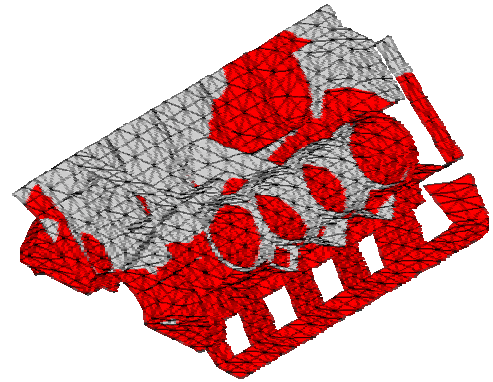


Technalysis[®]

dieCAS[®] Software

Version 5

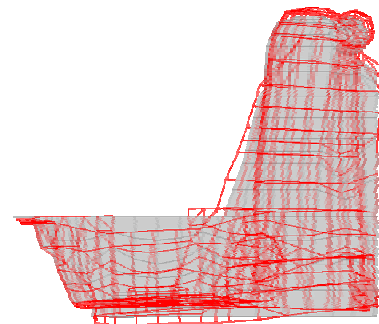
dieCAS[®] is a PC / Workstation based CAE software for process modeling and analysis of die casting and related processes, these include permanent mold, semi-permanent mold, and squeeze casting. dieCAS[®] is the only software system that provides analysis of the entire die and machine, including the nonlinear contact problem at the uneven parting surfaces between die components.



Cavity Fill of a V8 Engine

The capabilities of dieCAS[®] software are:

- **Cavity fill**, including full coupling with heat transfer, back pressure from the cavity gas, venting, and vacuum.
- **Heat transfer and solidification**, including solidification times, die temperatures, and casting temperatures.
- **Casting distortion**, including thermal shrinkage following ejection from the die and associated residual stress.
- **Die distortion**, including nonuniform thermal expansion, clamping forces of the die casting machine, cavity pressure, and uneven contact between die components at the parting surface.

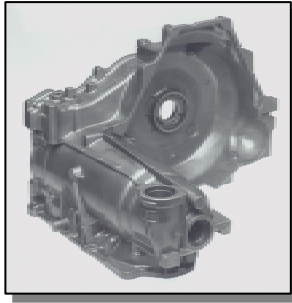


Casting Distortion of a front-drive transmission case

The analysis results provide revealing insight into a broad spectrum of die casting problems. dieCAS[®] software addresses a variety of product and process problems, many of which are unique to die casting, as shown in the table below.

Analysis Type	Die Casting Problem															
	Process							Casting								
	Bolt breaking	Die cracking	Erosion	Flash	Heat checking	Soldering	Sticking	Tearing	Dimensions	Drags	Gas porosity	Galls	Poor fill	Seams	Shrink porosity	Thin wall
Casting temperature																
Die temperature																
Solidification																
Cavity fill																
Casting distortion																
Die distortion																

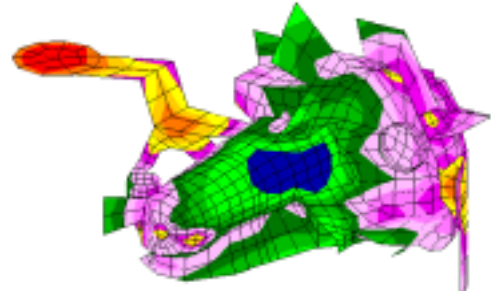
Traditional
 Unique to die casting



Front-drive Transmission Case



Fifty percent cavity fill of a front-drive transmission case



Casting ejection temperature of a front-drive transmission case

Unlike other general-purpose casting analysis products, dieCAS[®] software is specialized to die casting. As a result, it can take advantage of die casting's characteristics and achieve enormous savings in analysis time, without sacrificing solution accuracy. dieCAS[®] has been used for more than ten years at GM Powertrain to improve existing processes as well as avoid problems on new product programs; this experience has helped to quantify the relationships between analysis results and the occurrence of process problems.

The analysis is based on a shell-like finite element model of the casting together with a 3D finite element model of the die; this combination creates the following unique advantages:

- **Direct calculation of the steady periodic die temperatures.** Unlike all other commercial systems, dieCAS[®] software does not have to analyze the leading process transient to calculate die temperatures at steady state. This reduces computer time from several days (and even weeks for a large die) to about a few hours.
- **Simplified model creation and editing.** Because dieCAS[®] uses 3D unstructured finite element meshes, the user has to create only the surface meshes to create the volume meshes automatically. This greatly simplifies the process of both creating and editing the die model. Since cooling lines are represented by one-dimensional elements in the die interior, they can be altered independently of the die model.
- **Rapid analysis of cavity filling.** The unique two-dimensional representation of the die cavity enables an extremely fast analysis of liquid metal flow during cavity fill. Cavity filling run times for even large castings are within an hour, compared with several days for conventional methods.
- **Complete thermo-mechanical model of casting and die distortion.** Thermal distortions and residual stresses are calculated with minimal user input after the completion of filling and thermal analyses. All Results are available in about an hour, even on very large dies.

The combination of analysis speed and ease of use make dieCAS[®] software ideally suited to a design environment, where much different process must be investigated in a short period of time.

The analysis results in dieCAS[®] software have been validated by experiments on production die casting equipment at the GM Powertrain Bedford plant. Nearly 200 thermocouples were installed in a transmission case die and the process was monitored during several independent experiments, each spanning a 24-hour period.