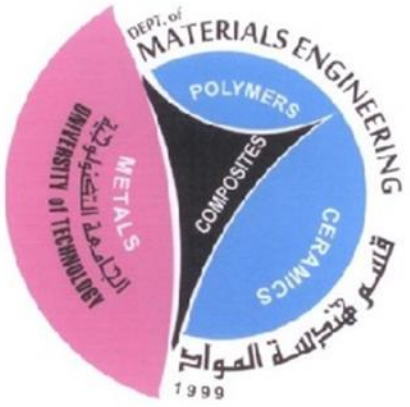


Materials Engineering Department
General Materials Department

Casting Technology

Fourth Class II

Lecture Ten : Computer Applications in Casting

Advantages of Computer Modeling

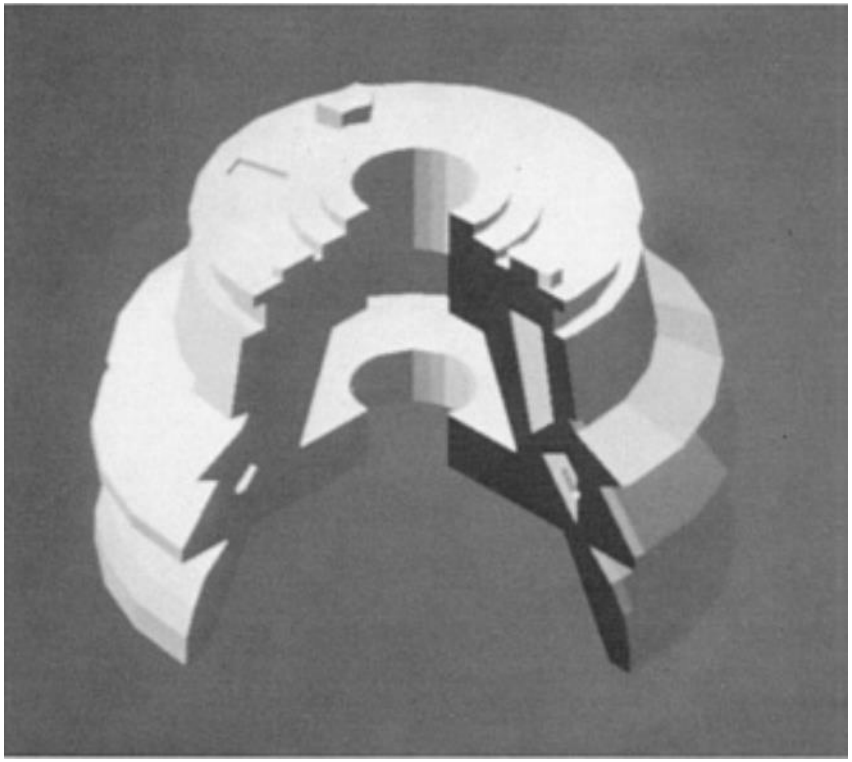
1. Increased casting yield per pound of metal poured
2. Improved casting quality (absence of unsoundness)
3. Enhanced productivity of casting system
4. Geometric models provide casting volume, weight, and surface area data, allowing rapid cost-estimating
5. permitting efficient rigging design

Advantages of Computer Modeling

6. Automated enmeshment for general purpose heat transfer simulators permits shorter design time
7. Automated machining of patterns, which in turn reduces costs
8. Fewer prototypes to be experimentally evaluated; shorter lead times from design concept to product
9. Easier implementation and evaluation of engineering changes
10. Enhanced ability to deal with batch production of castings of different design

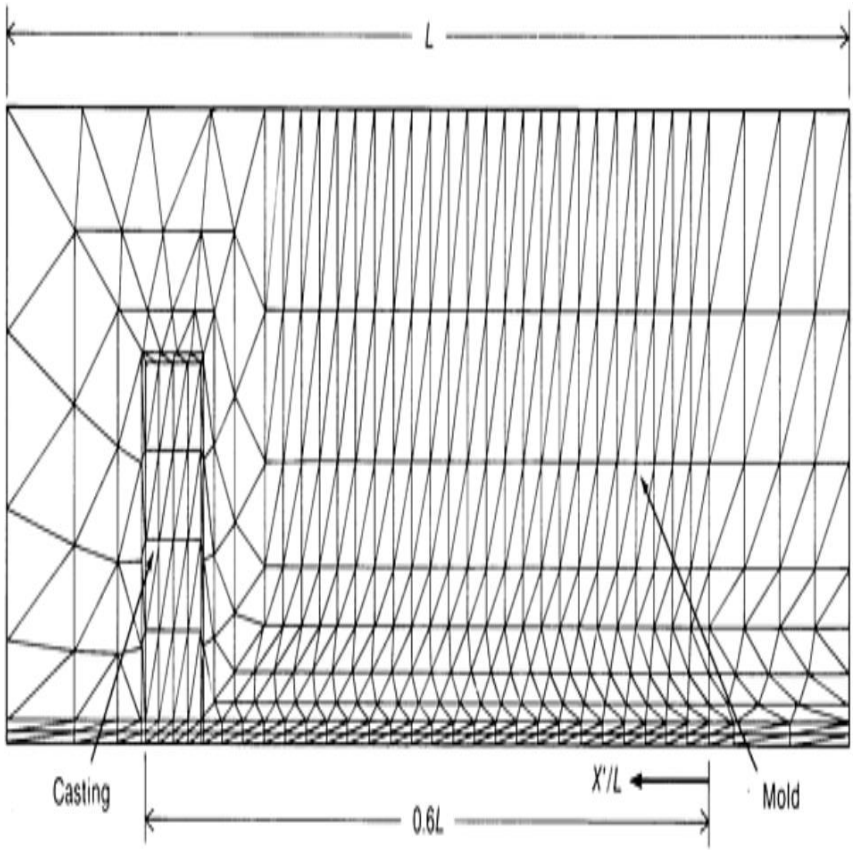
Computer-Aided Casting Design

1. Those based on classical heat transfer equations
2. Those based on finite-element methods or finite-difference methods (FEM or FDM), which are iterative Techniques based on classical heat transfer
3. Those based on ratios of surface area to volume.



Type of Casting Software

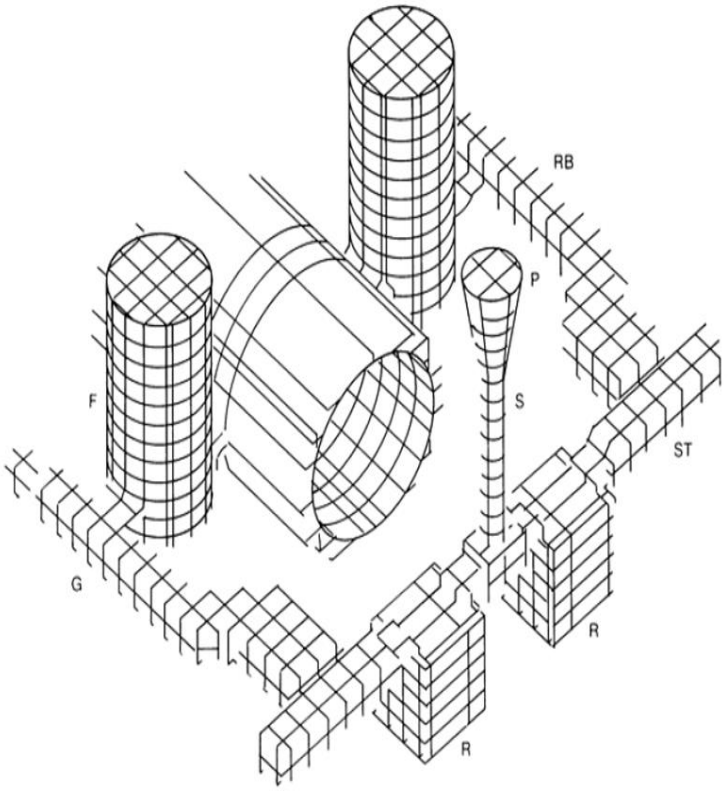
1. Special-Purpose Programs
2. Knowledge-Based Expert Systems
3. Finite Elements Software(FEM)



Type of Casting Software

In solving the basic governing equations, the simulator permits the use of the following boundary conditions:

1. Temperature specified
2. Heat flux specified
3. Radioactive heat transfer specified
4. Convection heat transfer specified



Type of Casting Software

Feature	Ideal	ANSYS	MARC	MITAS-II
Ease of setup and use	Easy	Difficult	Moderately difficult	Moderately difficult
Running cost	Low	High	High	Moderate
Ability to account directly for latent heat	Yes	No	Yes	Yes
Dedicated heat transfer code	Yes	No	No	Yes
Accuracy	Good	Very good	Very good	Very good
Pre- and postprocessing capabilities	Good	Good	Good	Poor

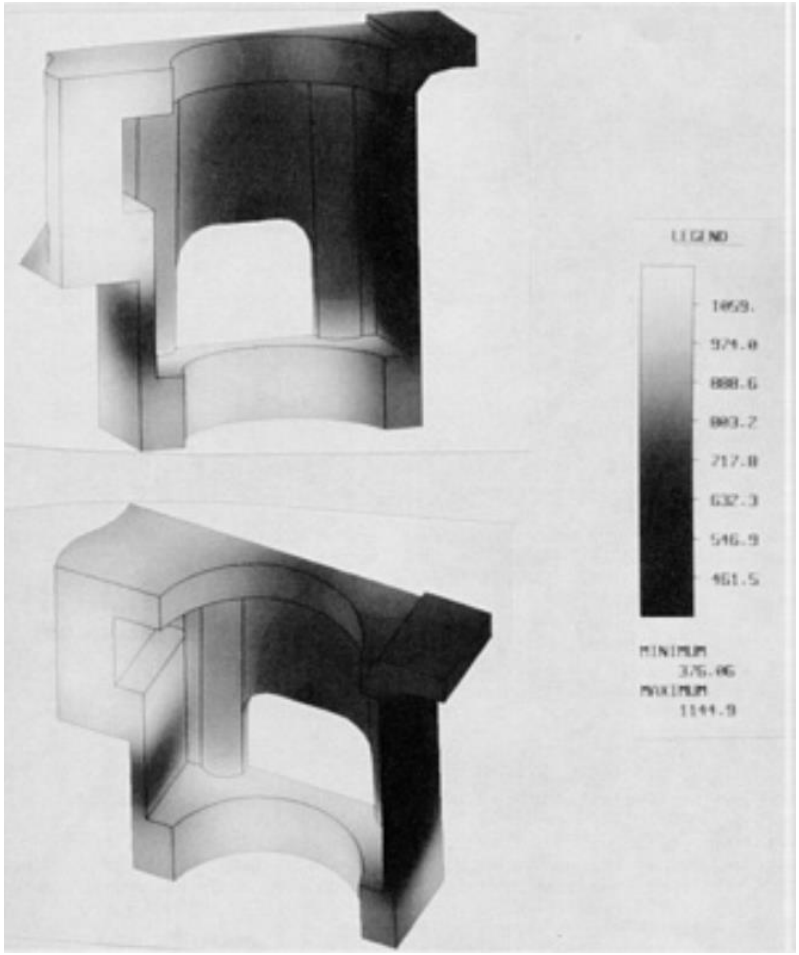
Type of Casting Software

Nonetheless, the reader should examine carefully publications describing these new and alternative computational approaches. Particular attention should be paid to the:

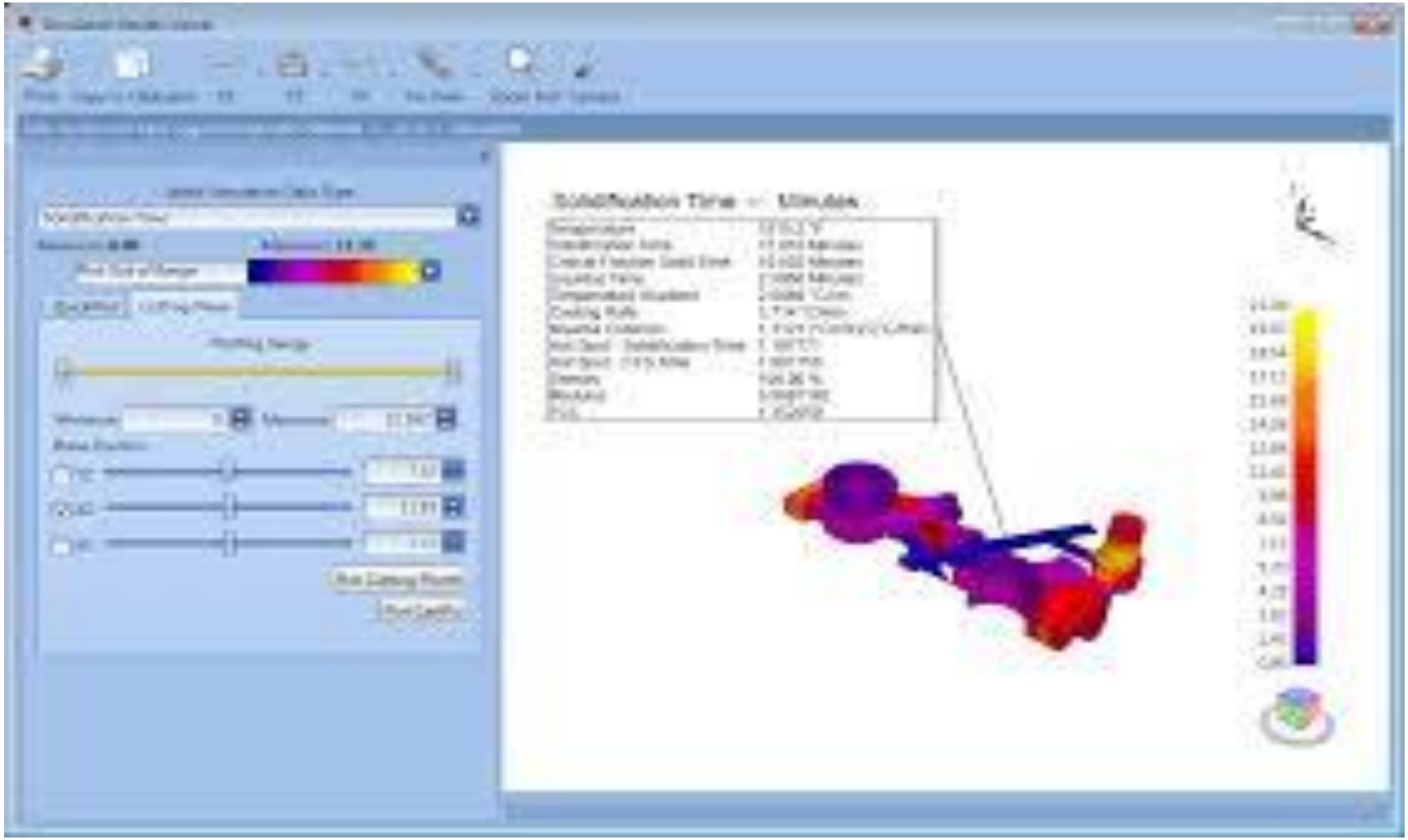
1. Ability to handle complexities of external shape
2. Ability to handle totally enclosed portions of the mold, such as coring
3. Speed of computation and type of computer on which the simulation is run
4. Linkages provided with pre- and post processing packages, in particular the existing commercially available geometric modeler based CAD systems

Type of Casting Software

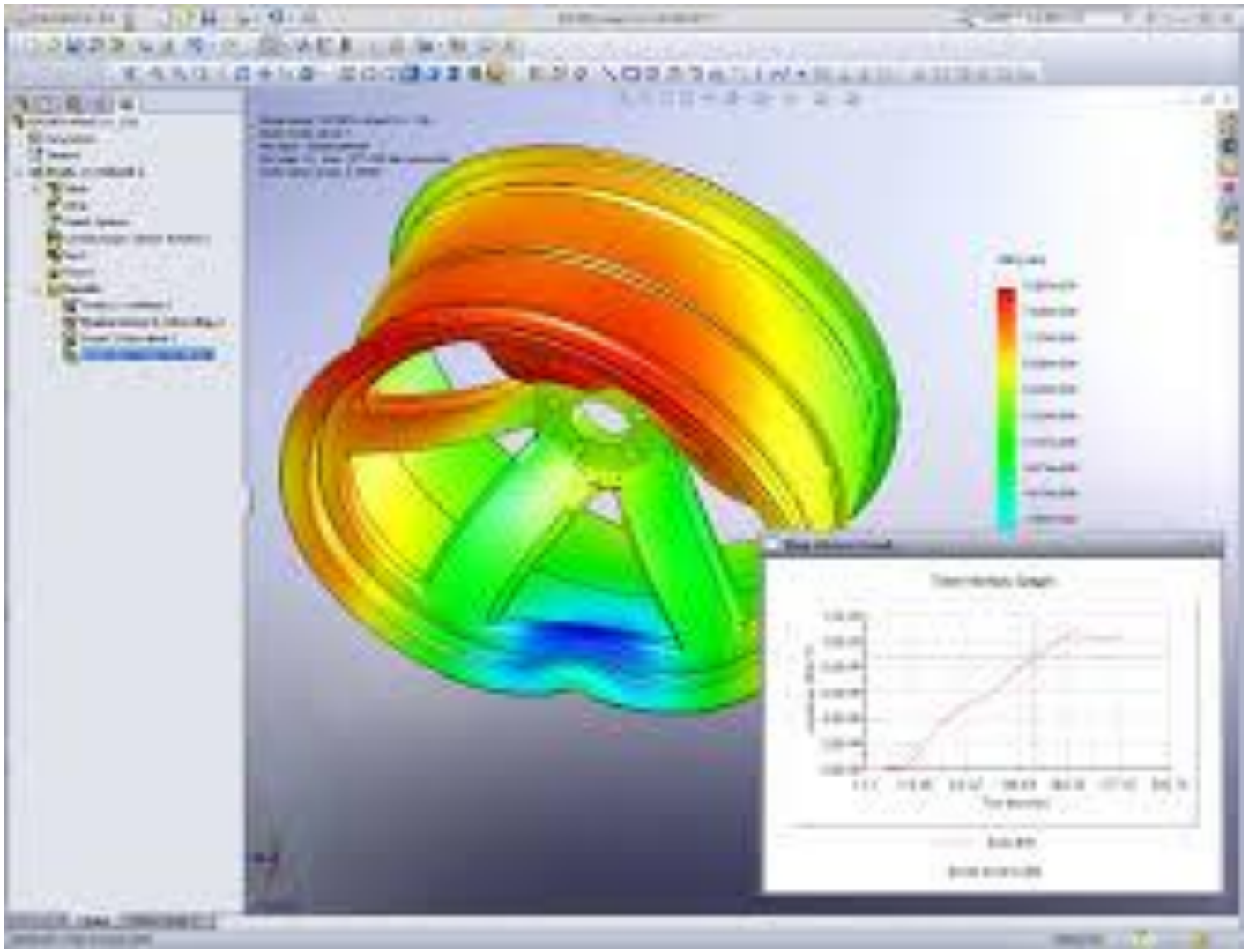
- All mathematical models of the solidification process should possess
  1. An accurate representation of geometry
  2. An adequate treatment for evolution of latent heat
  3. A sensitivity to the thermo-physical properties of the materials involved in this process



Computer Modeling of Casting Processes



Computer Modeling of Casting Processes



Computer Simulation

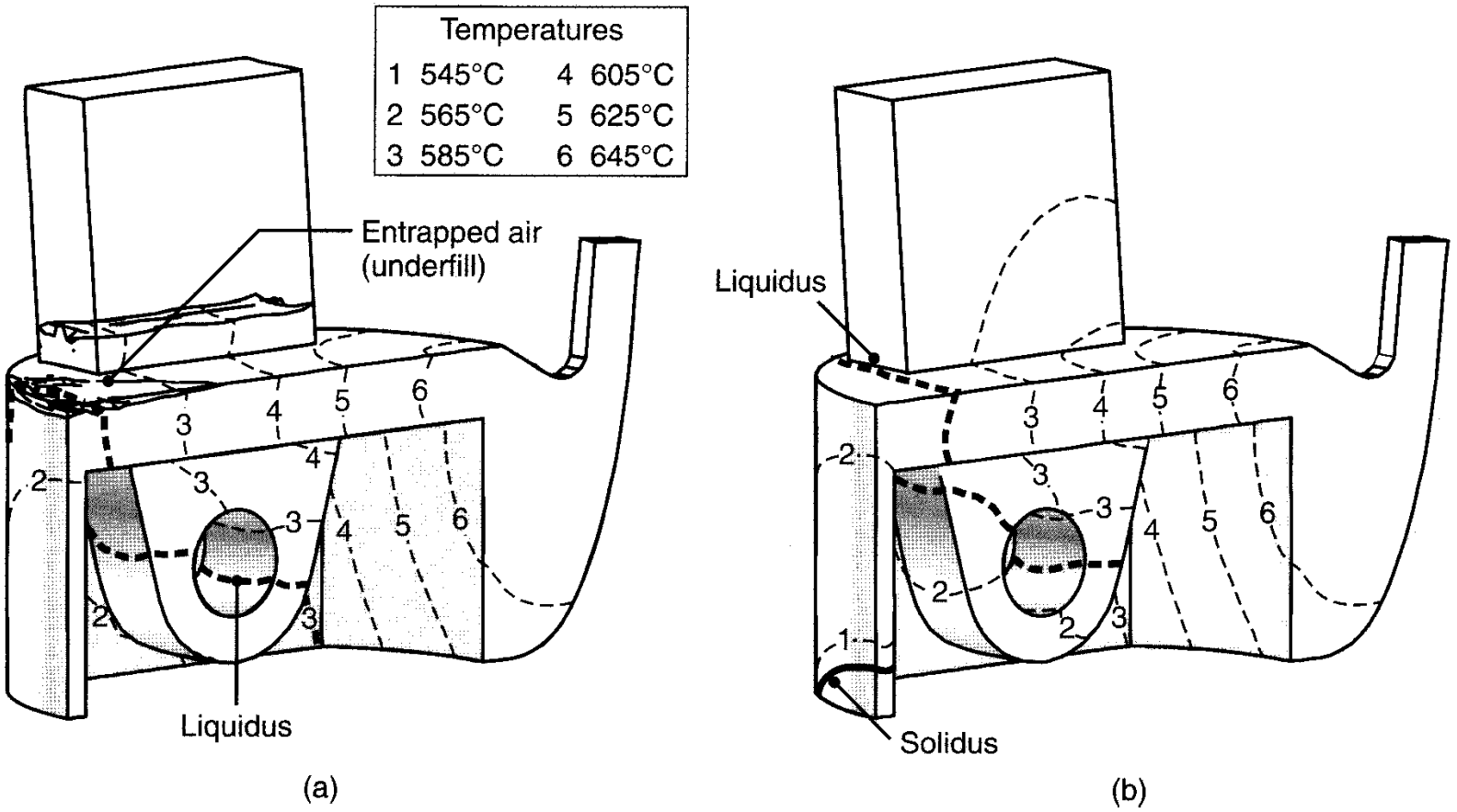


FIGURE 10.17 Simulation of mold filling and solidification. (a) 3.7 seconds after start of pour. Note that the mushy zone has been established before the mold is completely filled. (b) Using a vent in the mold for removal of entrapped air, 5 seconds after pouring. *Source*: After S. Paolucci.

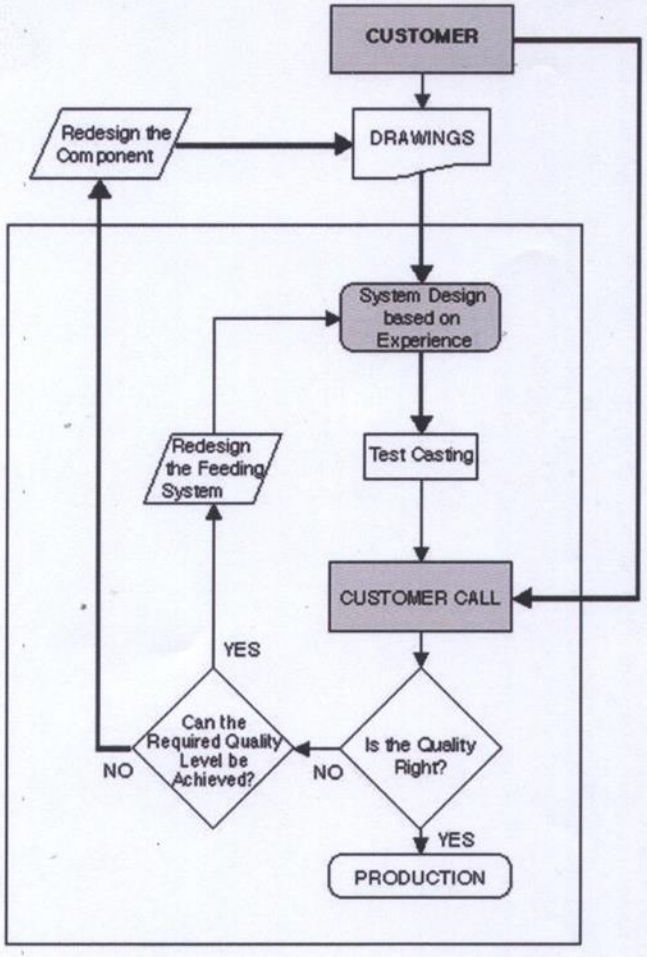


Fig. 1. Flowchart of a traditional procedure of designing component and casting system without the help of numerical simulation and 3D CAD-programs. Large box represents a foundry. Heavy lines indicate expensive operations.

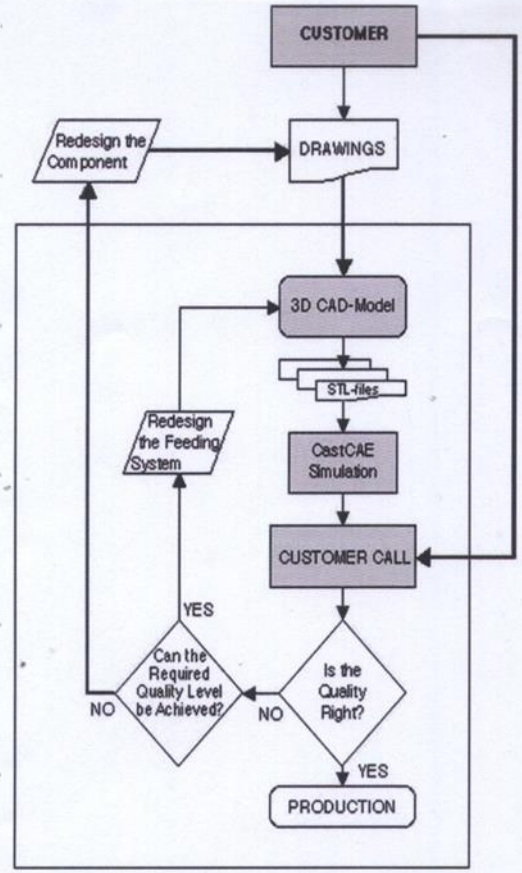
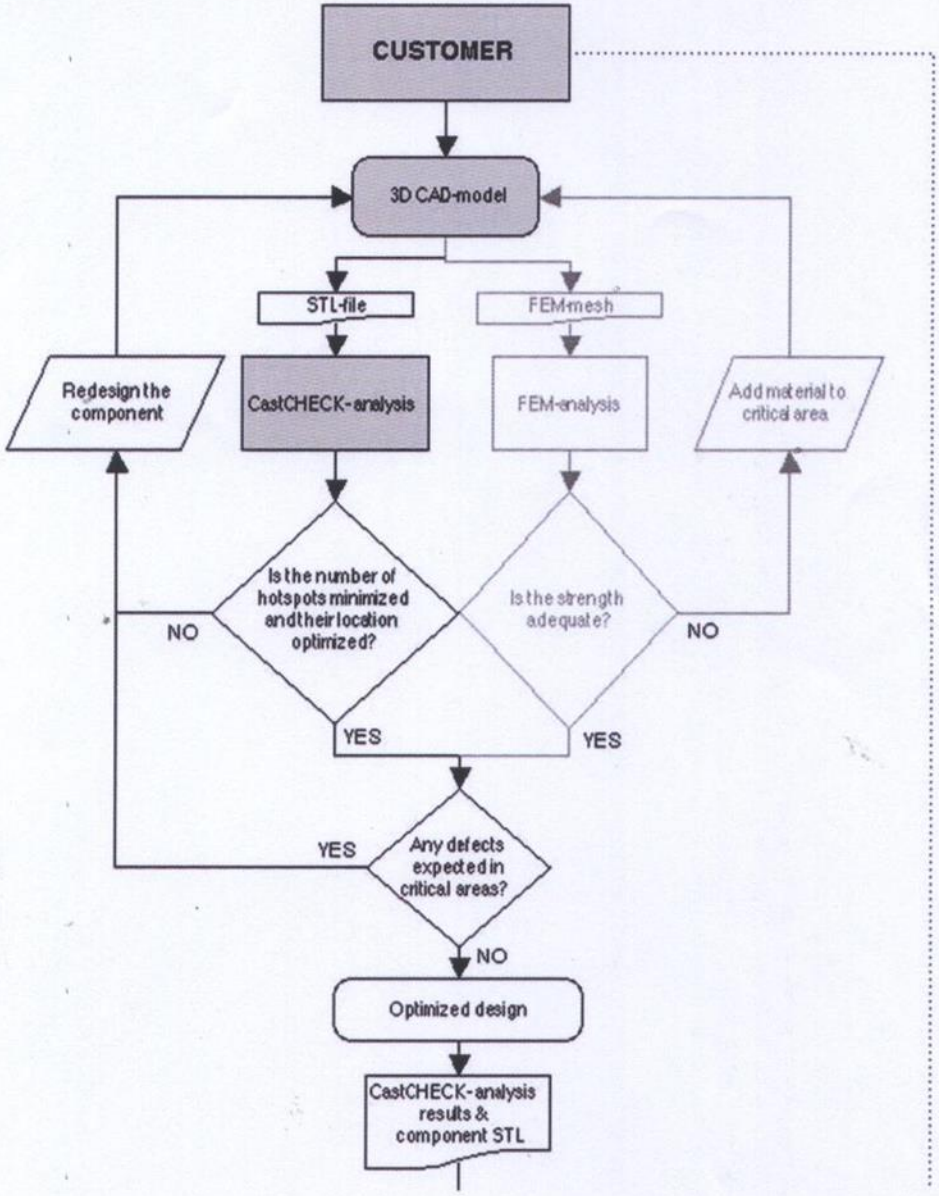


Fig. 2. Flowchart of a design process, in which 3D CAD and simulation are used by the foundry. In Finland this is the most typical situation today. In this procedure simulation results are used, when foundry and the machine shop engineers negotiate about construction and other design changes including the expenses of different design options. Large box represent a foundry. Heavy lines indicate expensive operations.


CUSTOMER
3D CAD-model
STL-file
FEM-mesh
Redesign the component
CastCHECK-analysis
FEM-analysis
Add material to critical area
Is the number of hotspots minimized and their location optimized?
Is the strength adequate?
NO
NO
YES
YES
YES
Any defects expected in critical areas?
NO
Optimized design
CastCHECK-analysis results & component STL

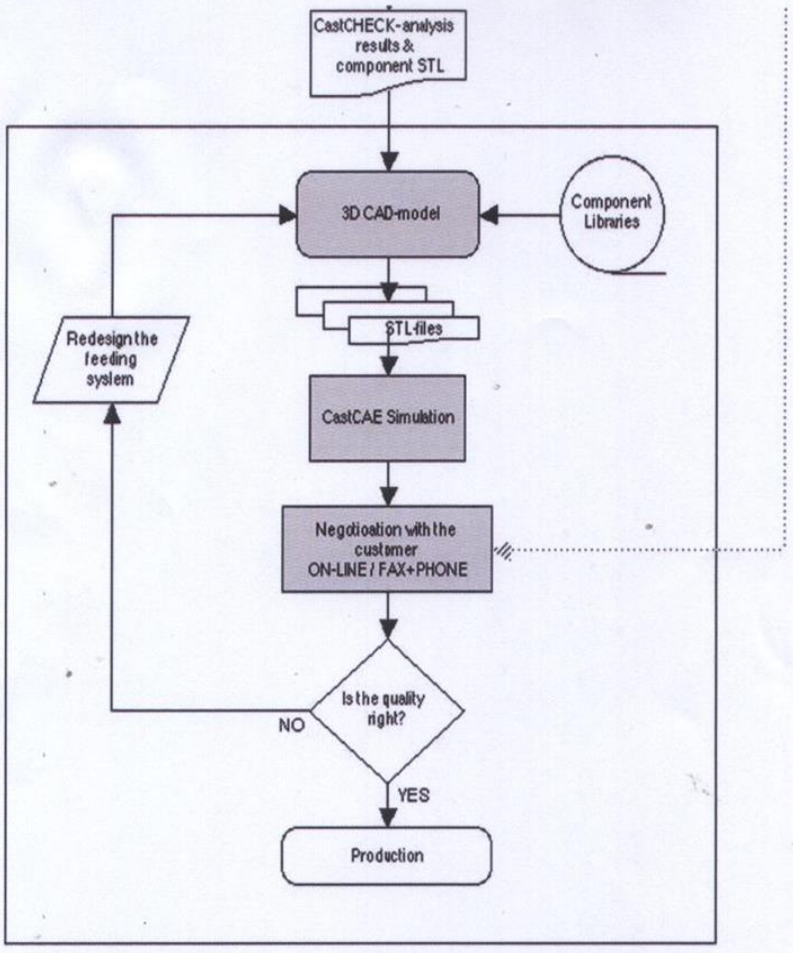


Fig. 3. Flowchart of a process, in which 3D CAD and simulation tools are utilised both by the machine shop and the foundry. This is the procedure which is expected to be reality in most cases of designing new castings in Finland by the end of this year. Large box represents a foundry. Dotted line indicates telephone call/ Internet connection.