RISER DESIGN BASICS FOR SHRINKING ALLOYS

DAVID C. SCHMIDT
Vice President
FINITE SOLUTIONS, INC.

ARTICLE TAKEAWAYS:

- Riser sizes are determined based on thermal modulus and available feeding volume
- Risers are positioned to provide feed metal to distinct feeding areas
- Riser design can be automated using casting simulation tools

BASIC THEORY OF RISER DESIGN

Riser design for shrinking alloys is based on a simple premise; as metal cools and solidifies, it shrinks, or contracts. Risers must be large enough to solidify after the casting, or casting section, being fed, and must have enough volume to provide enough 'feed metal' to offset casting shrinkage. One starts by estimating the Solidification Time of a casting, based on Chvorinov's Rule:

$$t = B\,(V/A)2$$

where

t = Time to complete solidification
B = Mold Constant
V = Volume of a section of the casting
A = Surface area of the same section of the casting

This can be simplified, so that solidification time is proportional to the ratio of V/A, commonly known as the geometric modulus, or just modulus. Before computers, the modulus was a fairly easy value to estimate, and a riser calculation method was developed, known as the Modulus Technique. The two key features of this technique are:

1) The modulus of the riser should be larger than the modulus of the casting, which encourages directional solidification, insuring that feed metal will be available to counteract shrinkage in the casting throughout solidification
2) The riser should have enough volume to provide the required feed metal to the casting.

Figure 1 illustrates the concept of directional solidification.

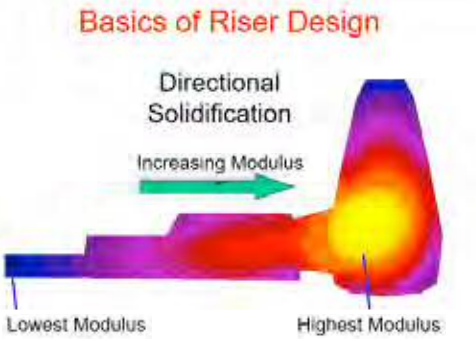


Figure 1. *Directional Solidification, from Low Modulus to High Modulus.*

The following example was created using the Riser Design Wizard, a part of the SOLIDCast simulation software. Much of the data input needed for riser size calculation can be extracted from simulation models. For detailed descriptions of complete design of risering components and systems, see the AFS Handbook on Basic Principles of Risering.

Unrigged Simulation

The first step is to run a simulation of the part without rigging, to determine the 'natural' pattern of solidification. Gate locations and chills may be added at this stage, if you know the locations. Typical results are shown in Figure 2.

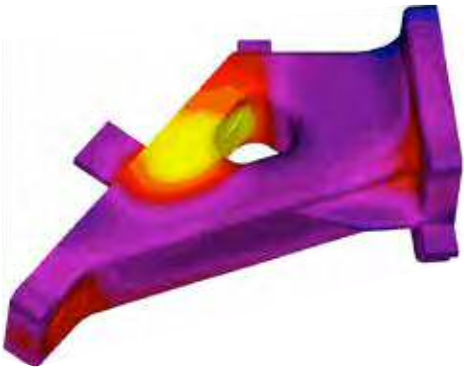


Figure 2. *Unrigged Simulation Results.*

Once the unrigged simulation is complete, the Riser Design Wizard takes the solidification time data and converts it to thermal modulus. This is more accurate than the traditional geometric modulus, since it accounts for the dynamics of the process.

Feeding Area Analysis

The modulus information is scanned to determine where areas separate into distinct feeding areas. In this example, three areas are identified. By plotting low modulus values, we can see the feeding areas themselves, as shown in Figure 3. By plotting high modulus values, we can see the last points to freeze on each zone, which are the desired riser connection points, as shown in Figure 4.

Riser Size Calculation

Each riser size can then be calculated, using data from the unrigged simulation, including feeding area volume and thermal modulus, as shown in Figure 5.

Finally, the risers can be added to the geometric model, so that a comprehensive feeding simulation can be done. The risered model is shown in Figure 6.

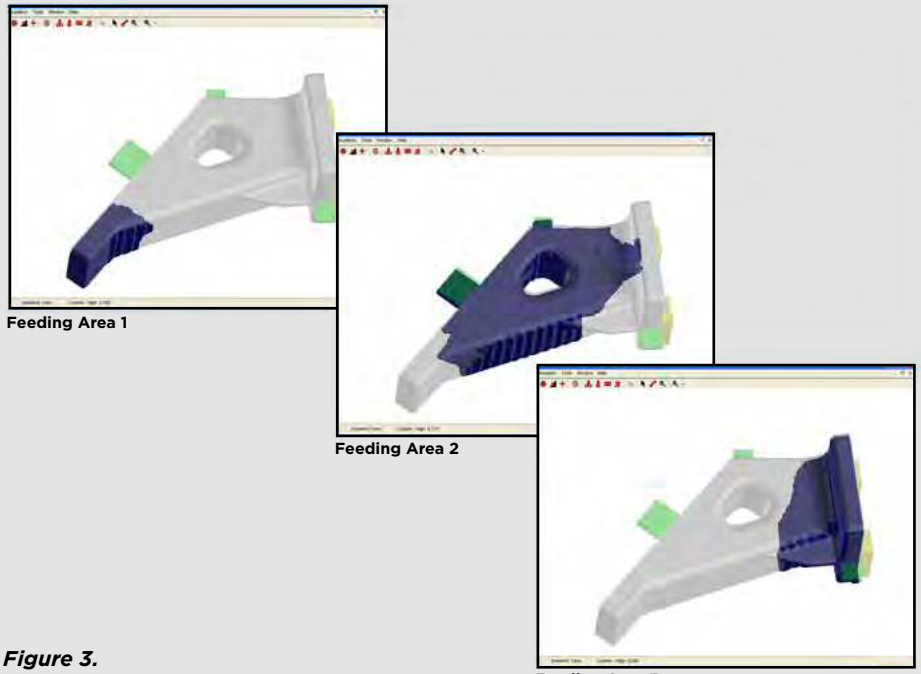


Figure 3.
Feeding Area Locations

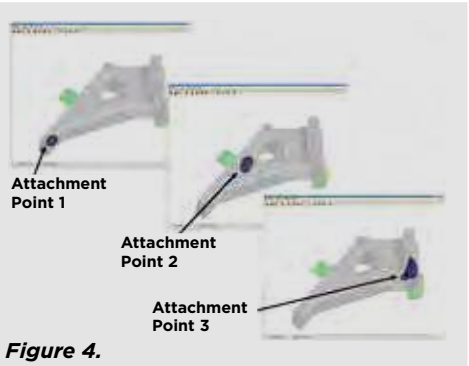


Figure 4.
Riser Attachment Points (High Modulus)

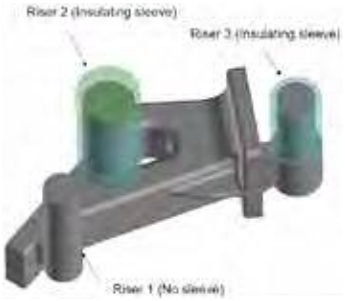


Figure 6.
Risered Model. Sizes and Locations Determined by the Riser Design Wizard

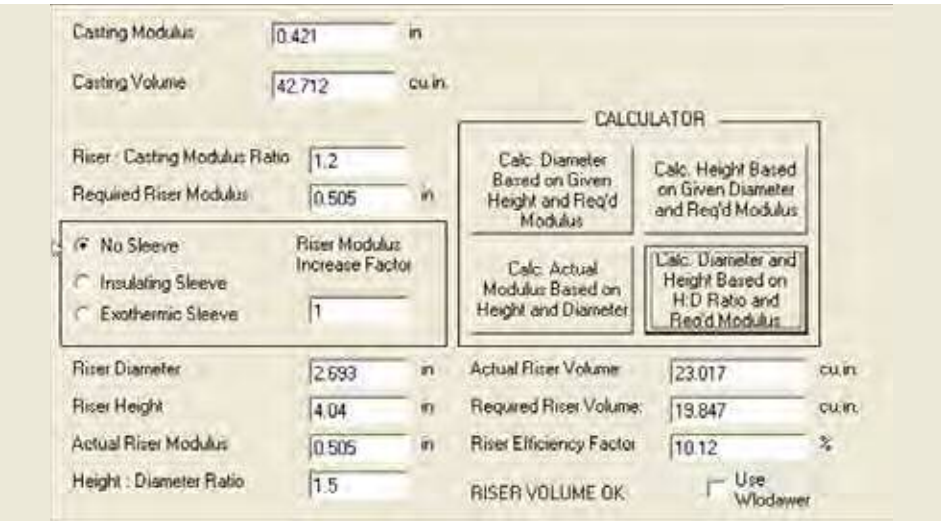
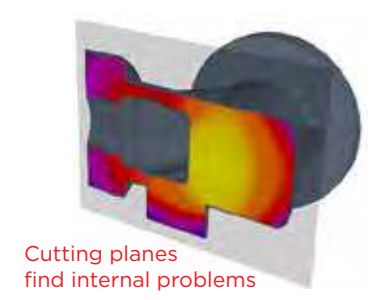
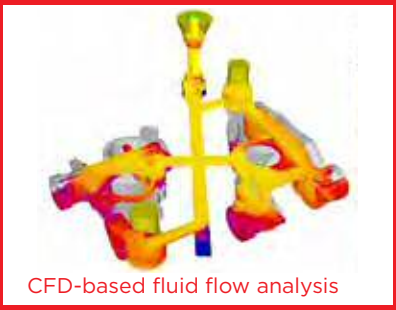


Figure 5. *Riser Size Calculator.*

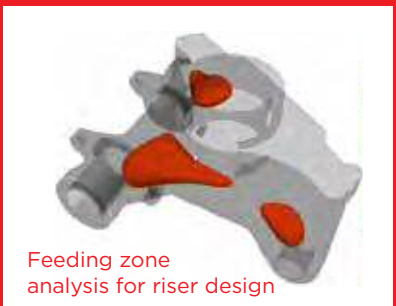
Contact:
DAVID C. SCHMIDT
dave@finitesolutions.com



Cutting planes
find internal problems



CFD-based fluid flow analysis



Feeding zone
analysis for riser design

- **All Site Licenses**
- **Easiest to Use**
- **Fastest Results**
- **Integrated Gating/ Riser Design**
- **Stunning Graphics**
- **Lowest Cost to Buy & Use**
- **Combined Thermal/ Volumetric Calculations**

Finite solutions Incorporated

ALL CASTING SIMULATION SOFTWARE IS THE SAME... RIGHT?

WRONG

Finite Solutions Inc. has spent over 30 years developing the world's most practical simulation solution. We use simulation to help CREATE an effective rigging system, not just to test an existing design. Results from an unrigged simulation of the casting are used directly to design efficient gating and risering, both for shrinking alloys and for graphitic irons. Methods are confirmed using CFD-based fluid flow analysis and combined thermal/ volumetric solidification calculations. We provide the most accurate analysis, in the least amount of time, all at the lowest cost.

Want to learn more about our casting simulation software?
Contact David Schmidt by calling **262.644.0785** or reach out via email at **dave@finitesolutions.com.**

AFS METALCASTING CONGRESS
April 3-5, 2018–Fort Worth, TX

VISIT US AT BOOTH #100