

Ford TME Bearing Cap 福特球铁 轴承盖

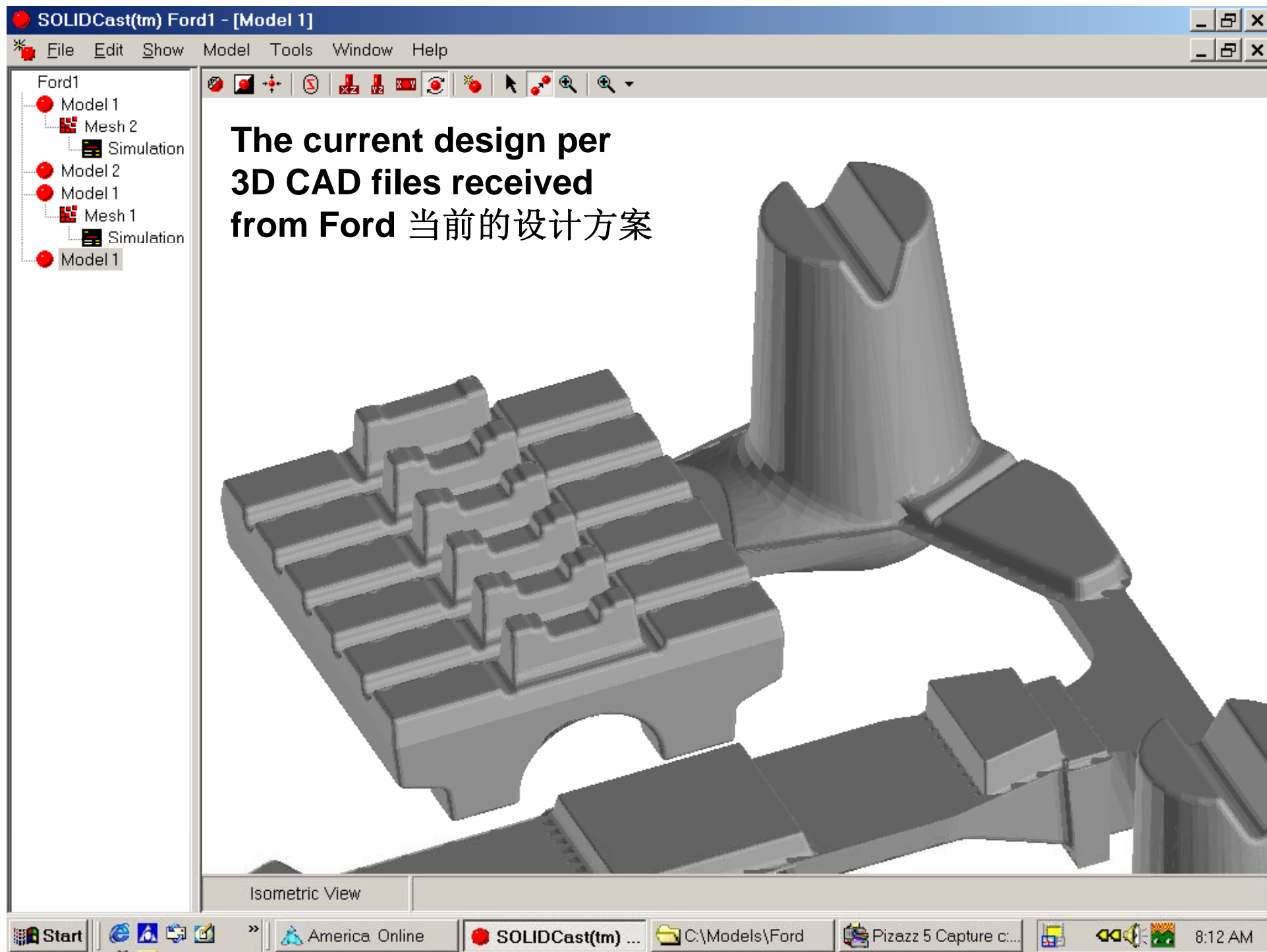
Ductile Iron

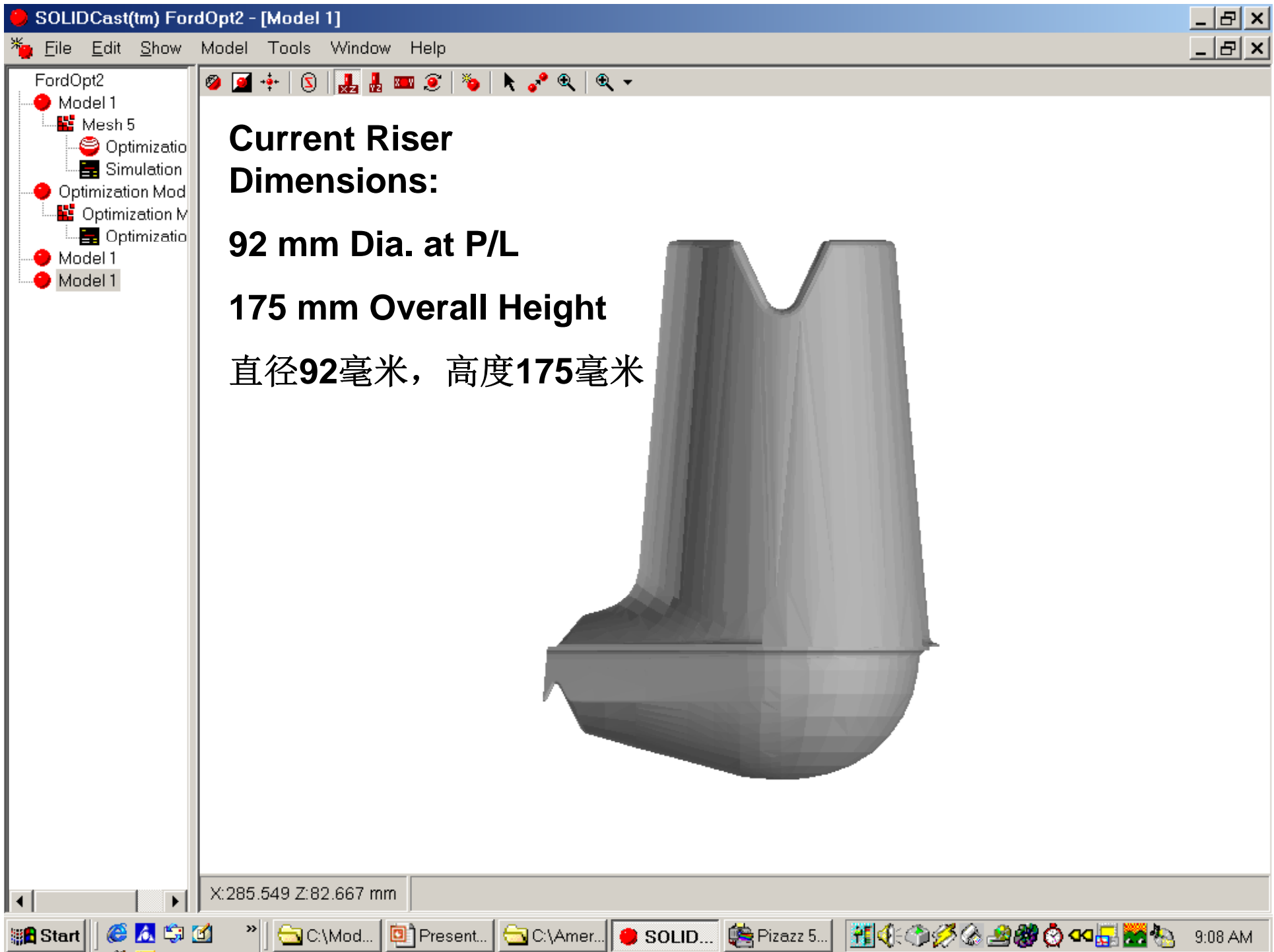
Riser Optimization 冒口自动优化

April 24, 2002

Analyzed with:





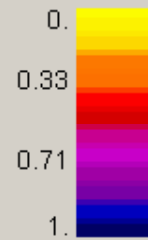
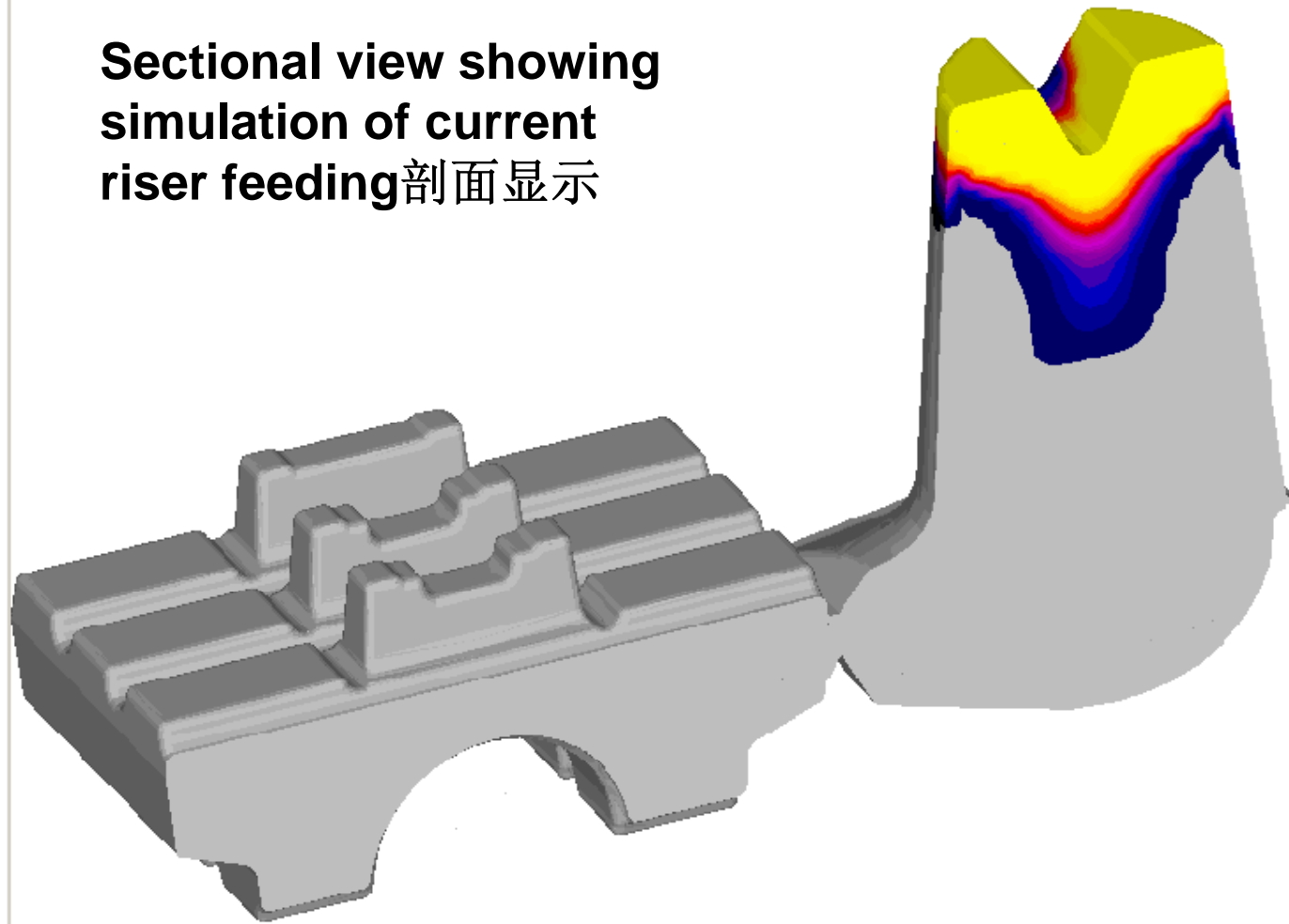


**Simulation of current riser
shows adequate size and mass
to feed the casting properly.**

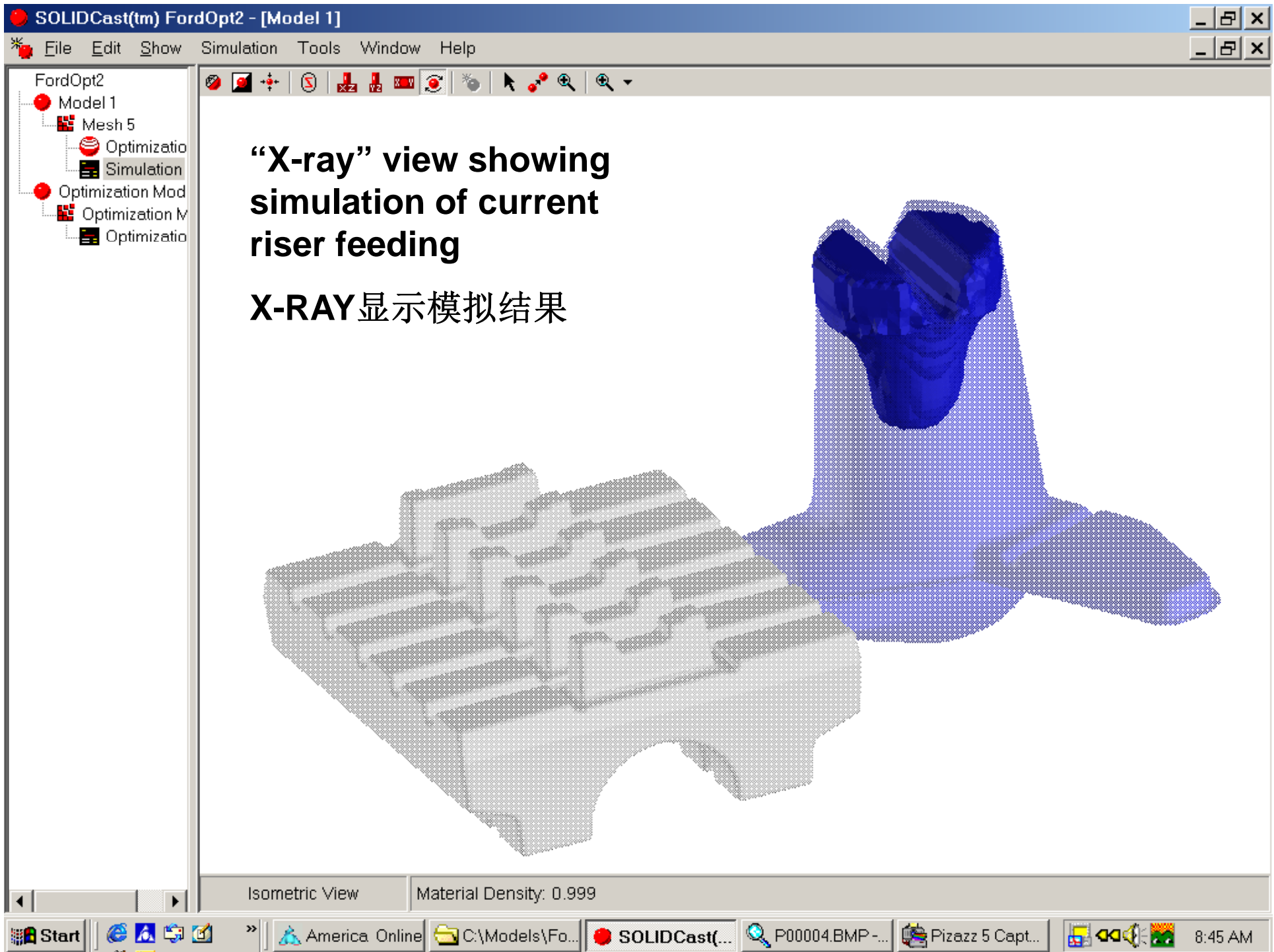
通过对当前的工艺的模拟显示冒口
的尺寸足够大

Material Density: 0-0.999

**Sectional view showing
simulation of current
riser feeding**剖面显示



movie...



Question:问题

Can the weight of the riser be reduced, and yet still provide adequate feeding to the casting?

在保持足够补缩条件的前提下，冒口重量能缩小么？

We can answer this question using mathematical optimization.

我们可以使用**OPTICast**工艺优化模块回答这个问题

**The OPTICast® system
combines the SOLIDCast®
casting simulation package
from Finite Solutions, Inc.
with HyperOpt® Optimization
from Altair Engineering.**

**OPTICast模块与SOLID Cast联
合使用，由美国FSI公司与
ALTAIR公司合作开发完成的**

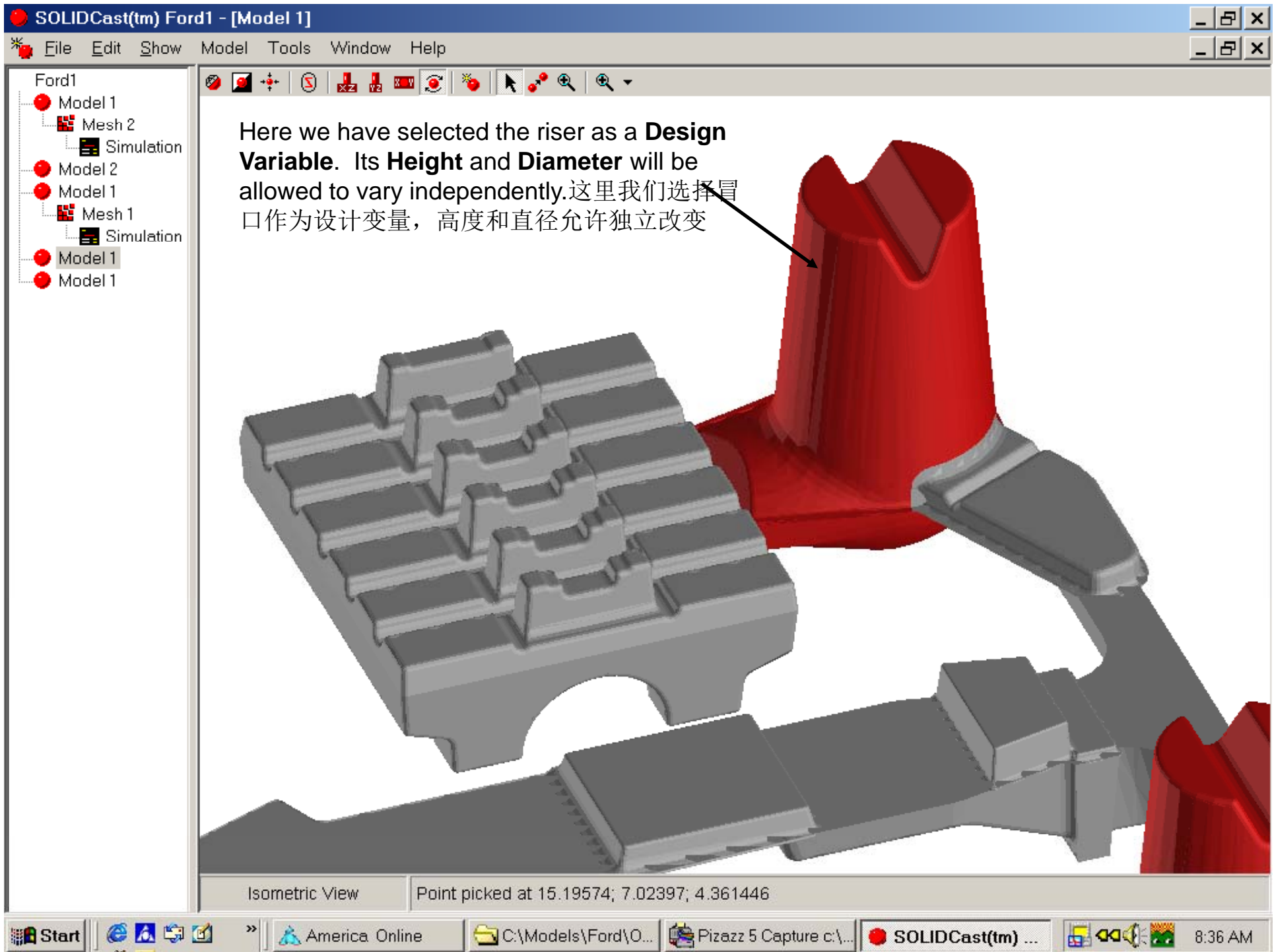
In order to perform optimization on this riser design, we need to define three parameters:

为了优化工艺，我们需要定义三个参数

- **Design Variables**设计变量
- **Constraints**约束条件
- **Objective Function**功能函数

Design Variables are any aspects of the design that we will allow the optimizer to vary during the optimization run.

设计变量即优化的时候允许改变的参数，如冒口的尺寸等



A **Constraint** is an output which determines whether a design is acceptable.

Here we set **Casting Porosity** as a constraint. Porosity is measured by considering the minimum local material density in the casting. The constraint value is set to 1.0, which indicates no casting porosity allowed.

约束即决定设计方案是否被接受的标准

这里我们选择铸件缩松作为约束，使用材料密度判
据，将其设置成最高的1.0,即不允许任何缩松

The **Objective Function** is a simulation output which measures the end result we are trying to achieve.

目标函数即要达到的结果

For purposes of this optimization, we define a yield number such that

$$\text{Yield} = \frac{\text{Casting Weight}}{\text{Casting} + \text{Riser Weight}}$$

The Objective Function is the maximization of this number, which results in minimum riser weight.

对于这次优化，我们定义出品率作为目标函数
即出品率最大化

The Optimization Process

The **Optimization Engine** varies each **Design Variable** within the **Design Space** to create a series of process models.

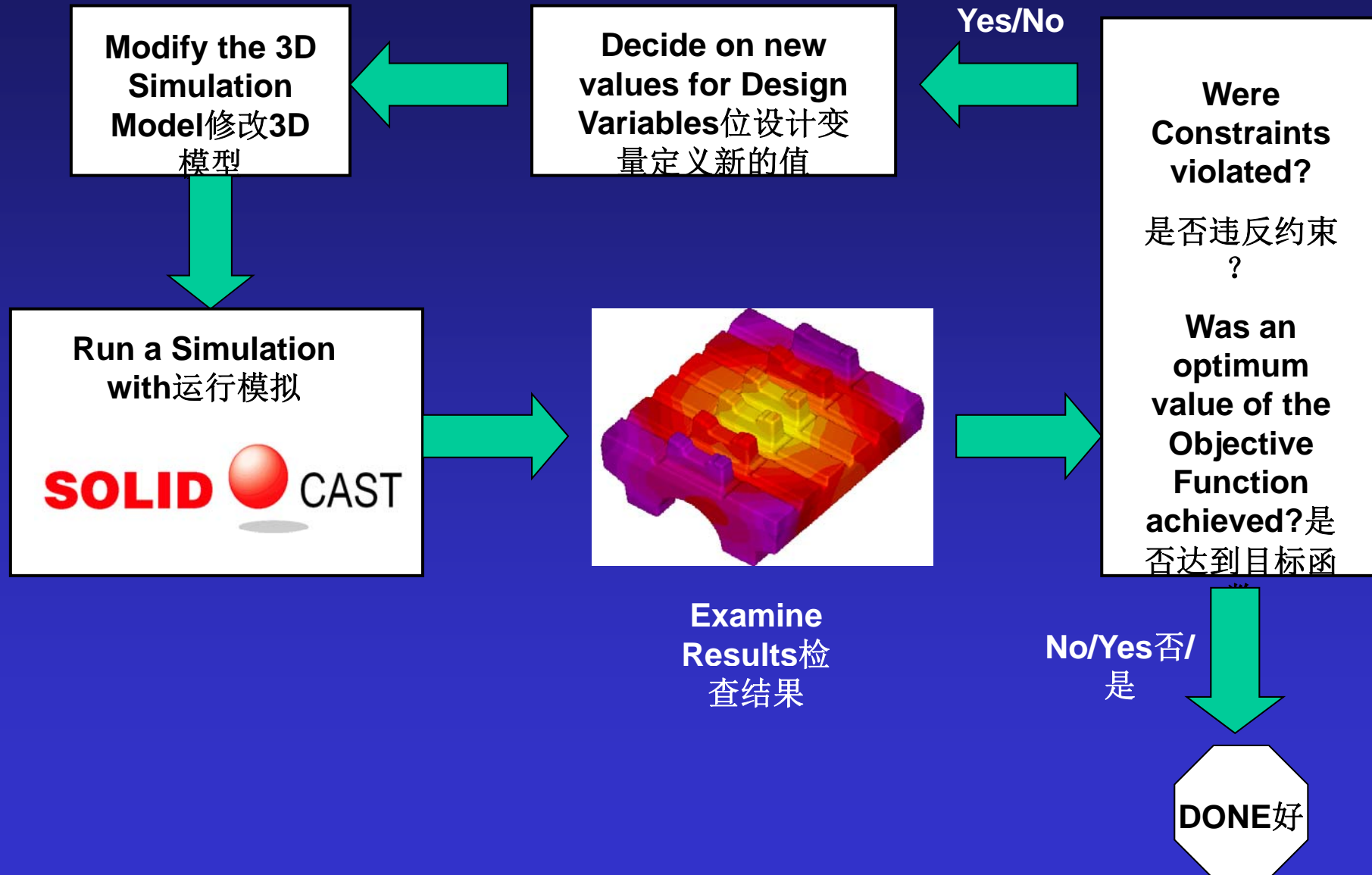
Each design is evaluated as to whether it violates any **Constraint**.

Each design is then evaluated to determine if the **Objective Function** has been achieved, through the use of convergence criteria.

优化程序改变每个设计变量创建一系列模型

评估每个变量的结果是否违反约束条件，然后看是否达到目标函数的要求

How OPTICast Works如何工作的

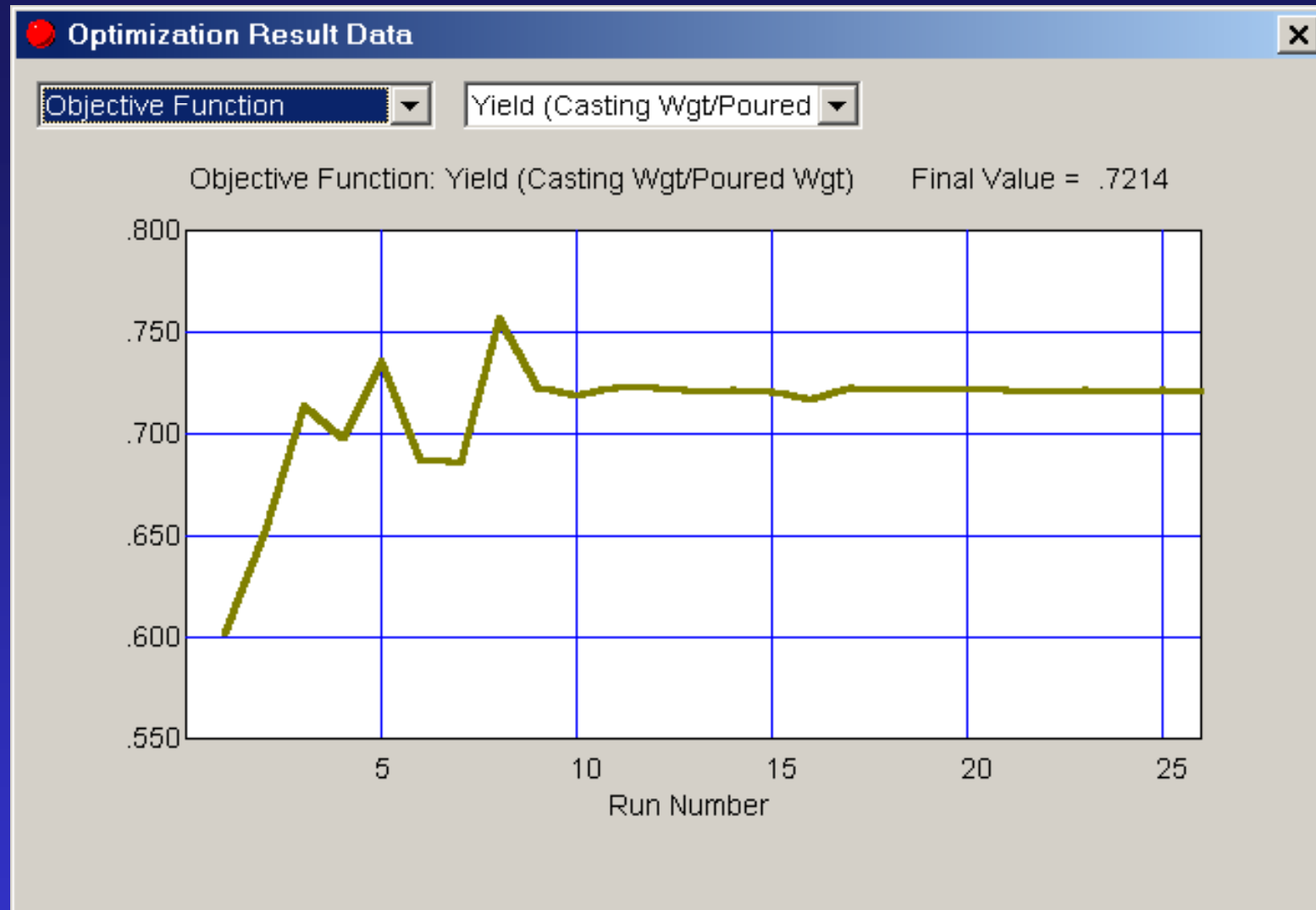


Optimization Results优化结果

The riser design optimization was complete after 26 simulations. These were run completely automatically.

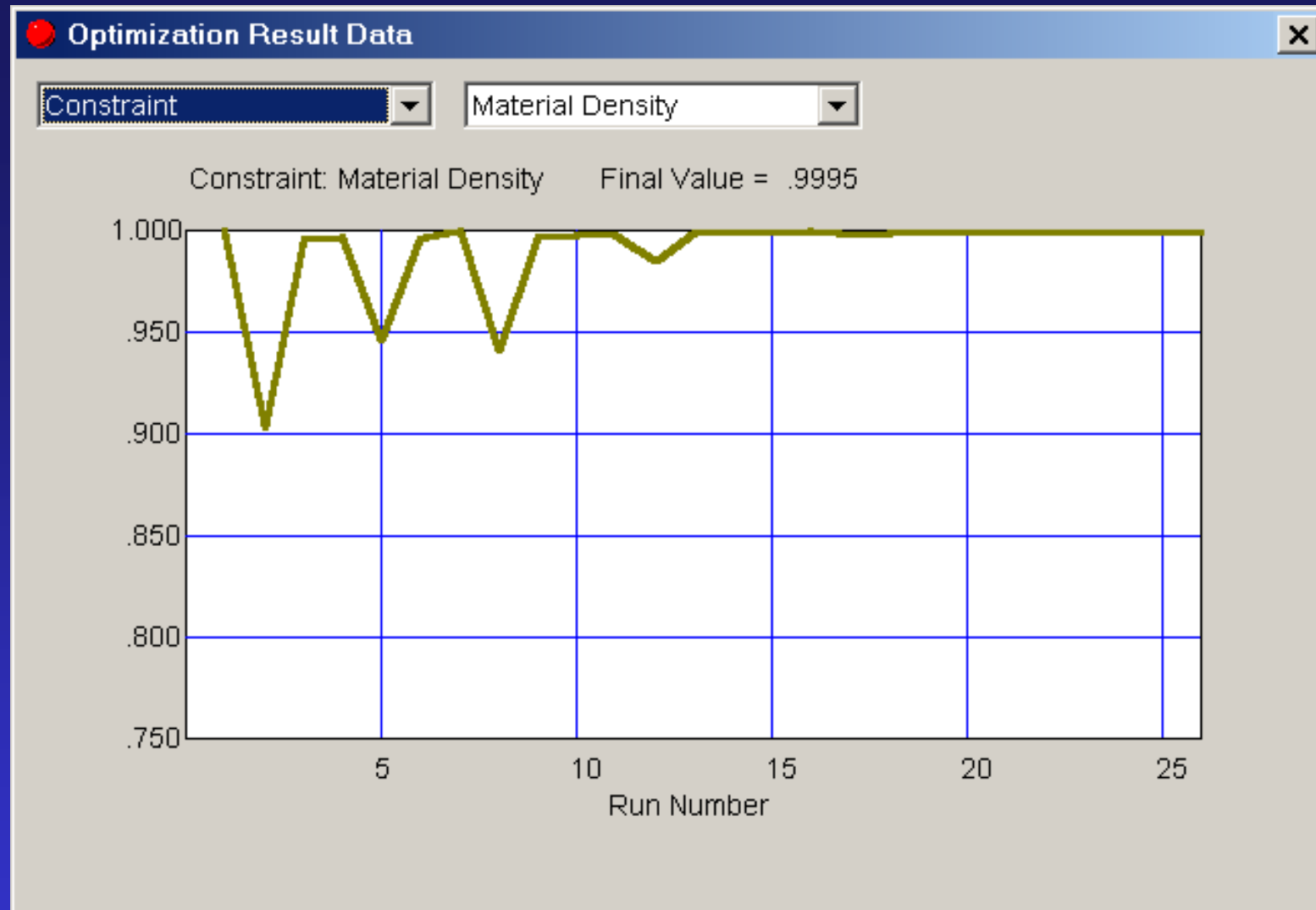
Total processing time was 2 hr. 56 min.

反复做了**26**此模拟，完全都是自动运行，整个过程持续了**2小时56分钟**



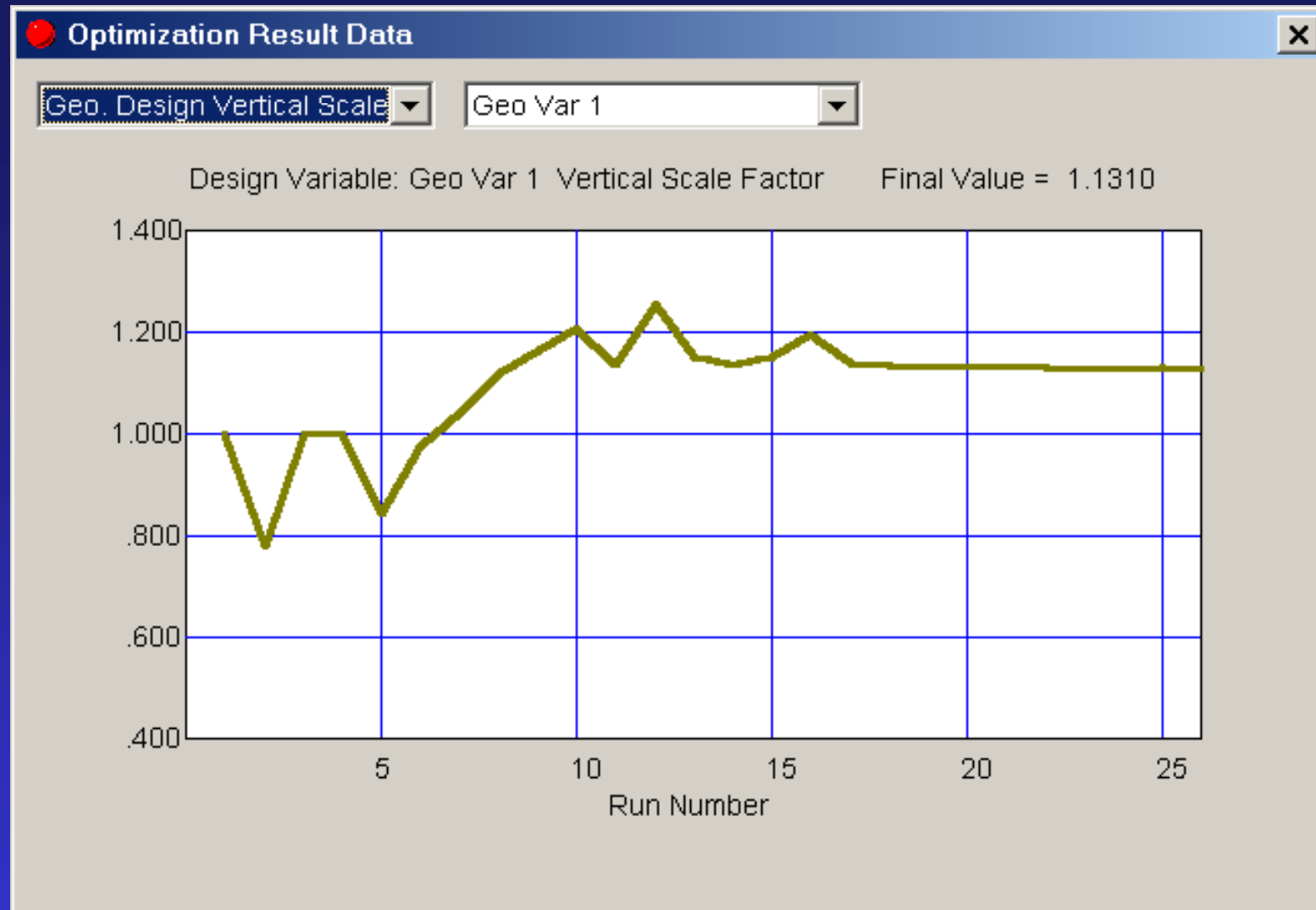
This chart shows the progressive value of the Yield function over 26 simulations. Its value started at 0.60 and ended at 0.72.

此表显示了出品率的变化过程，从开始的0.6到最后的0.72



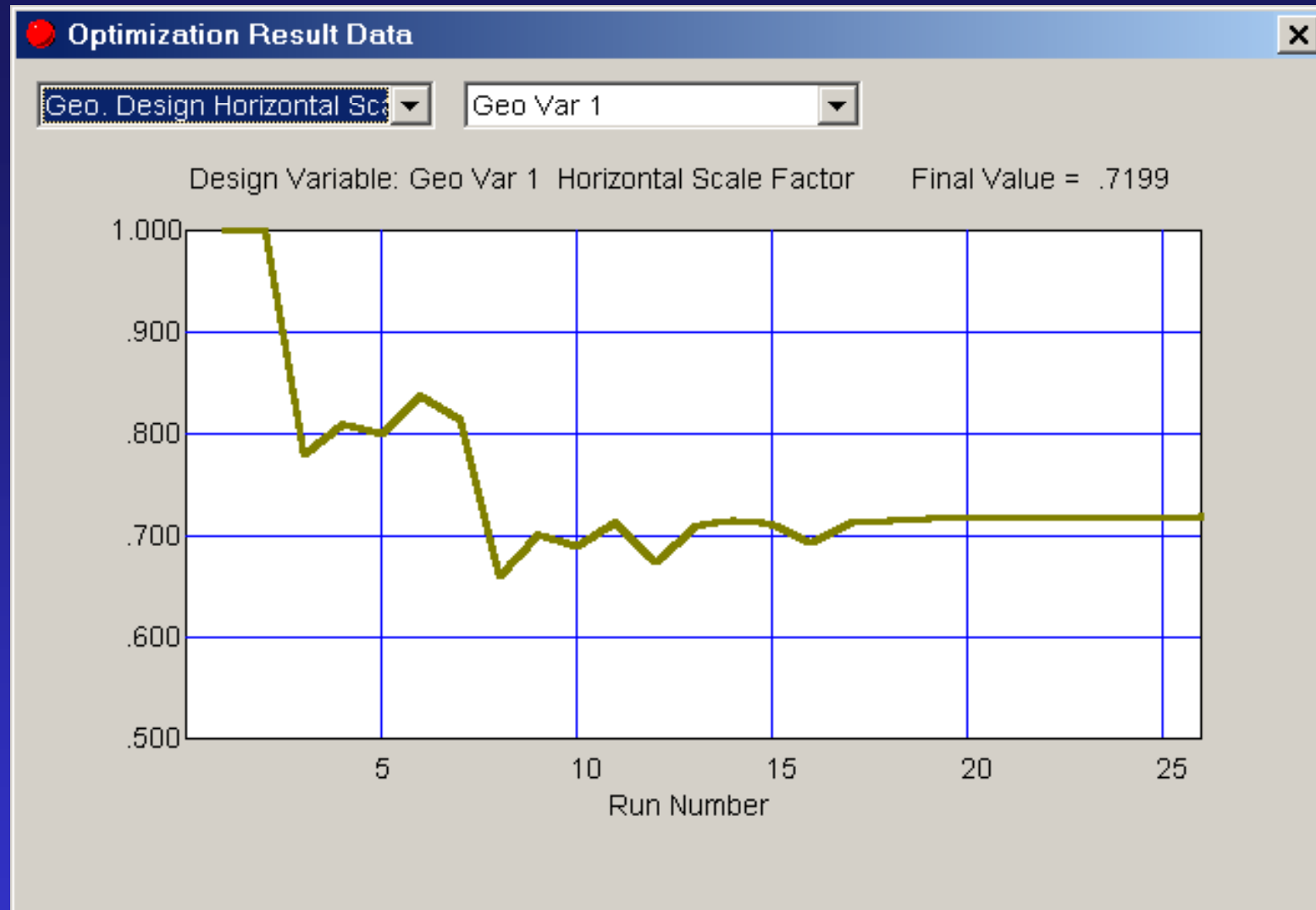
This chart shows simulated porosity in the casting. A value of 1.0 represents a completely sound casting. Final value of 0.9995 is within allowable limits.

这个显示了材料密度判据的变化过程。最后是**0.9995**



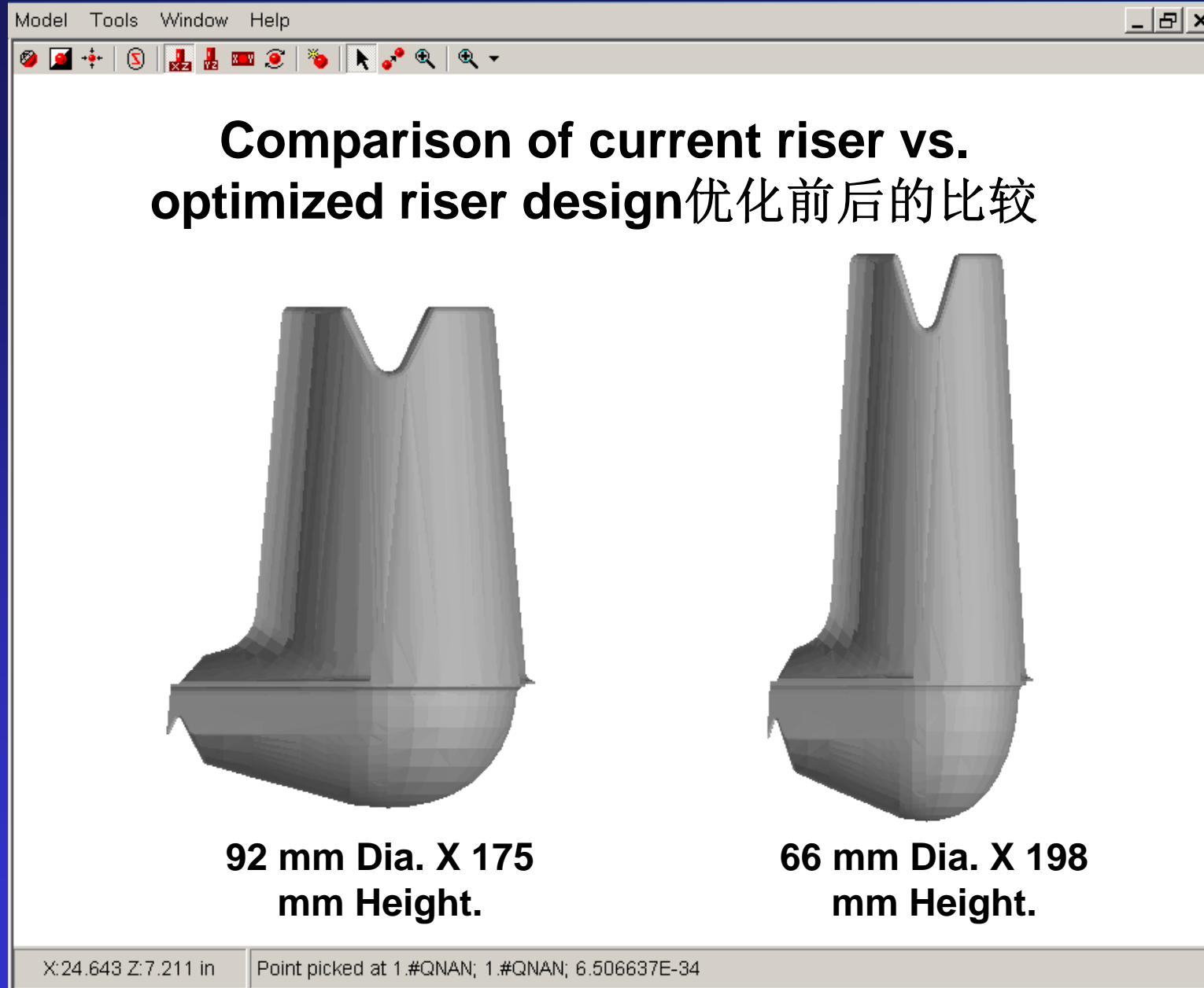
A plot of the vertical scale of the riser. The final riser design is 13.1% taller than the current riser.

显示了冒口尺寸的变化过程，最后的冒口要比当前的高**13.1%**



A plot of the horizontal scale (diameter) of the riser. The final riser design is 72% smaller in diameter than the current riser.

显示冒口尺寸的变化，最后的直径比以前的减小**72%**

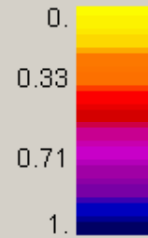
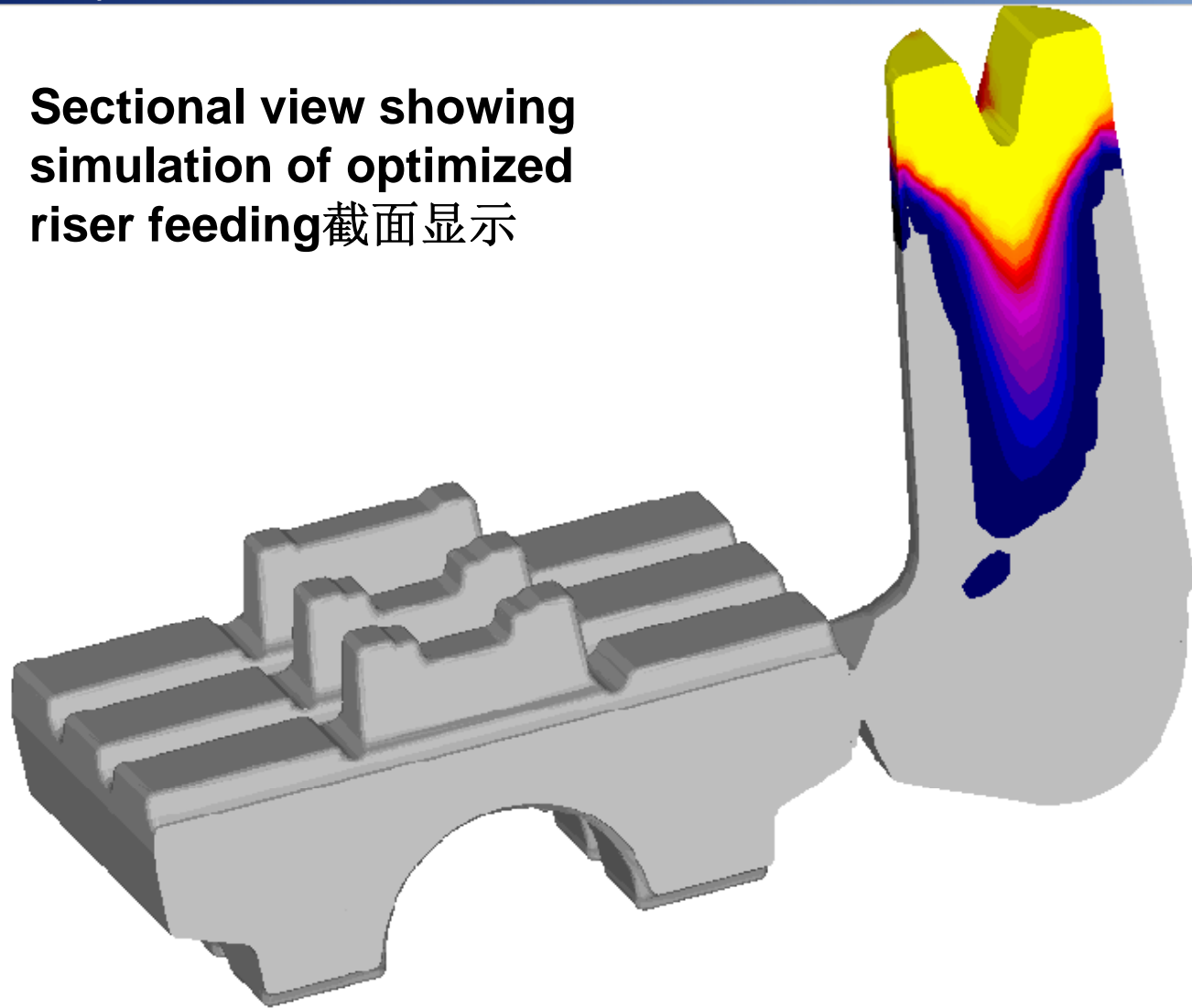


**Simulation of optimized riser
shows adequate size and mass to
feed the casting properly.**

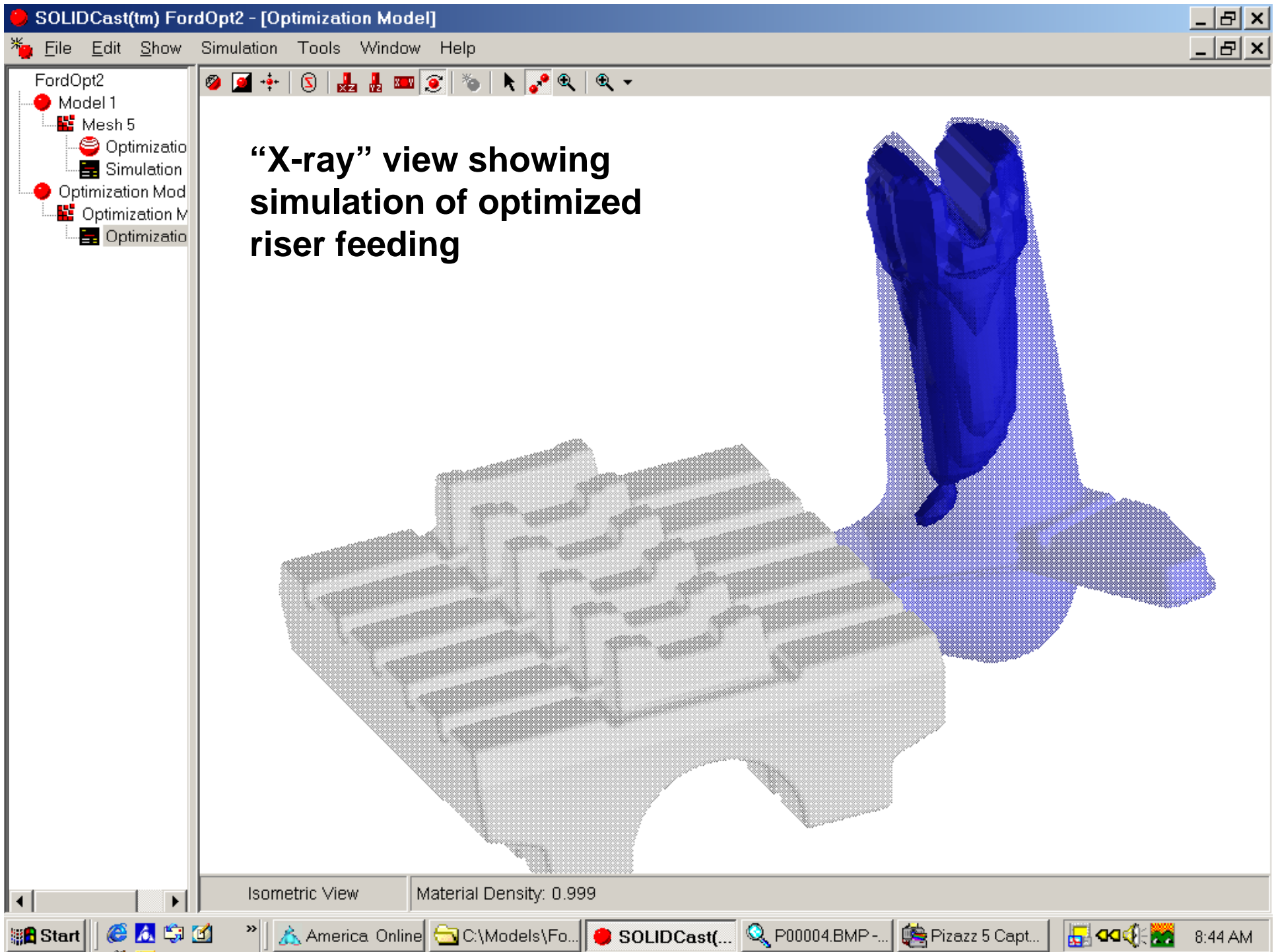
模拟显示优化后的冒口也能足够补缩

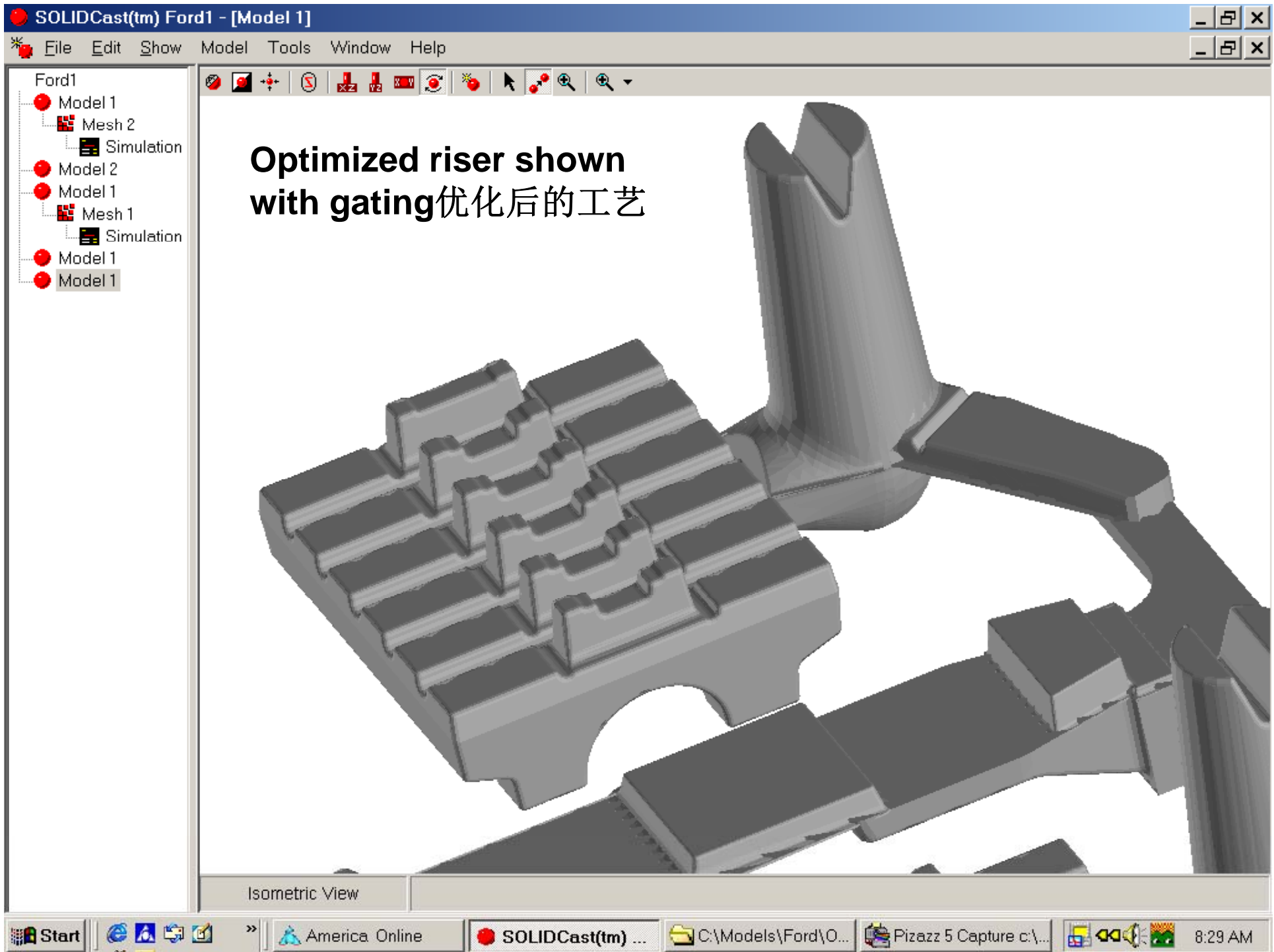
Material Density: 0-0.999

**Sectional view showing
simulation of optimized
riser feeding** 截面显示



movie...





Weight Reduction重量减低

Current Riser Weight: 当前冒口重量 **16.03 lbs.**

Optimized Riser Weight:

优化后的重量 **9.39 lbs.**

Weight Reduction/Riser: 减少了 **6.64 lbs.**

Weight Reduction/Mold (8-on): **53.1 lbs.**

Conclusions:结论

- Pour weight per mold can be reduced by 53.1 pounds through redesign of the riser by optimization
- 浇注重量减少了53.1磅
- Current porosity problems are likely caused by failure of the riser to pipe. This can be reduced by:
 1. Making the inlet gate to the riser thinner
 2. Eliminating the atmospheric wedge at top
 3. Slight increase in pouring temperature