THE BASICS OF VERTICAL GATING SYSTEM DESIGN

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ARTICLE TAKEAWAYS:

- Vertical Gating System components are sized using Bernoulli's Theorem and the Law of Continuity
- Properly-sized components will help to fill the mold smoothly
- System calculations can be automated using casting simulation

BASIC THEORY OF GATING DESIGN

Vertical gating system design is quite simple. Step one is estimating the Fill Time required for a casting. This may be based on experience or on a calculation involving the pour weight, alloy type and the critical section thickness.

Knowing the Fill Time, weight and density of the casting, you can calculate the volumetric flow rate using the formula:

$$\text{Flow rate} = \frac{\text{Volume}}{\text{Fill Time}}$$

Next, we consider how far the metal will fall when poured, which gives a metal velocity. Knowing the velocity and the volumetric flow rate, the cross-sectional area of flow can be calculated. The flow area is adjusted for friction loss, and this area is apportioned so that there is the desired flow rate at each ingate. It is also necessary to establish the "choke" point, which controls flow through the gating system.

The following example was created using the Gating Design Wizard, a part of the SOLIDCast simulation software. Much of the data input needed for gating system calculation can be extracted from simulation models. For a detailed description of vertical gating system design, see the AFS Handbook on Basic Principles of Gating, and papers by Roger Brown of Disamatic.

System design starts with calculation of an Optimal Fill Time (OFT) (Fig 1). The following data is required:

Alloy Sensitivity - This is specified with the slider bar at the top of the screen (Fig 1). This is the tendency of metals to form oxides during pouring. Low sensitivity alloys may be poured more quickly. Alloys which are more sensitive should be poured slowly to avoid turbulence which may form and entrain inclusions in the finished casting.

Weight per Casting – This is the weight of one casting without gating. The exact value of the weight is not highly critical, since the OFT formula uses the cube root of the weight to estimate fill time.

Critical Section Thickness - The thickness of the thinnest section of the casting, which is most likely to misrun.

You may also enter your own Fill Time as an alternative to the OFT calculation.

After calculating or entering the Fill Time, enter the **Number of Castings per Mold** and the **Number of Gates per Casting**.

After this, select the following:

Type of Gate

Type of Sprue

Pressurization Factor

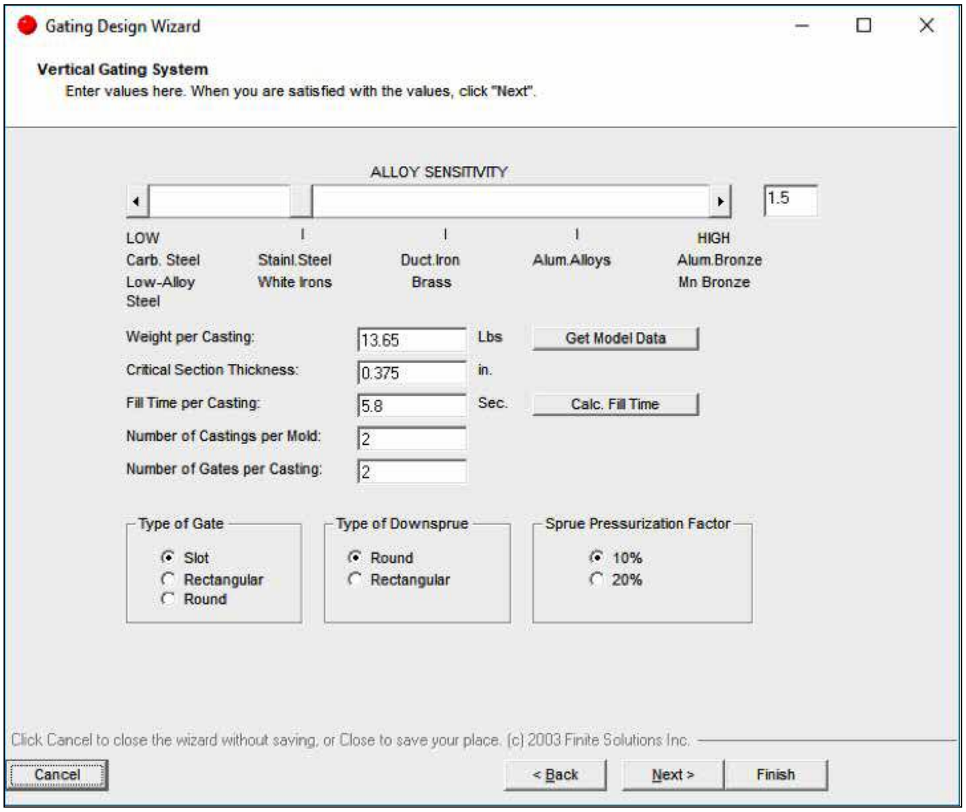

Figure 1. Alloy Selection and Optimal Fill Time (OFT) Calculation.

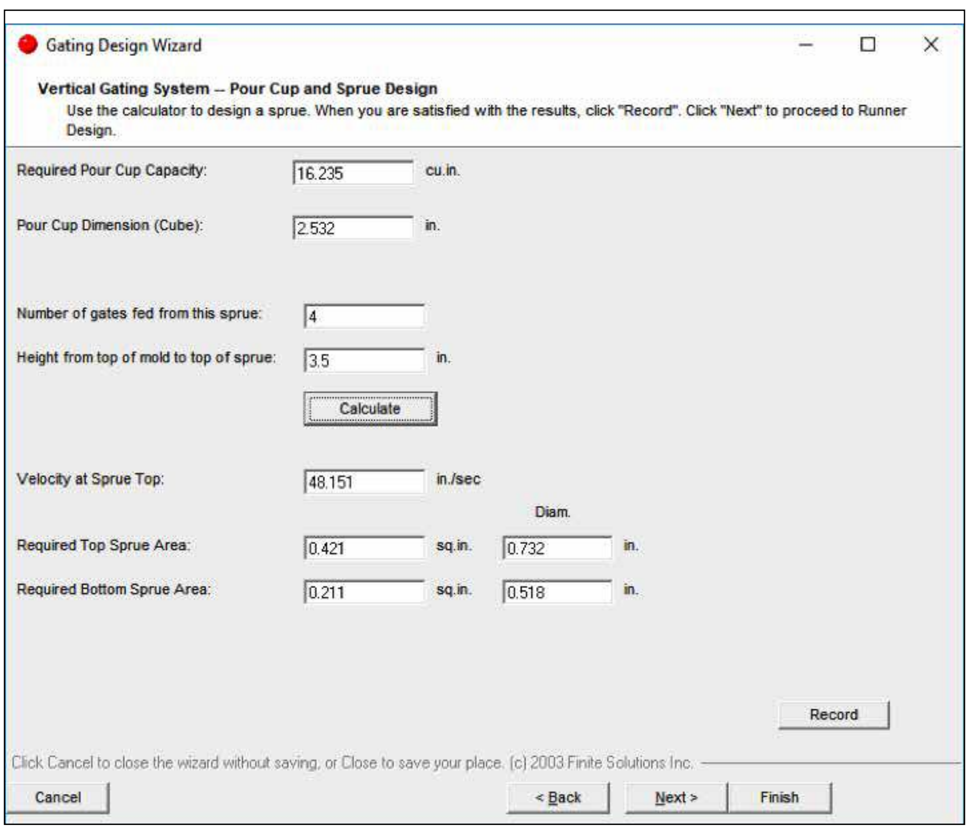

Figure 2. Pour Cup and Sprue Design.

The pressurization factor will increase the sprue area to ensure that the gating system remains pressurized, which is preferred for vertical gating systems.

This next stage is the Pour Cup and Sprue Design window (Fig 2).

The pour cup should have enough volume to accommodate one second of metal flow, with a minimum dimension of 2.5 inches (63.5 mm). These fields are display only; no data entry is required.

For downsprue design, the program needs to know how many gates are fed from this sprue and the height from the top of the mold to the top of the sprue. This establishes the velocity and area at the sprue top. Include a generous radius at the transition from the bottom of the pour cup to the top of the sprue. Recommended design practice is for the area at the bottom of the sprue to be one-half that at the top.

The next display is the Runner Design window (Fig 3). This is used if you have any horizontal runners in the gating system.

The system needs to know how many gates are fed from this runner and the height from the top of the mold to the center of the runner. This establishes the velocity and area of the runner.

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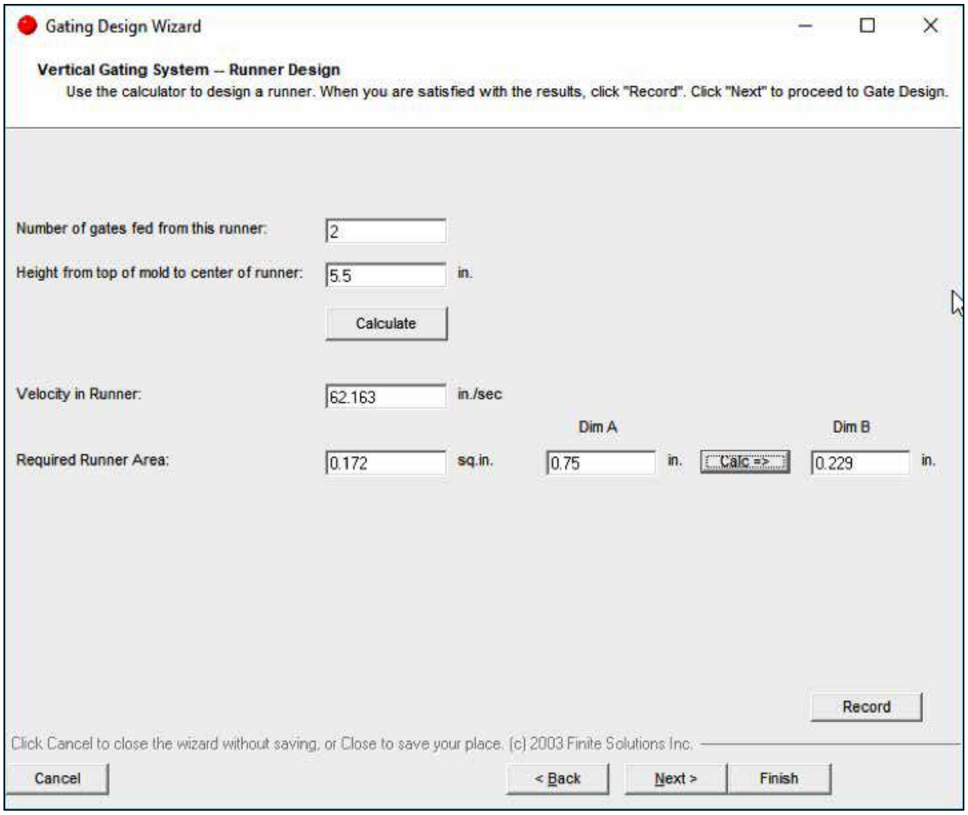

Figure 3. Runner Design.

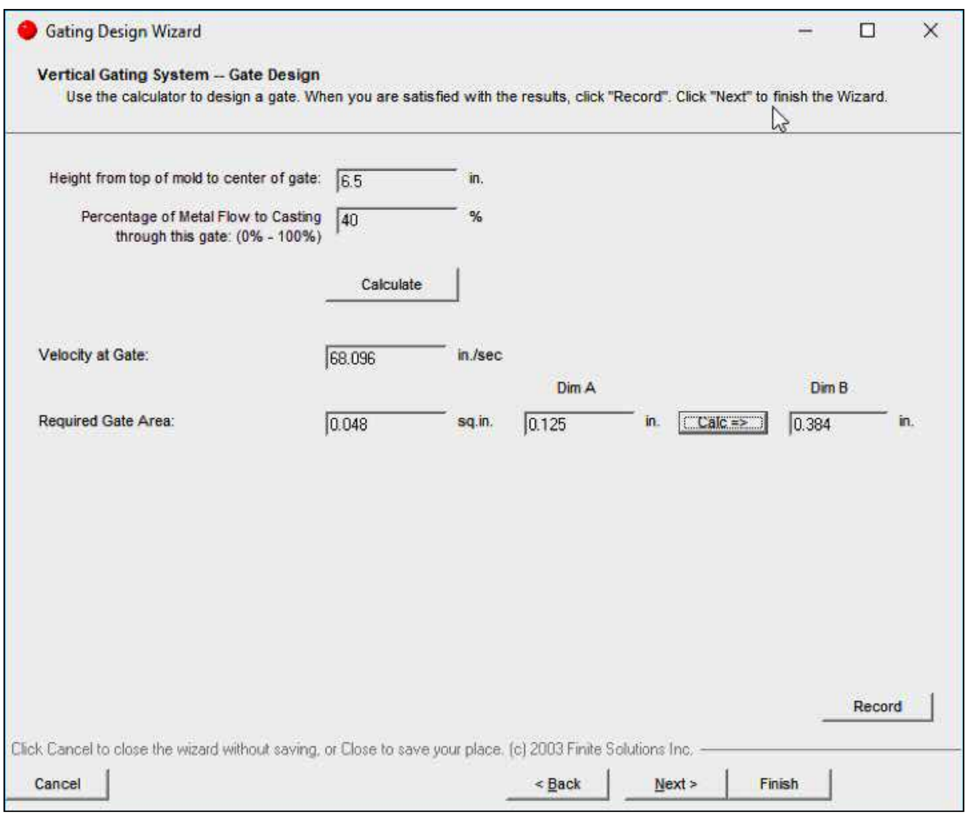

Figure 4. Gate Design.

Assuming the runner is rectangular in cross section, you can enter one dimension and press the Calc button to have the system calculate the other dimension of the runner.

The program needs to know the height from the top of the mold to the center of this gate. If there is more than one gate per casting, then the system will ask what percentage of the flow is to pass through each gate. For example, the flow might be divided equally between two gates, which would be 50%-50%, or this could be allocated 40%-60% depending on casting geometry. This data establishes flow rate and velocity at this gate, which makes it possible to calculate the required area.

Assuming the gate is rectangular in cross section, you can enter one dimension and have the system calculate the other dimension of the gate.

This procedure can be duplicated for each unique gate within the gating system, so that all gates can be designed using this window.

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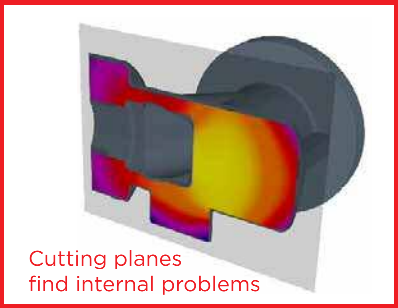
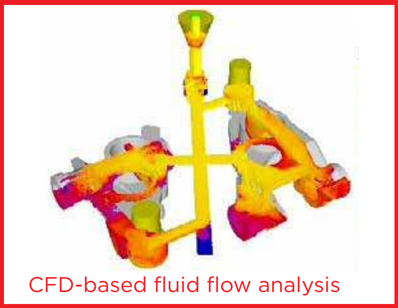
ALL CASTING SIMULATION SOFTWARE IS THE SAME... RIGHT?

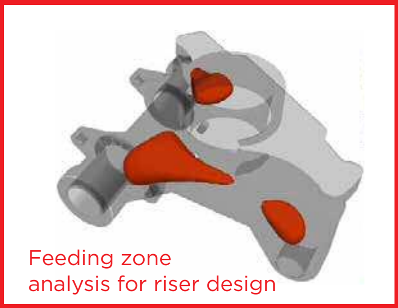
WRONG



Cutting planes find internal problems



CFD-based fluid flow analysis



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