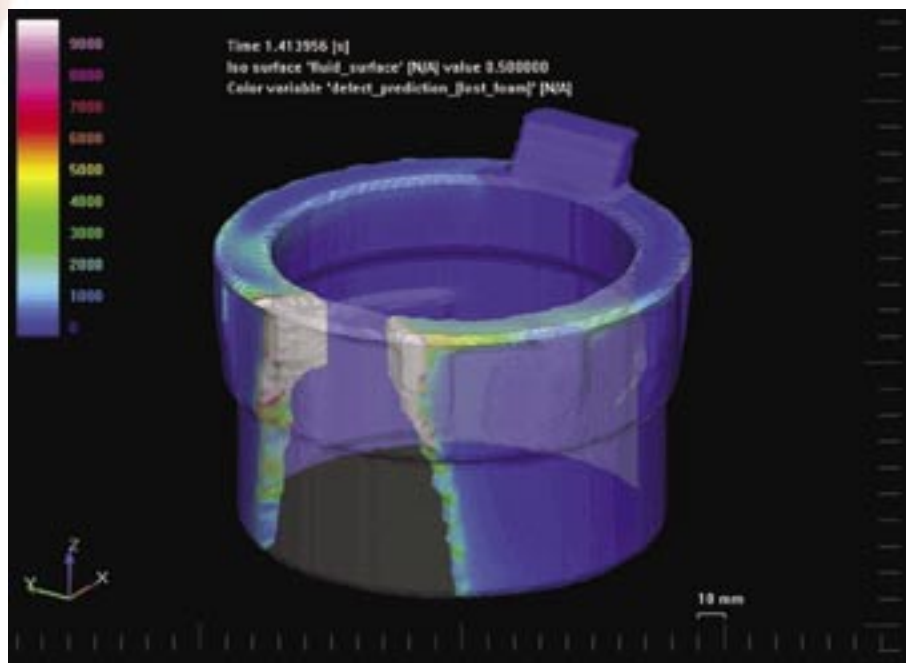


Courtesy by Flextronics International

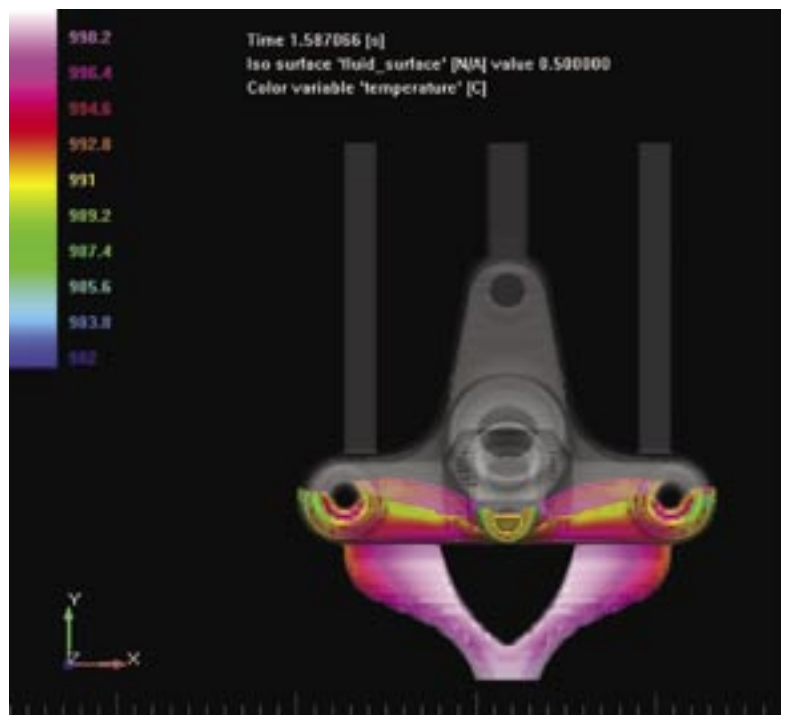
Solver levels

ADVANCED

Advanced casting processes and manufacturing methods such as semi-solid and thixocasting, lost foam casting, low pressure die casting, sand core blowing and composite matrix inserts can be simulated using **ConiferCast®** Advanced.



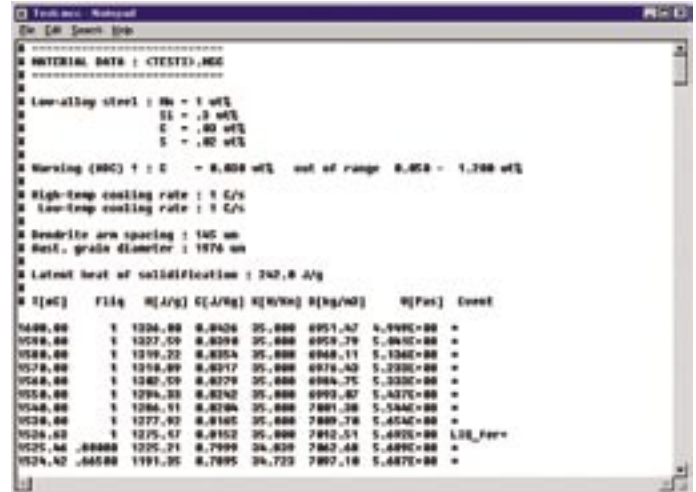
Courtesy of M. Sc Markku Eljaala,
Foundry Institute, Tampere, Finland
(Current address: Peiron Oy, Kokemäki, Finland)



Courtesy by KOHLER MIRA LTD.

Additional modules IDS¹⁾ & CASBOA¹⁾

There are two dynamical materials data-bases available in **ConiferCast[®]**, IDS-Thermophysical and physicochemical pro-perties of low alloyed steels and stainless steels and CASBOA - Thermophysical and physicochemical properties of copper binary-alloys.



IDS -Module

Depending on the steel composition (low-alloyed or stainless), the cooling rate and the microstructure dimensions, the IDS package determines the stable phases (liquid, ferrite, austenite and certain binary compounds), and their fractions and compositions during solidification. It also determines the stable phases and their fractions during austenite decomposition, at temperatures below 1000°C. In addition, important thermophysical material properties (enthalpy, thermal conductivity, density, etc.) are calculated, from liquid state down to room temperature. This data is derived from two separate modules IDS and ADC (Austenite decomposition).

Outputs:

- Temperatures, phase fractions and thermophysical data concerning important events
- Surface tension between liquid and air at the liquidus temperature
- Latent heat of solidification (between liquidus and solidus)
- Latent heat of ferrite/ austenite transformation (below solidus, down to 800 if ferrite still left)
- Relative contraction associated to the mushy zone and the solid state just below solidus
- Interdendritic compositions and microsegregations of solutes at the solidus and at 1000°C
- Phase fractions of the final structure
- MSC cracking sensitivity index due to sulfur enrichment in liquid (MSC<1: increased sensitivity)

CASBOA Module

CASBOA is a program that calculates temperature dependent materials data for copper-based binary-alloys and pure copper.

Possible maximum compositions:

P	Ag, Fe	Mn, Si	Al, Sn	Ni, Zn
1wt%	3%	4%	7%	30%

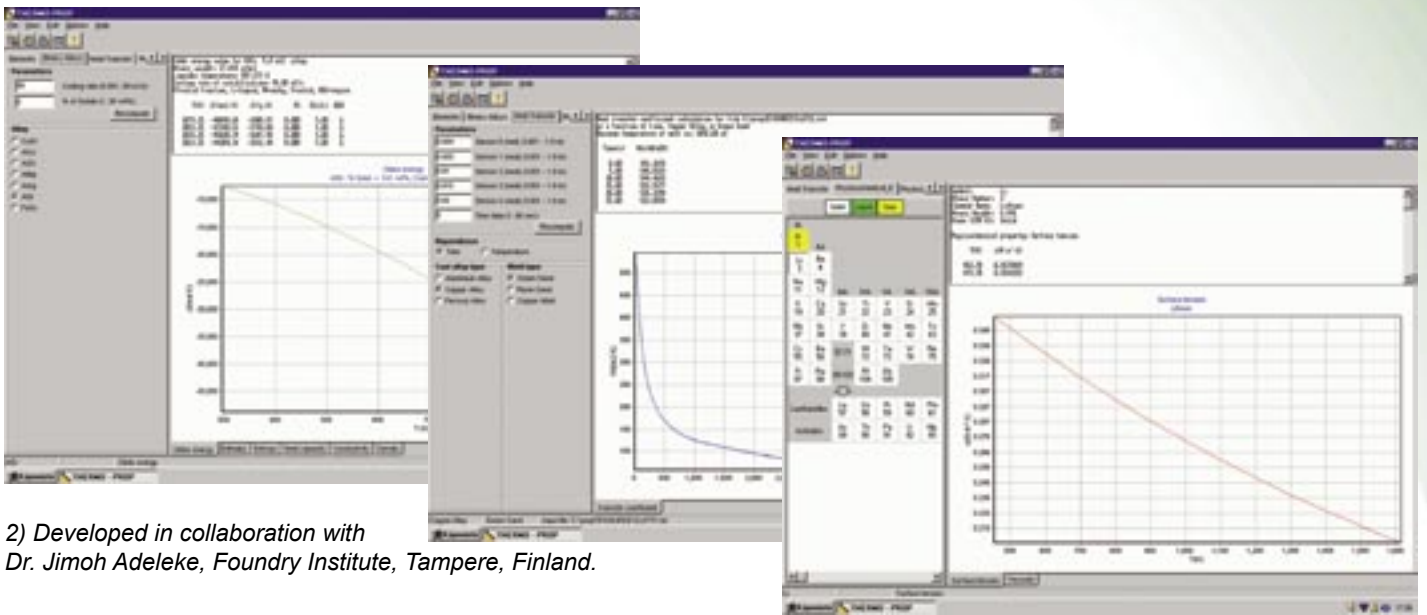
Outputs (Data as a function of temperature from 1300°C to 25°C):

- Liquid fraction
- Mean dendrite axis composition
- Interdendritic composition
- Enthalpy (derived from the thermodynamic data)
- Specific heat (derived from the thermodynamic data)
- Thermal conductivity
- Density
- Dynamic viscosity
- Liquidus temperature (start of local solidification)
- Zero-strength temperature (80% of the local structure solidified)
- Temperature of the formation of a new phase due to the eutectic or peritectic reaction (value given if the reaction occurred for the alloy)
- Solidus temperature (99.5% of the local structure solidified)
- Latent heat of solidification (between liquidus and solidus)
- Relative contraction in the mushy zone
- Interdendritic composition and micro segregation of the solute

1) Developed at Helsinki University of Technology, Laboratory of Metallurgy

Additional modules

INVERSE MODULE²⁾



2) Developed in collaboration with Dr. Jimoh Adeleke, Foundry Institute, Tampere, Finland.

The Inverse Module consists of five different modules: two thermophysical, two physico-chemical and a heat transfer module. These modules can be used for retrieving necessary thermophysical and physicochemical materials data and heat transfer coefficients at metal/mould interface. The thermophysical modules contains properties for single dements and binary alooys of copper, iron and steel. Physico-chemical modules include all the elements in the periodic table and their binary alloys.

HEAT TRANSFER MODULE

Heat transfer module is used to determine the heat transfer coefficient at the metal/ mould interface from cooling curves of actual casting process. The experimentally determined relationships between temperature and time within the mould and the casting have been used in conjunction with implicit finite difference technique to determine the magnitude of heat-transfer characteristics. The method, based on inverse solution, is well conditioned in the sense that it generates bounded solutions and never generates thermal characteristics oscillating with increasing amplitude.

THERMOPHYSICAL MODULES

Elements Module	Binary-alloys Module
No user inputs	Inputs:
	Nominal composition [wt%]
	Cooling rates
Outputs:	Outputs:
Gibbs energy	Gibbs energy
Enthalpy	Enthalpy
Entropy	Entropy
Specific heat capacity	Specific heat capacity
Thermal conductivity	Thermal conductivity
Density	Density
	Solid fraction
	Nominal liquid composition of solute [wt%]

Inputs:

- Distance of thermocouples from casting/ mould interface [m]
- Time step of solidification process [s]
- Input file name
- Type of alloy material
- Type of mould material

Columns of experimental data

- Time [s]
 - Temperature data at the location of Sensor 1 in mould [°C]
 - Temperature data at the location of Sensor 2 in mould [°C]
 - Temperature data at the location of Sensor 3 in mould [°C]
 - Temperature data at the location of Sensor 4 in mould [°C]
 - Temperature data at the location of Sensor 0 in melt [°C]
- Five sensors are needed to gather temperature data.

PHYSICO-CHEMICAL MODULES

Physicochemical_E	Physicochemical_B
For single elements	For binary-alloys
No user inputs	No user inputs
Outputs:	Outputs:
Viscosity	Viscosity
Surface tension	Surface tension

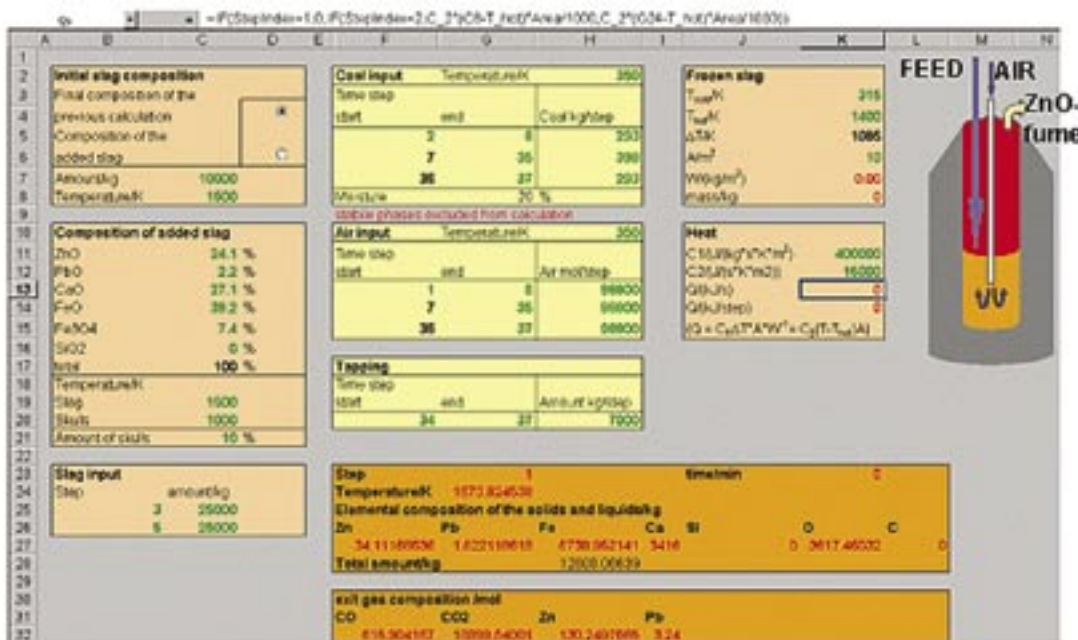
Outputs:

- Heat transfer coefficient [W/m²K] as a function of time or temperature

Additional modules

CHEMSHEET

ChemSheet is an user interface for ChemApp thermodynamic programming library allowing the user to calculate chemical equilibrium in different stages of casting process. Calculations can take account both reaction kinetics and heat transfer. Thermodynamic data is derived from different databases e.g. FACT and SGTE but also user given data can be used. It possible to calculate real processes because ChemSheet uses more Gibbs energy models for non-ideal solutions than any other thermochemical program.



These processes include among others:

- Dilute and concentrated alloys
- Liquid slags and molten salts
- Solid oxides and salts
- Non-stoichiometric solids

Excel spreadsheet gives a possibility to create process specific user interfaces that are easy to use. Calculation results can be linked to be with other calculations as boundary or initial conditions. The advantages ChemSheet can offer:

- Choose optimum process conditions
- Analyse probable compositions and impurities

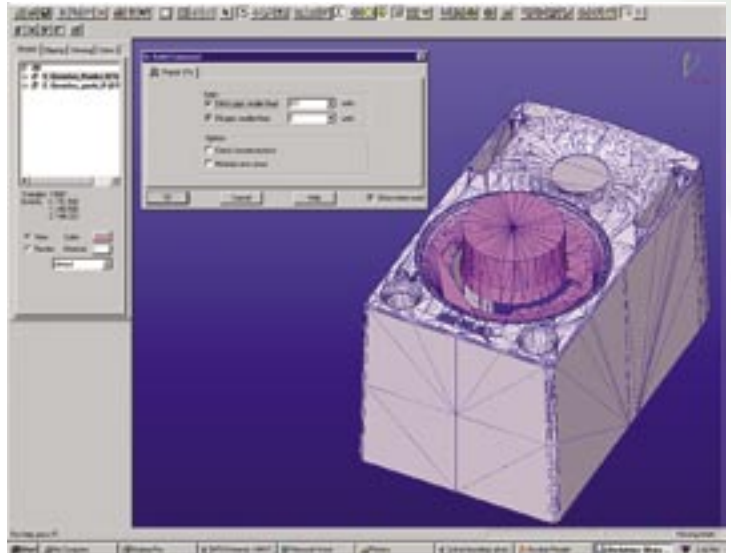
Additional modules

DESIGN EXPERT

Usually expensive 3D modeling tools are needed for designing models and simulations. **ConiferCast®** offers a new Design Expert module as a solution to this problem. Designer, developed by DeskArtes Oy, is a flexible modeling system providing a full range of functionality for interactive free-form curve and surface design and manipulation.

The product is complete with high end molding features such as

- Transform, Measure, Volume, Area, Annotate, Drawings
- Surface Design: Rotate, Extrude, Sweep, Lofting, Interpolate etc.
- Surface Deformations: Bend, Twist, Taper
- Multiple and Single Surface Trimming
- Real-time OpenGL Rendering: Rotate, Zoom, Pan, Clip, Move Light, Clipping
- Real-time OpenGL Materials, Reflections, Transparency, Background Images, Textures etc.
- Input/Output of Models in STL Format
- Input of Models in IGES or VDA format
- Conversion Surfaces to STL Models
- Full Repair & Editing of STL Models
- Reduce & Refine Triangle Count in STL Models
- Combine STL Models with Union and Difference



Design Expert includes a tool for conversion of surfaces to STL models.



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