Simufact.forming - 塑性成形模拟仿真

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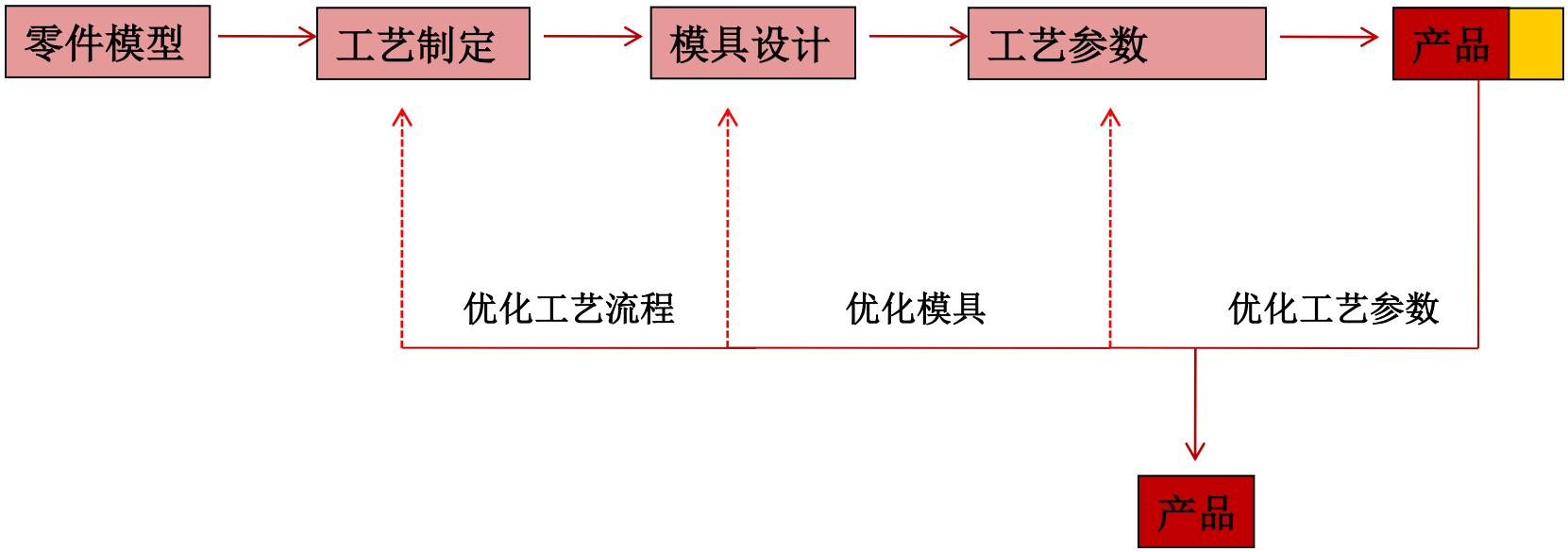
MSC Software®
Simulating Reality, Delivering Certainty™

为什么需要仿真—加工制造业

各行业的科技进步均离不开先进的加工制造技术

为什么需要仿真—产品生产流程



缺点：

1、人力物力浪费
2、研发周期长
3、成本高
4、精度低
5、产品竞争力低

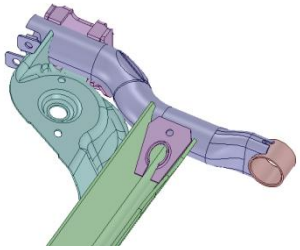
……

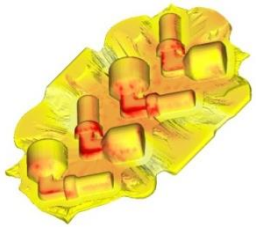
为什么需要仿真模拟？

零件模型 → 工艺流程 → 模具设计 → 工艺参数

CAE模拟分析

优化工艺流程　优化模具　优化工艺参数

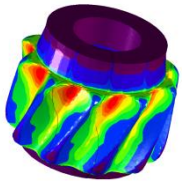




材料利用率高
研发周期短
节约成本
精度高
……

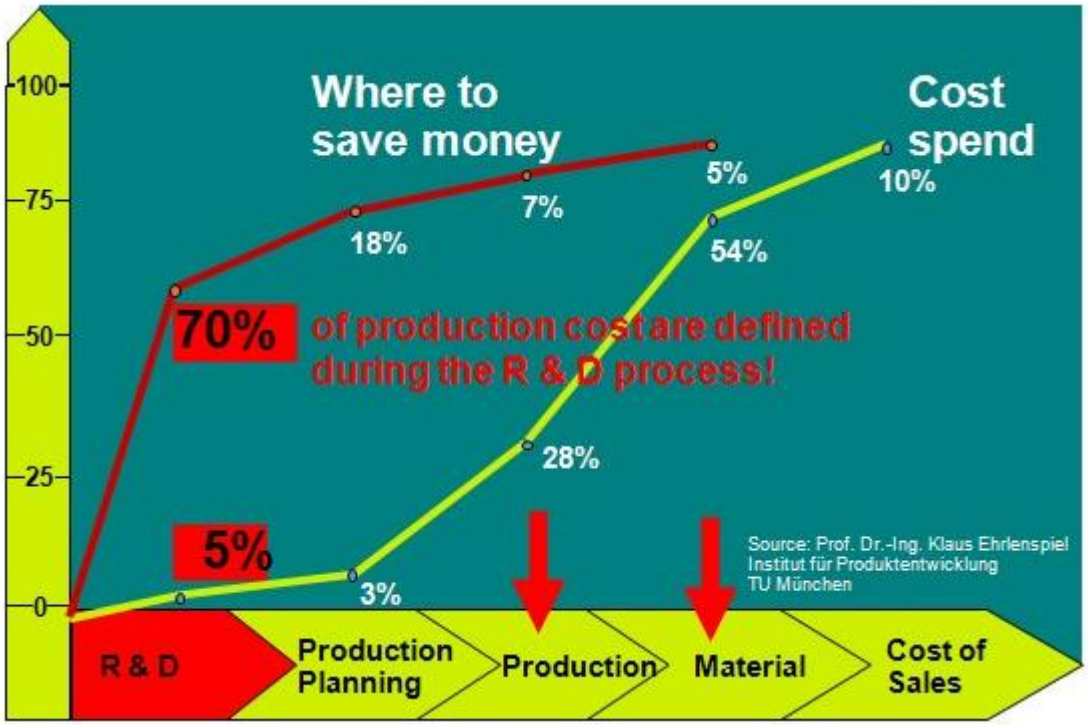
优化结果 ✚ 试制

产品



CAE软件帮助我们

- 缩短从设计到产品的周期
- 减少模具设计的费用
- 预估工艺过程中各种参数的影响
- 减少生产的费用
- 提高产品质量
- 了解材料性能
- 减少报废和材料浪费



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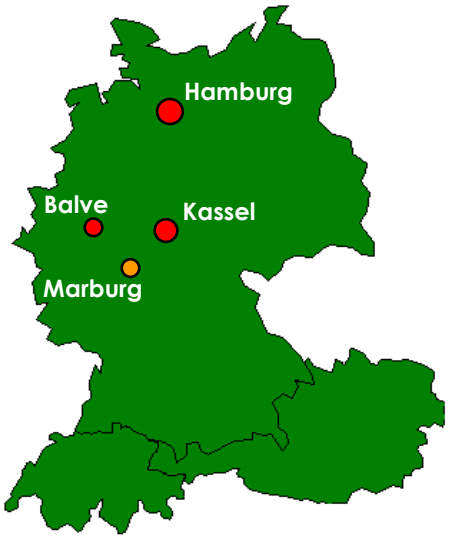
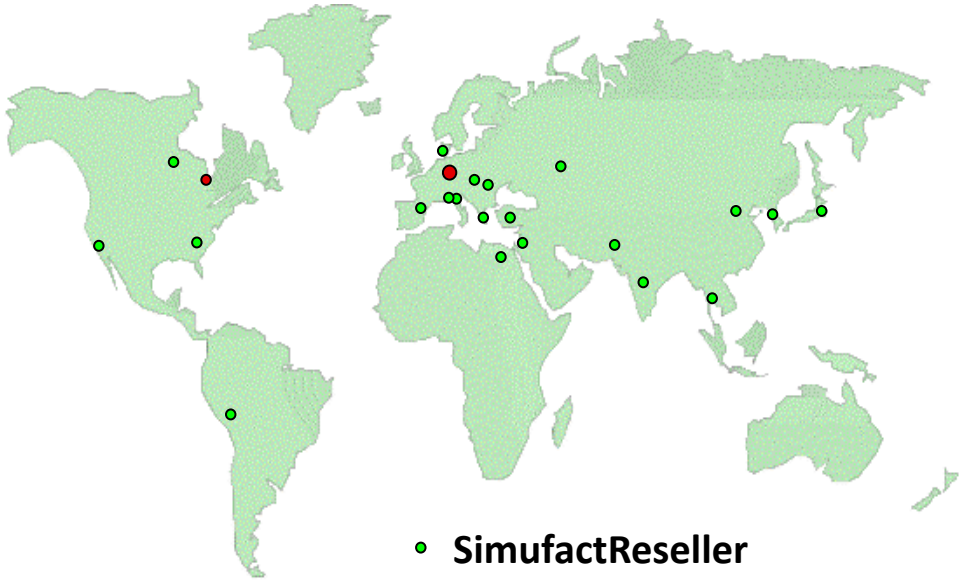
德国Simufact Engineering公司简介

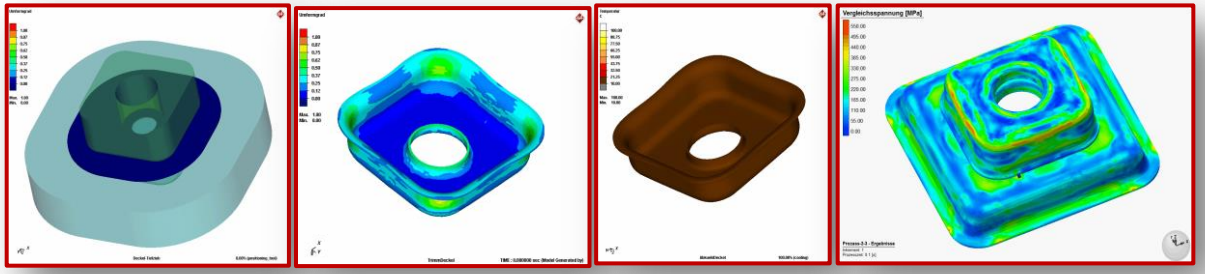
- 总部位于德国汉堡，德国和美国研发中心
- 19年的金属材料加工工艺仿真经验
- 开发锻压、热处理和焊接仿真软件，集成行业领先技术，合作伙伴：
  - MSC.Software – 求解器技术
  - Altair Engineering – 网格划分
  - Sente Software – 材料数据
  - ITI TranscenData – CAD接口
- 产品的使用培训
- 技术支持
- 工程咨询
- 2015年被MSC公司收购
  成为MSC全资子公司

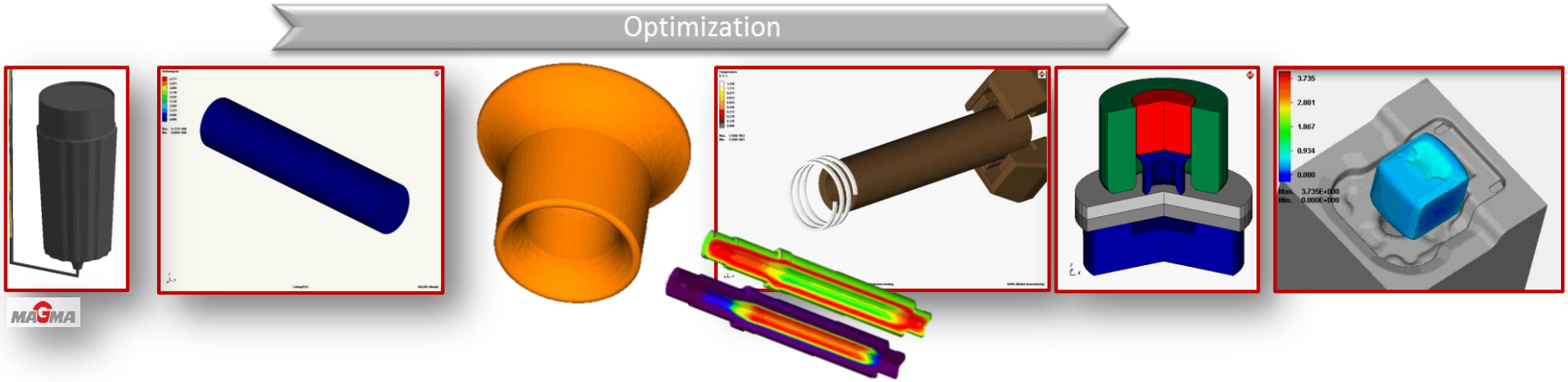




全工艺链仿真

Simufact全工艺链仿真技术





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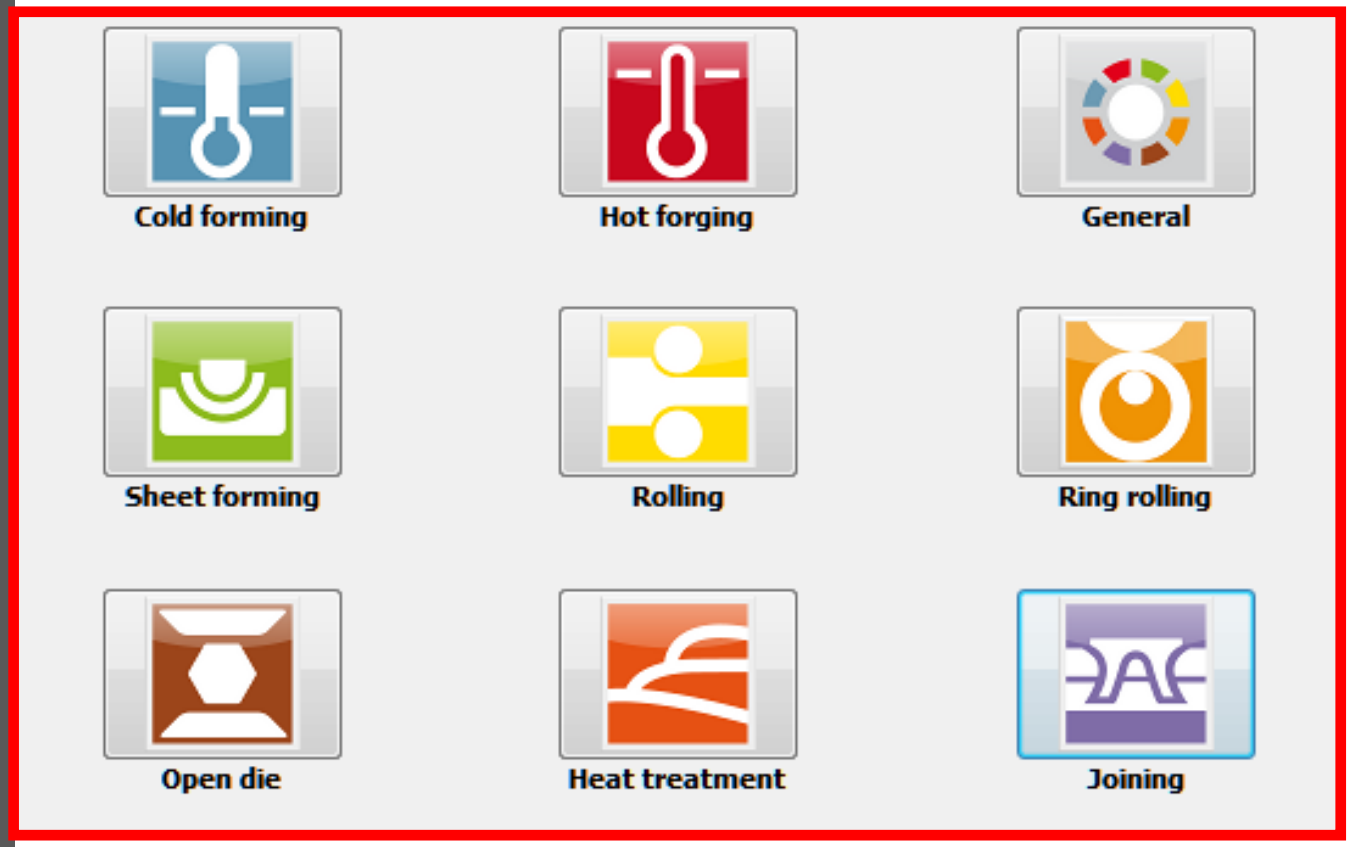
Simufact软件介绍

所有工艺类型仿真应用

simufact.forming

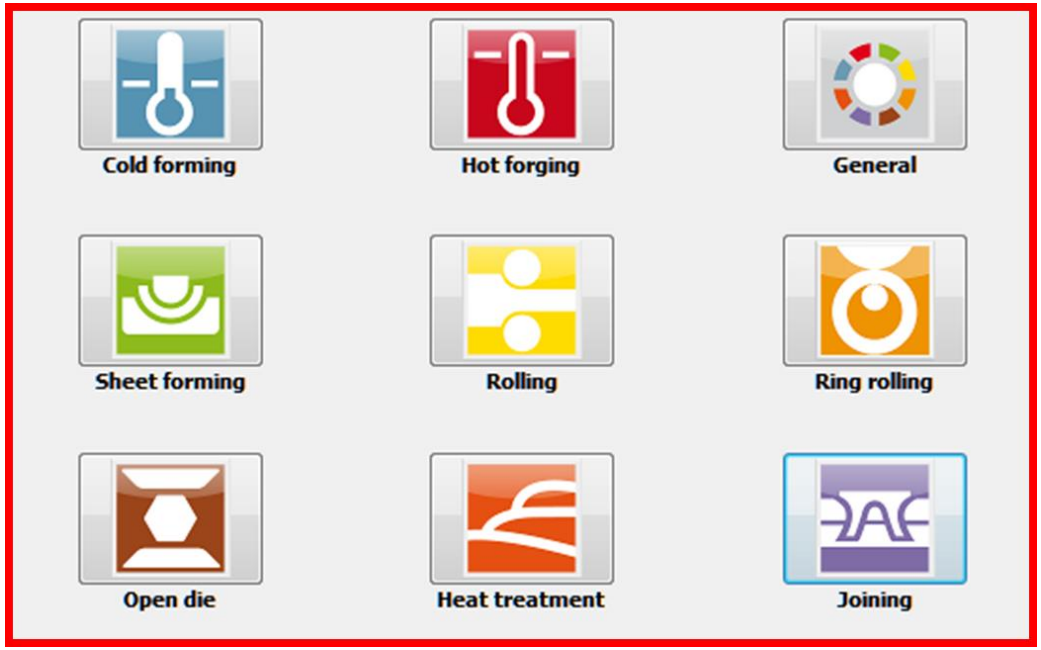


simufact.welding

独立软件包

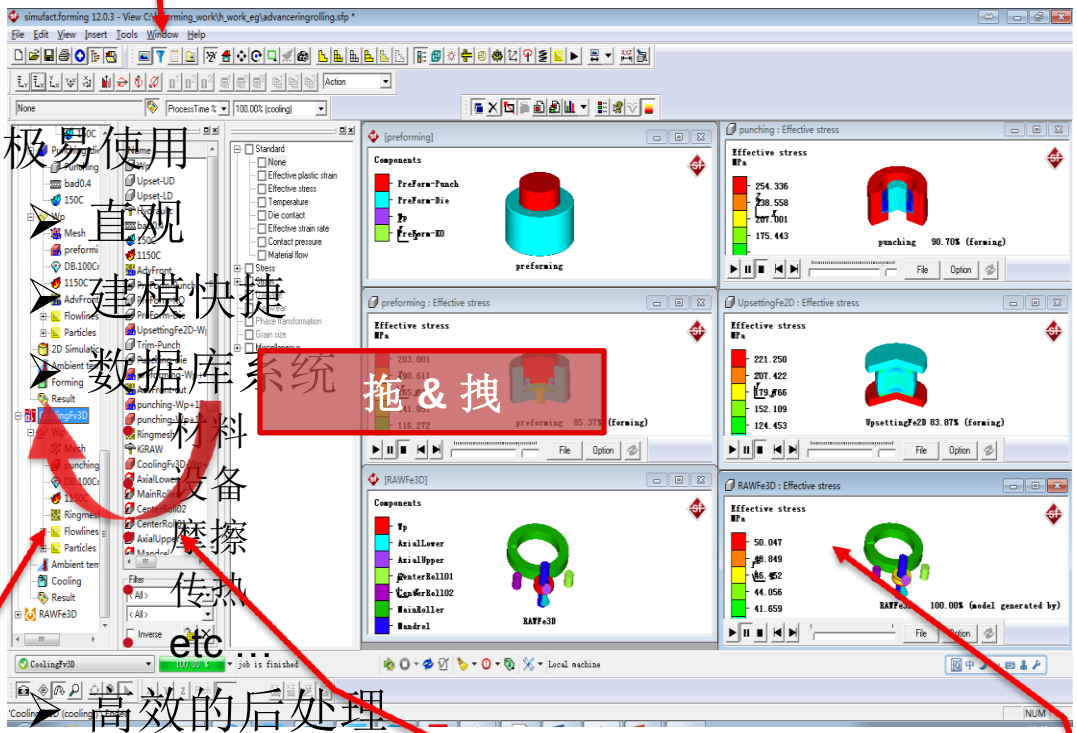
Simufact.forming新向导界面

- 新向导界面
  - 纵览Simufact.forming所有适用工艺仿真类型（包括工艺链仿真）
  - 针对所选应用领域的特定工艺类型简化模型创建与参数设置
  - 支持分析参数设置自定义(创建自己的标准设置)
  - 自动调整默认设置参数 (简化用户设置)
    - 时间步长
    - 摩擦模型
    - 收敛准则
    - 求解器选择
    - 网格划分



Simufact.forming操作界面

Windows 风格界面



极易使用

- 直观
- 建模快捷
- 数据库系统
  - 材料
  - 设备
  - 摩擦
  - 传热
  - etc ...
- 高效的后处理

工艺工程师和研发工程师

- 高级功能

进程树

备用区
(材料, 设备, CAD, 等.)

模型显示区

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Simufact.forming求解器

simufact.forming

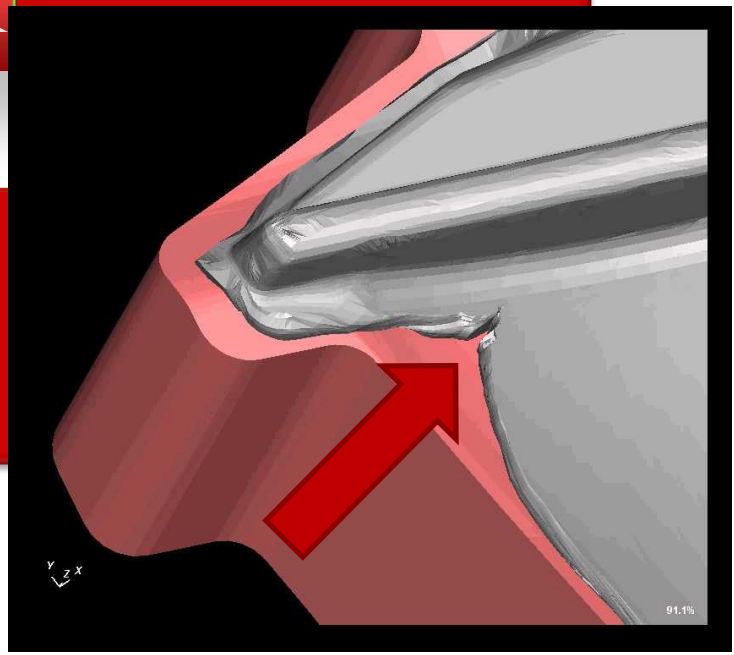
...
极易使用
精确
现实
求解快速
技术

有限单元法(FE)

有限体积法(FV)

CAD 导入
高级网格划分技术

Windows界面



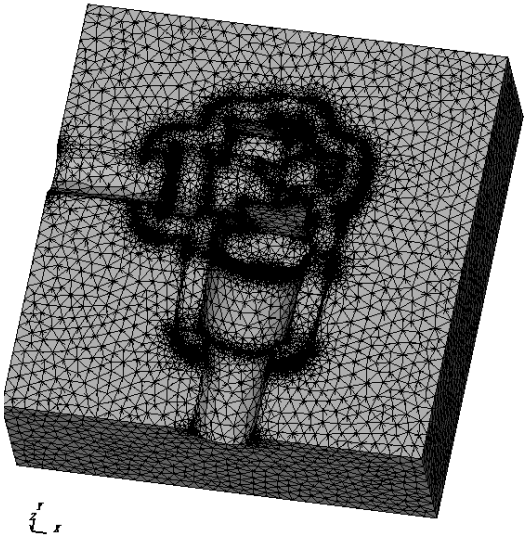
- 每个求解器均有优点
- 取长补短

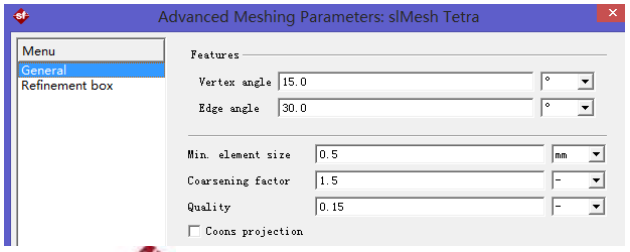
精确求解

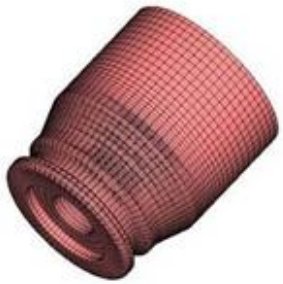
基于Marc与Dytran计算准确

Simufact.forming单元类型及网格重划分

	Simufact
四面体单元	有四面体单元
六面体单元	有六面体单元，且可以自动进行六面体单元划分和重划分。
实体壳单元	有单边精度和双边精度的实体壳单元
网格划分	采用了自适应网格技术，可以快速、高质量全自动生成六面体、四面体、实体壳单元等网格，有效地减少技术员的工作量，还可以在计算的时候根据曲率自动细化边角部的网格。

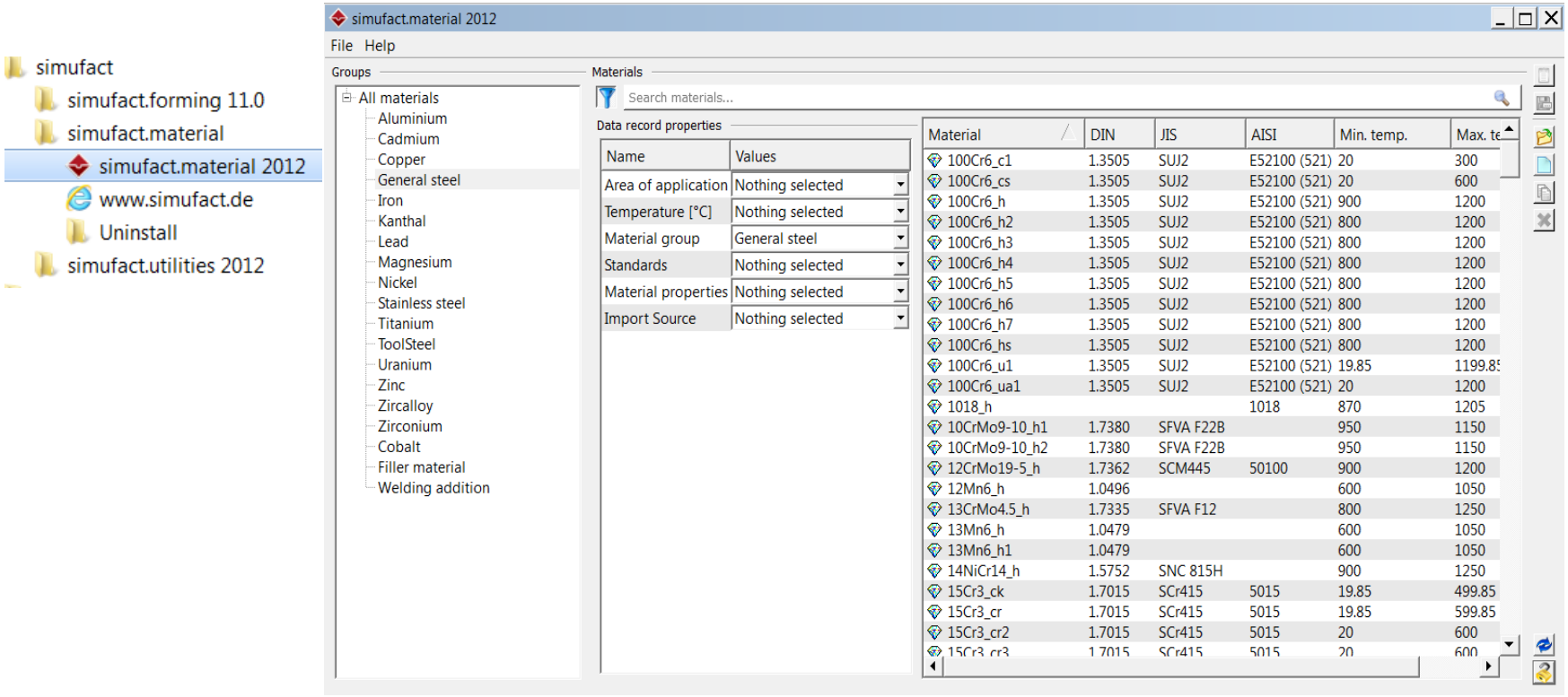




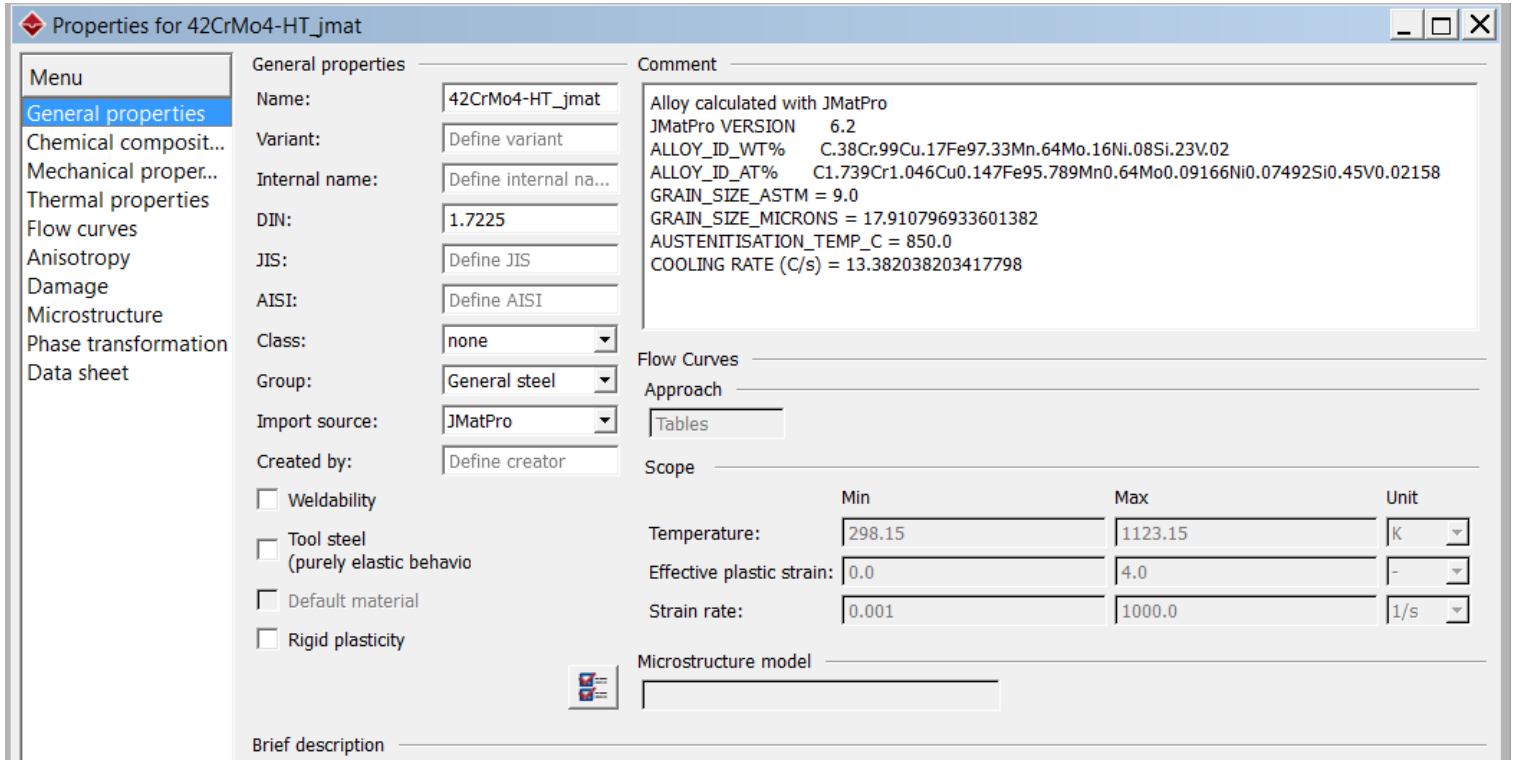


材料

- 材料数据库界面（**Material**）：
  - 独立软件，不依赖于模型
  - 材料参数在模拟中写入**UMT**文件，供求解器使用
  - 包含不同标准（**AISI/JIS/DIN/EN**），不同种类的材料（**>600**）
  - 支持自定义或导入新材料



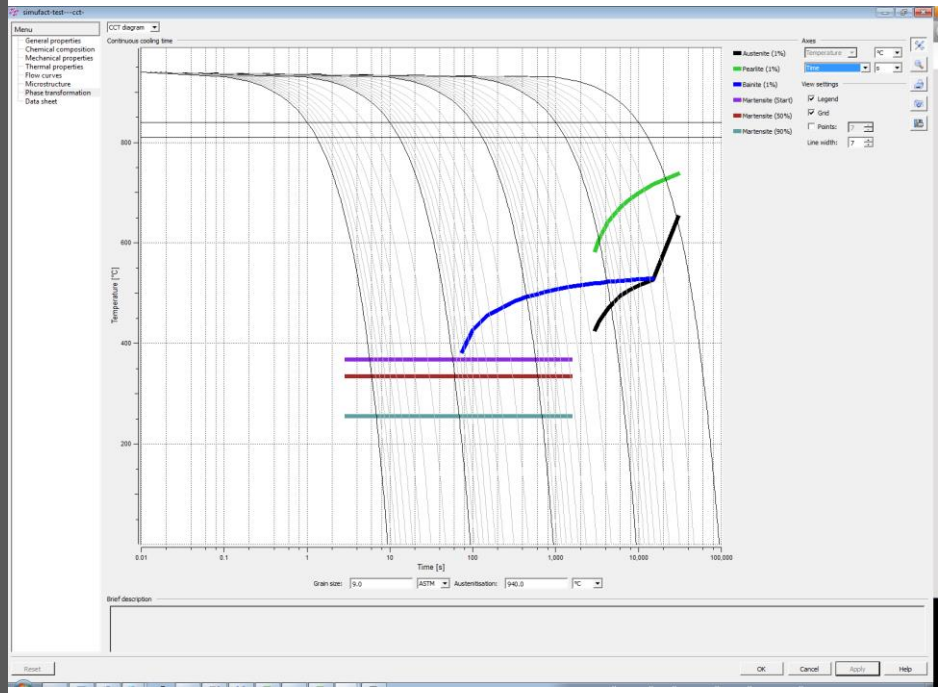
材料

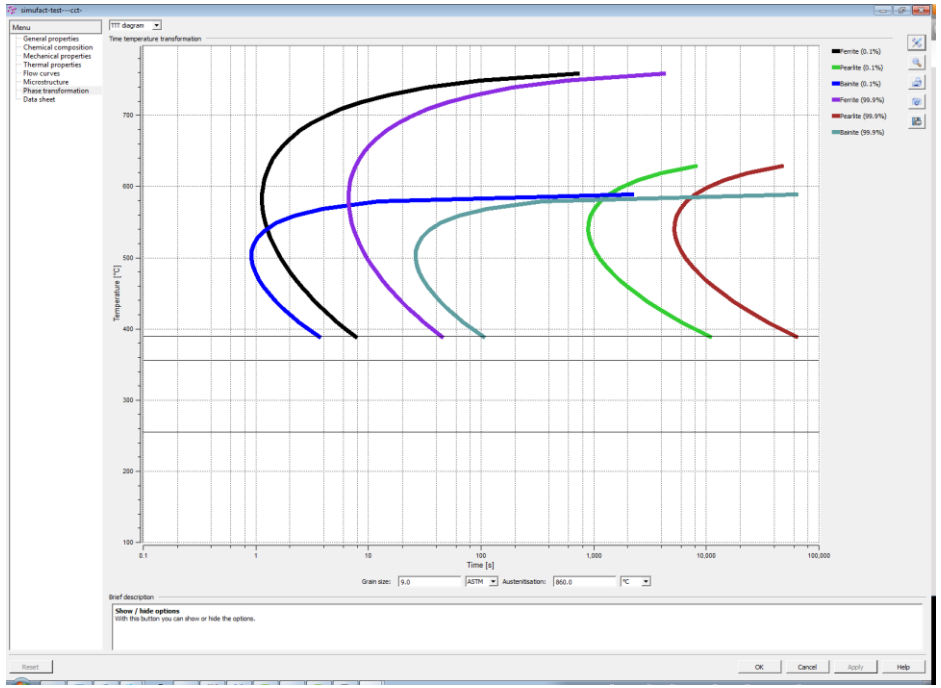


- 一套完整的材料数据包括：
  - 基本信息/化学成分/机械性能/热参数/屈服曲线/各向异性/疲劳/晶粒模型/相变图/数据总结
- 支持材料文件格式：
  - **umt/gmt (Matilda)/jmt (JMatPro)/mfd/mat/sf (simufact.forming)**

材料

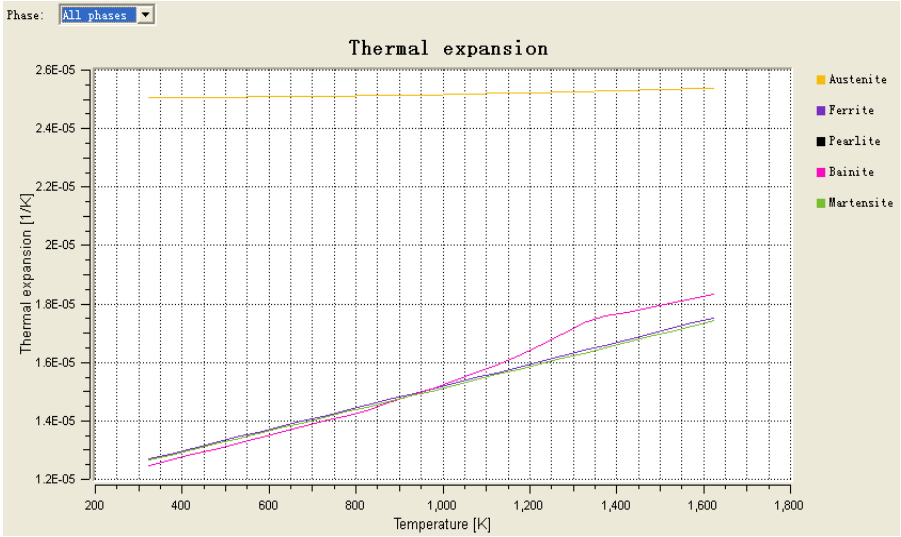
- 相变（**Phase transformation**）：
  - 连续相变（**CCT**）和等温相变（**TTT**）曲线（**JMatPro**）
  - 奥氏体向各相转变的数据：体积变化/潜热/TRIP效应
  - 准确计算变形和残余应力

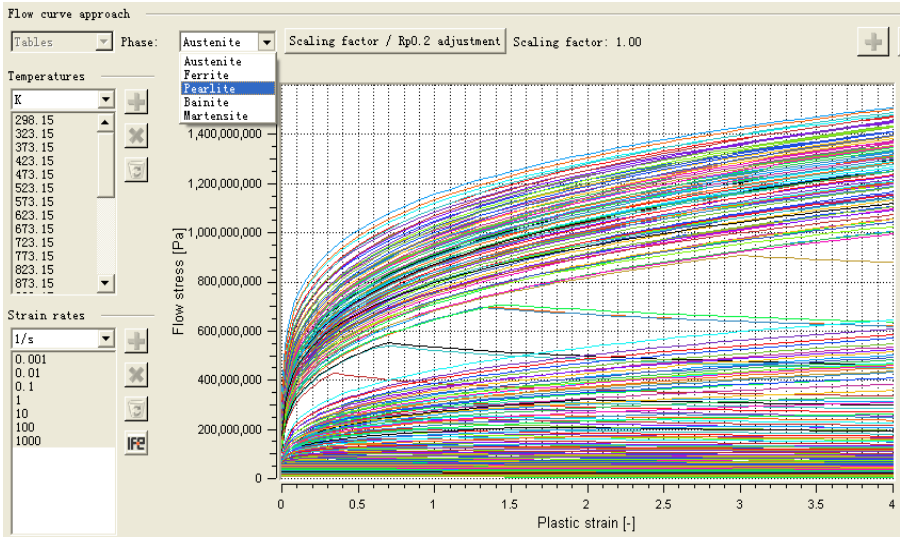




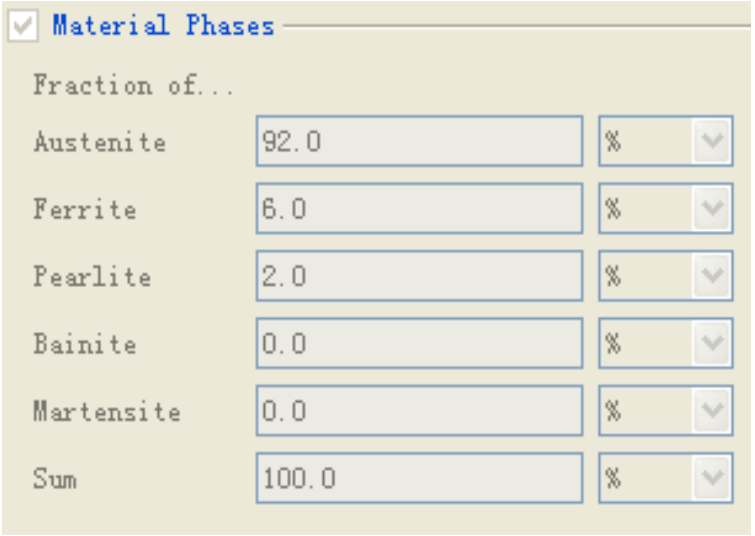
材料

- 考虑不同相的混合材料属性





- 设置材料初始相成份含量百分比



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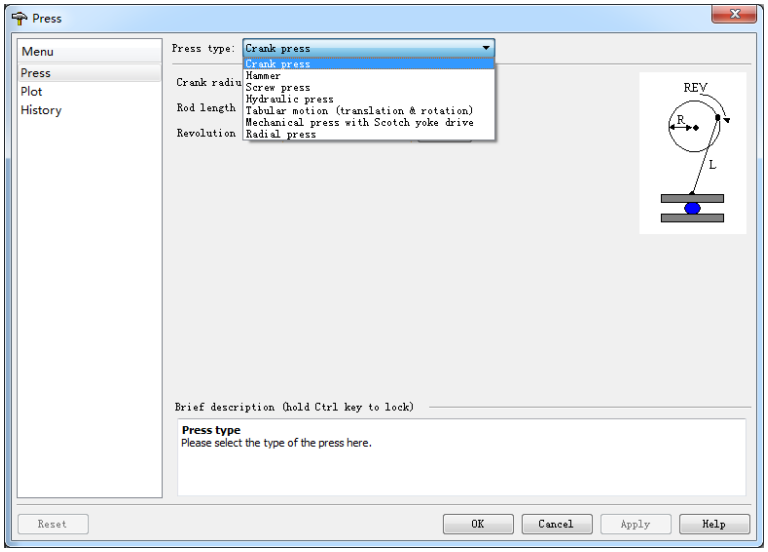
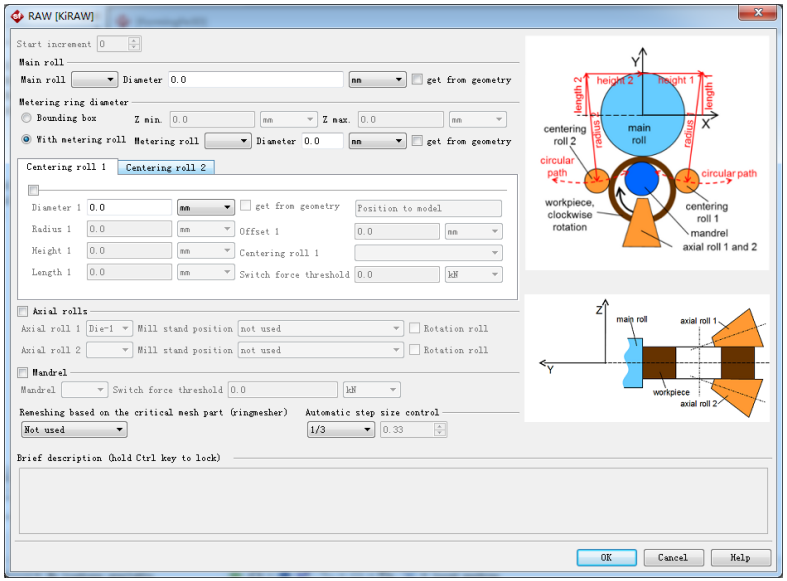
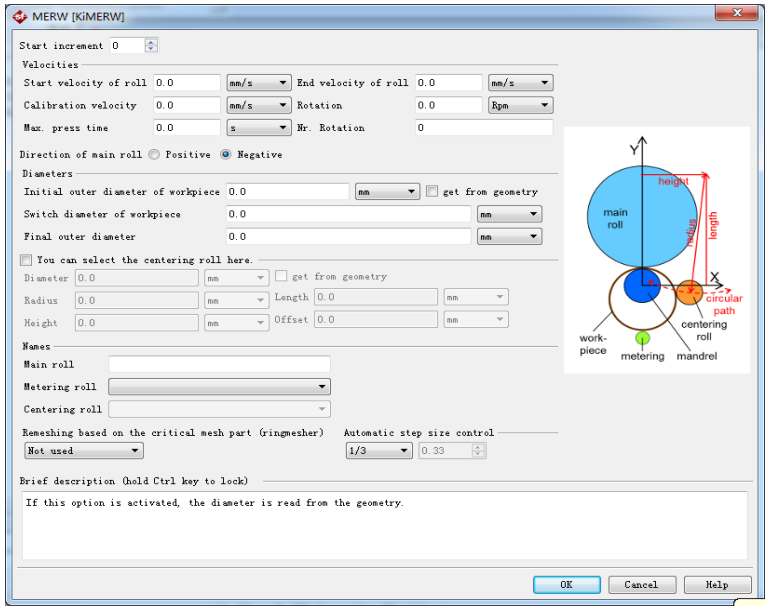
Simufact.forming设备库



曲柄压力机、螺旋压力机、对击锤、液压机、机械压力机等设备都有模型，还可以修改设备具体运动参数，并且具有环轧、开坯锻、扩孔、芯棒扩孔、摆碾等设备





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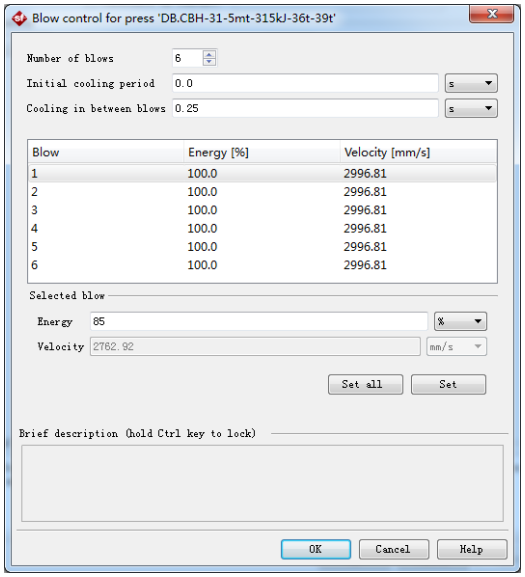
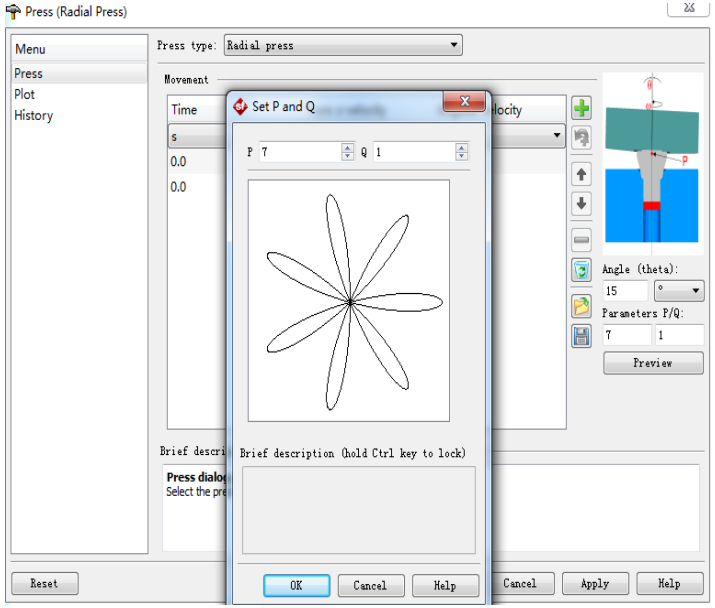
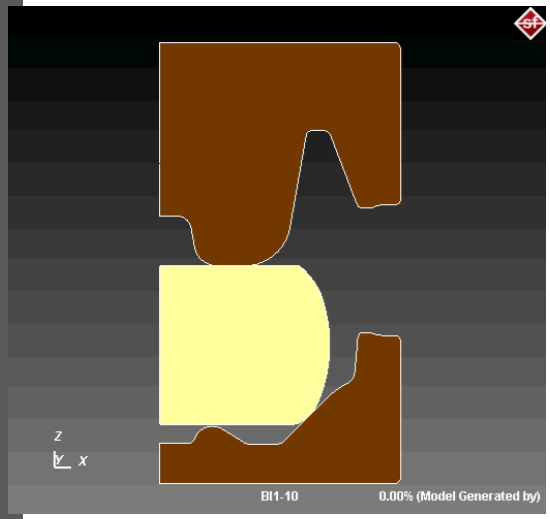
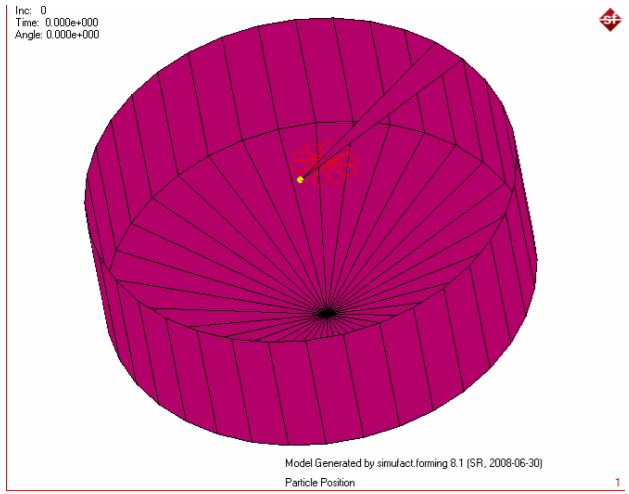
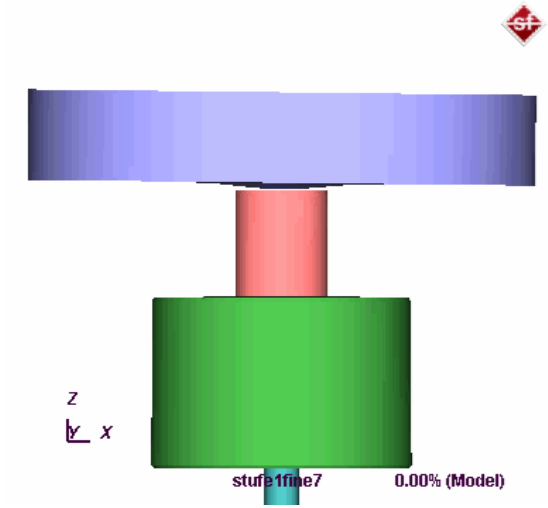
Simufact.forming特殊设备库











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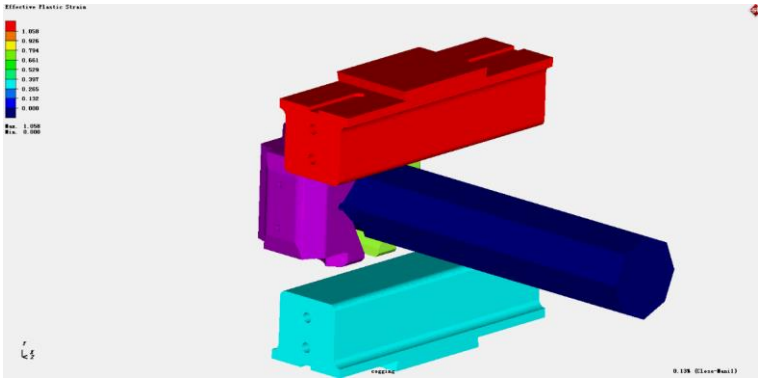
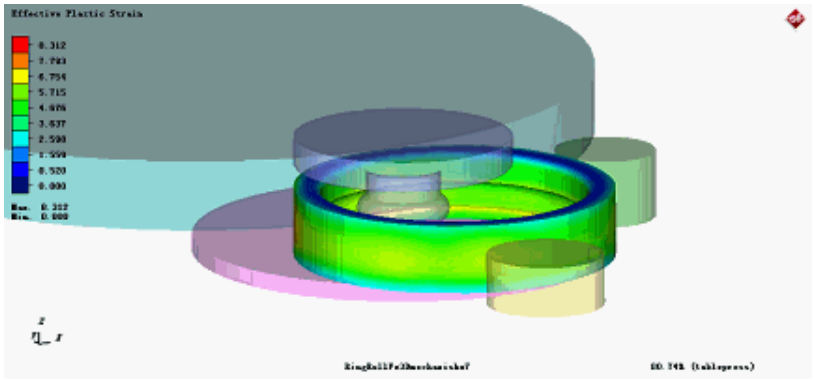
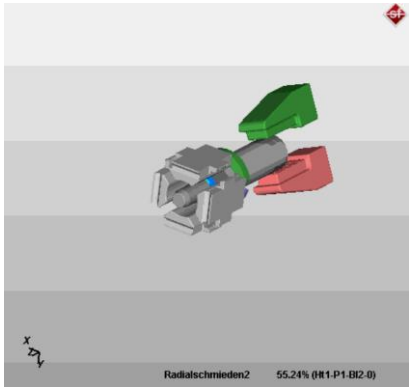
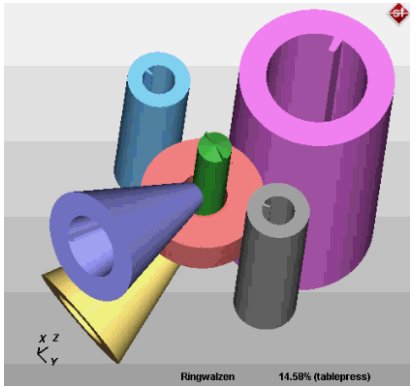
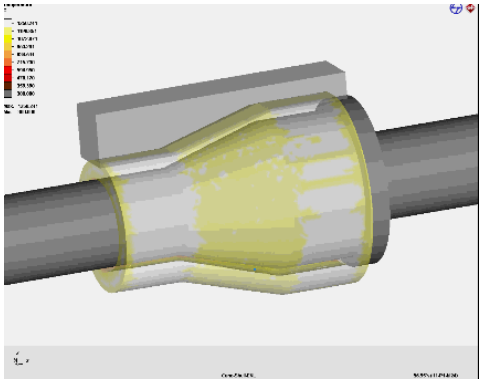
自由锻工艺模拟

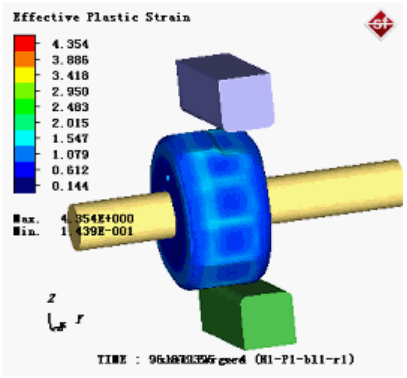




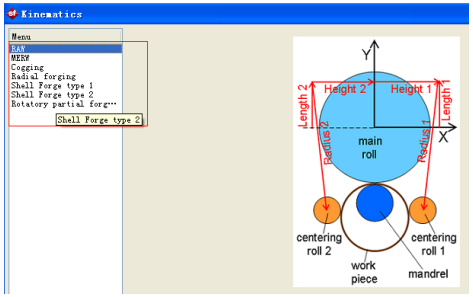


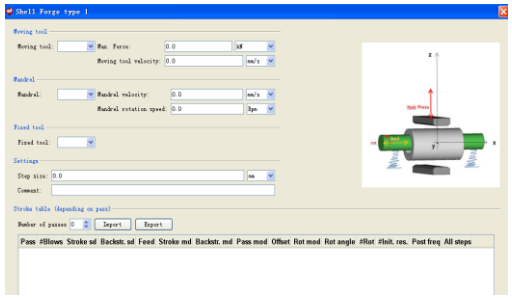


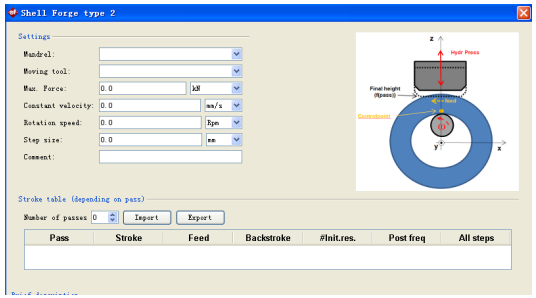




集成常用立式/卧式环轧、开坯锻、马杠扩孔、芯棒拔长、摆碾等复杂设备







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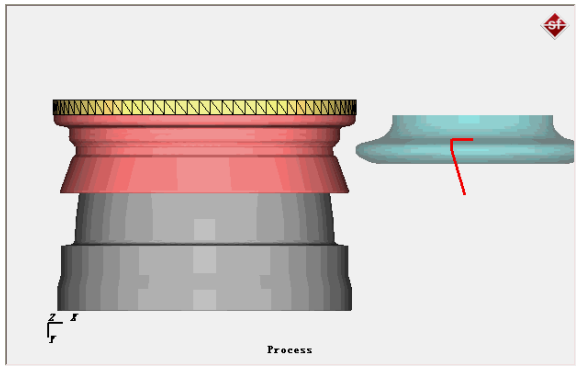
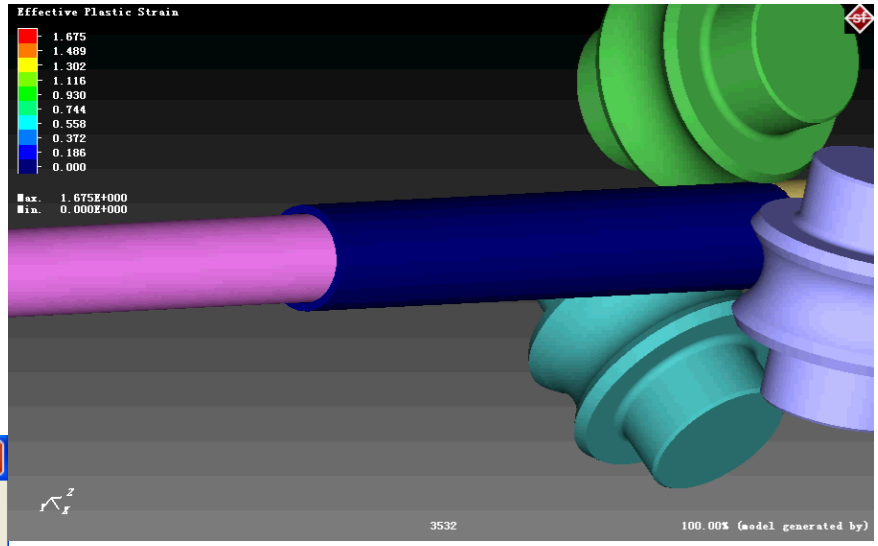
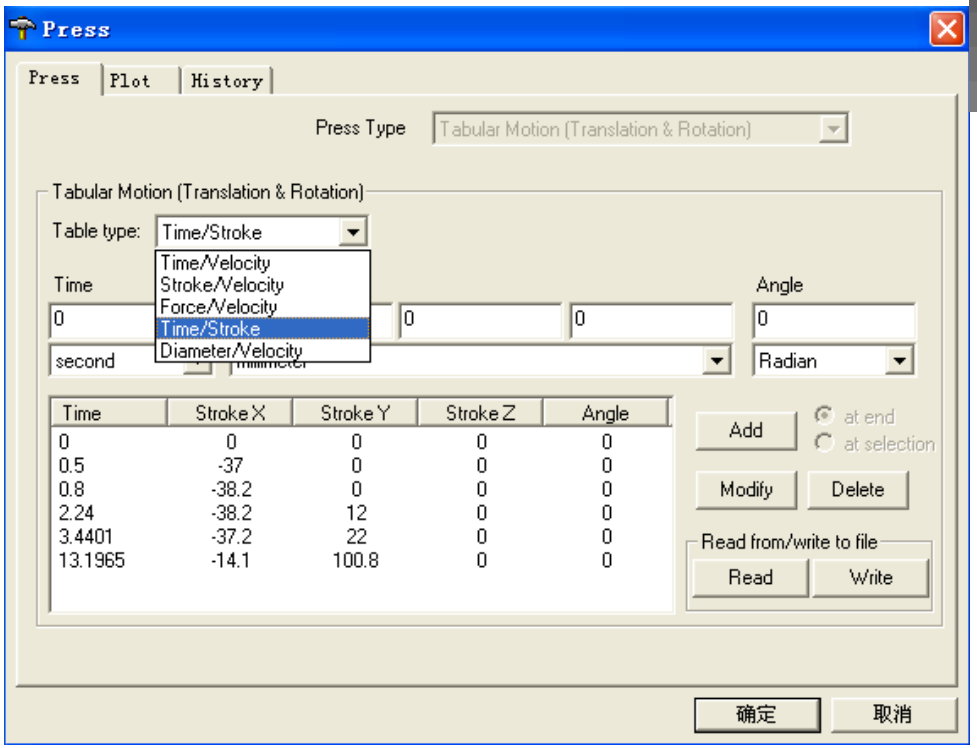
Simufact.forming复杂运动路径定义



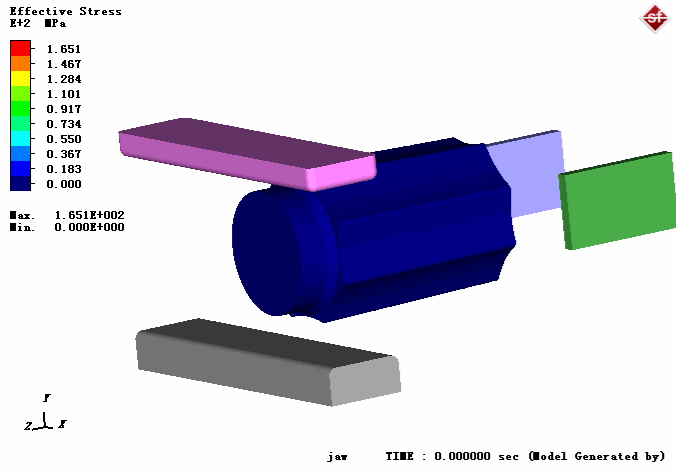


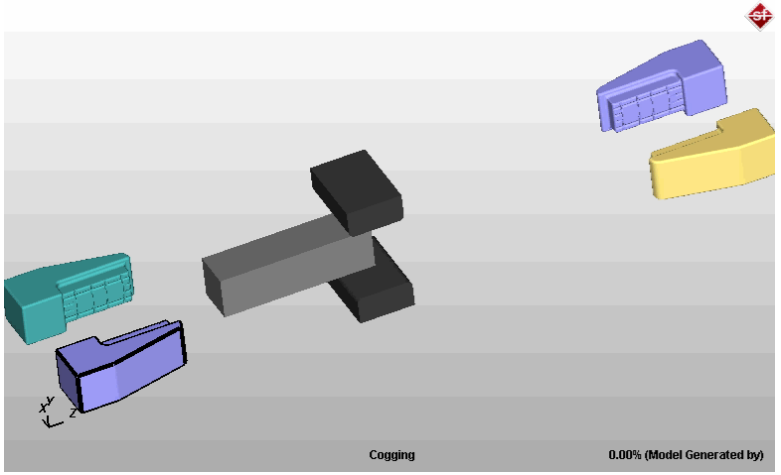


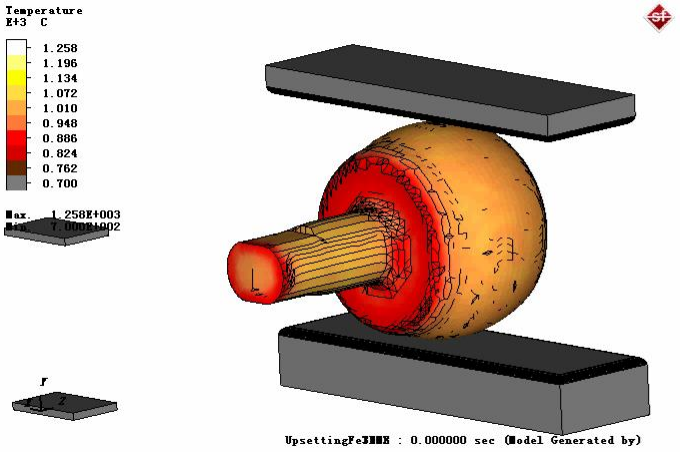
Simufact中很容易定义两个方向或三个方向复合的运动。

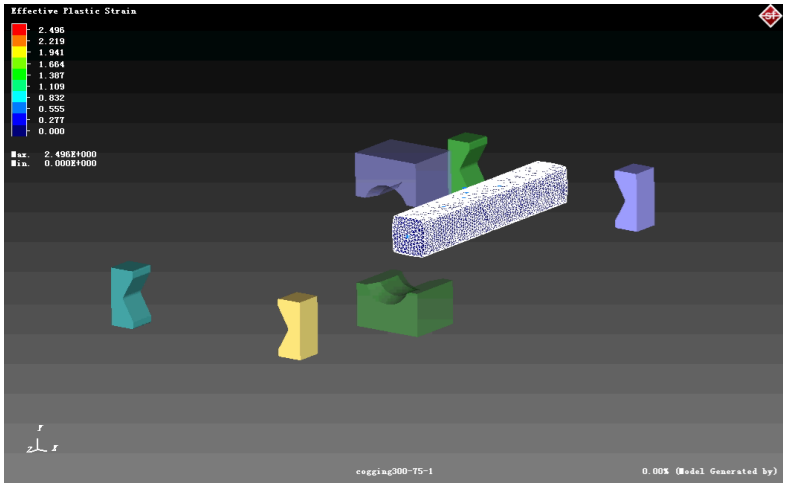
Excel文件导入

拔长案例



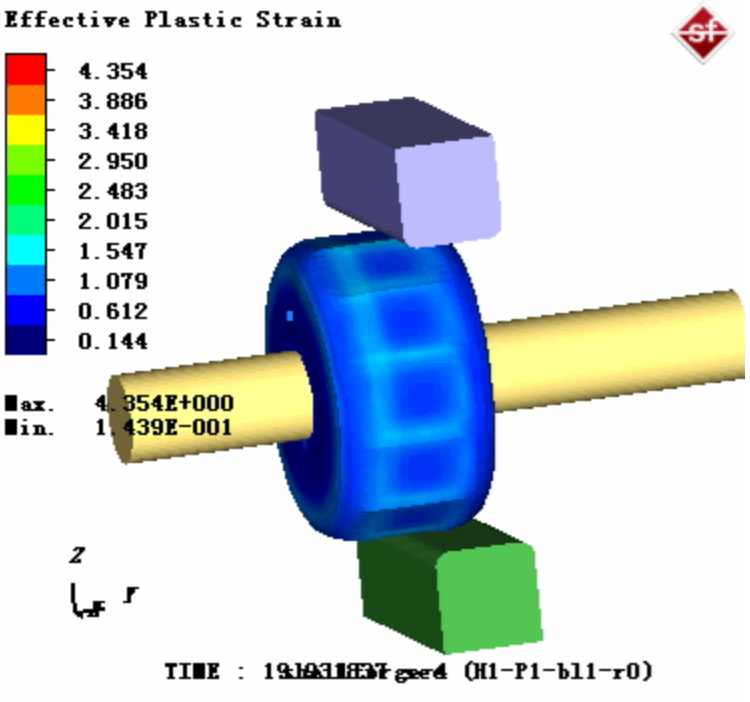


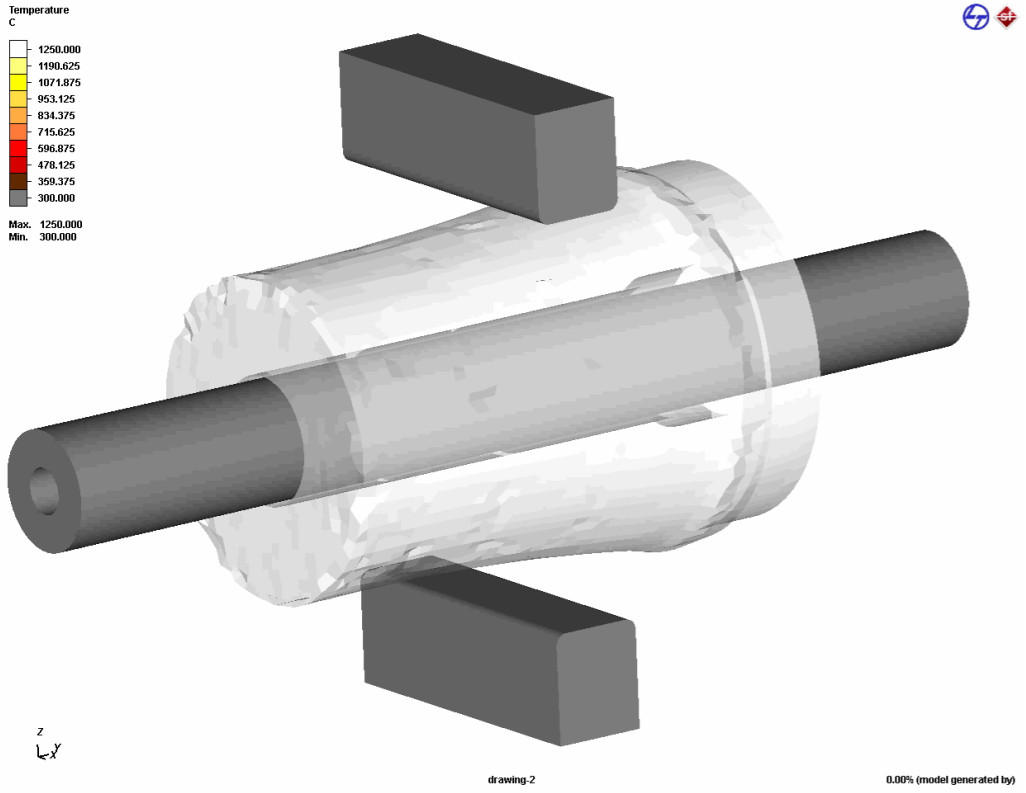




MSC Software

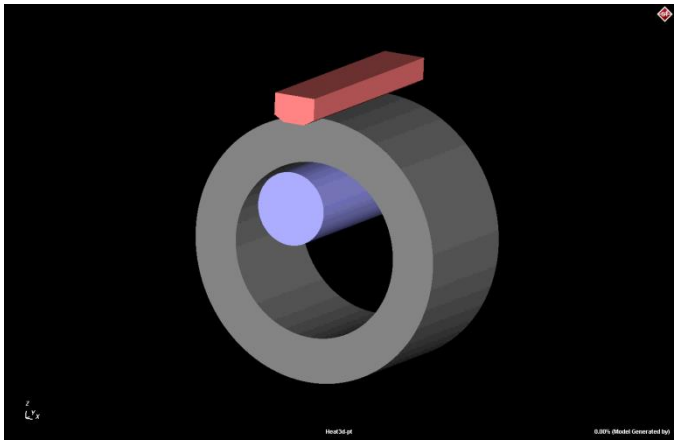
芯棒拔长模拟

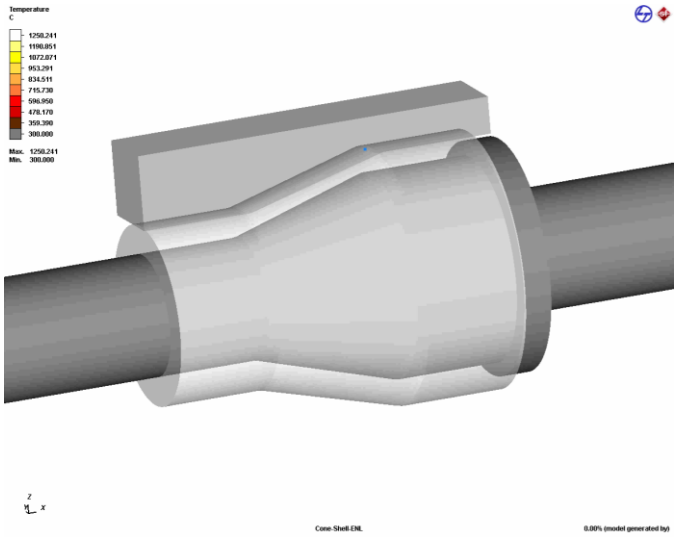


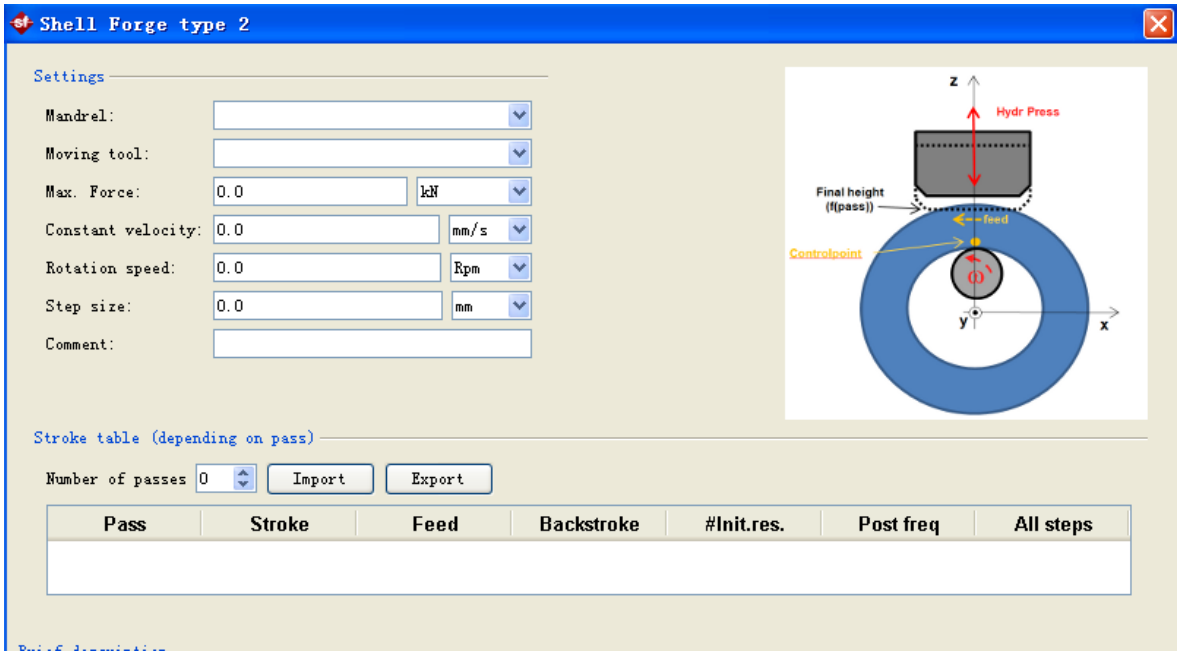


MSC Software

马杠扩孔模拟

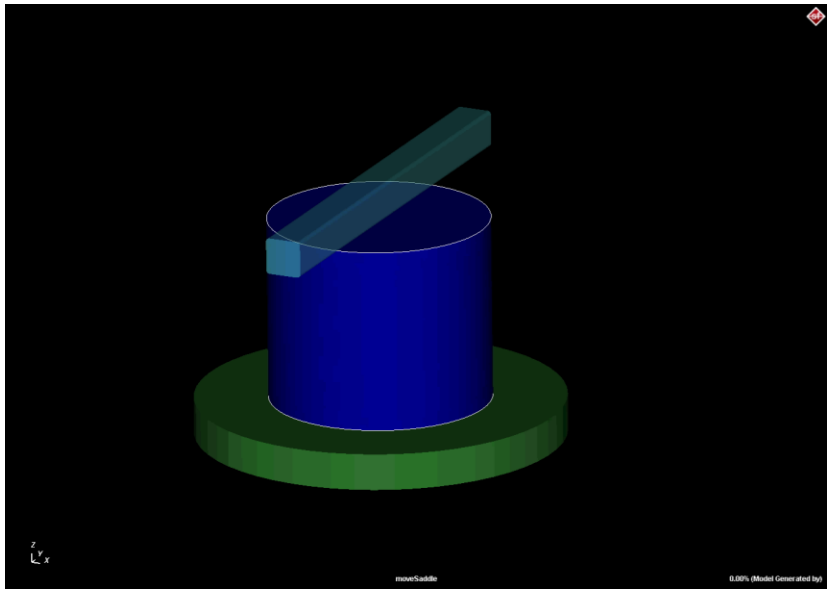


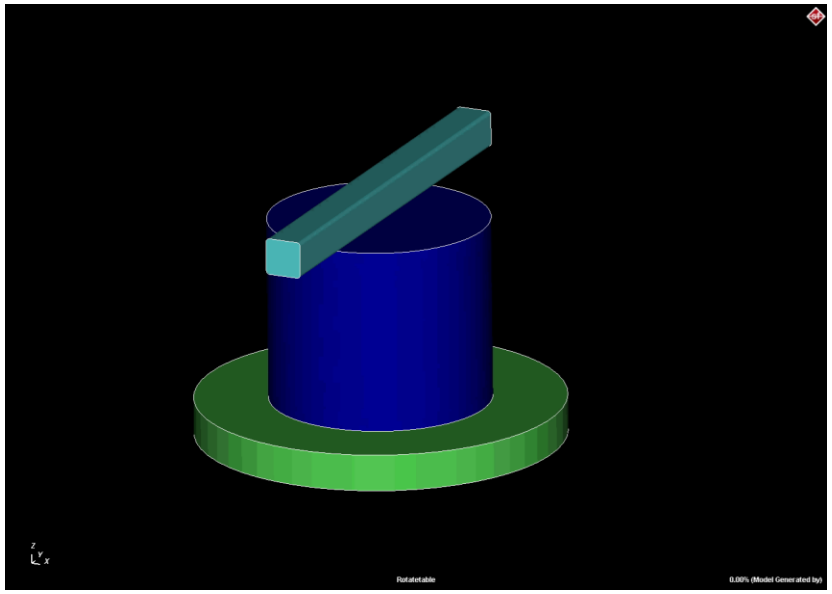


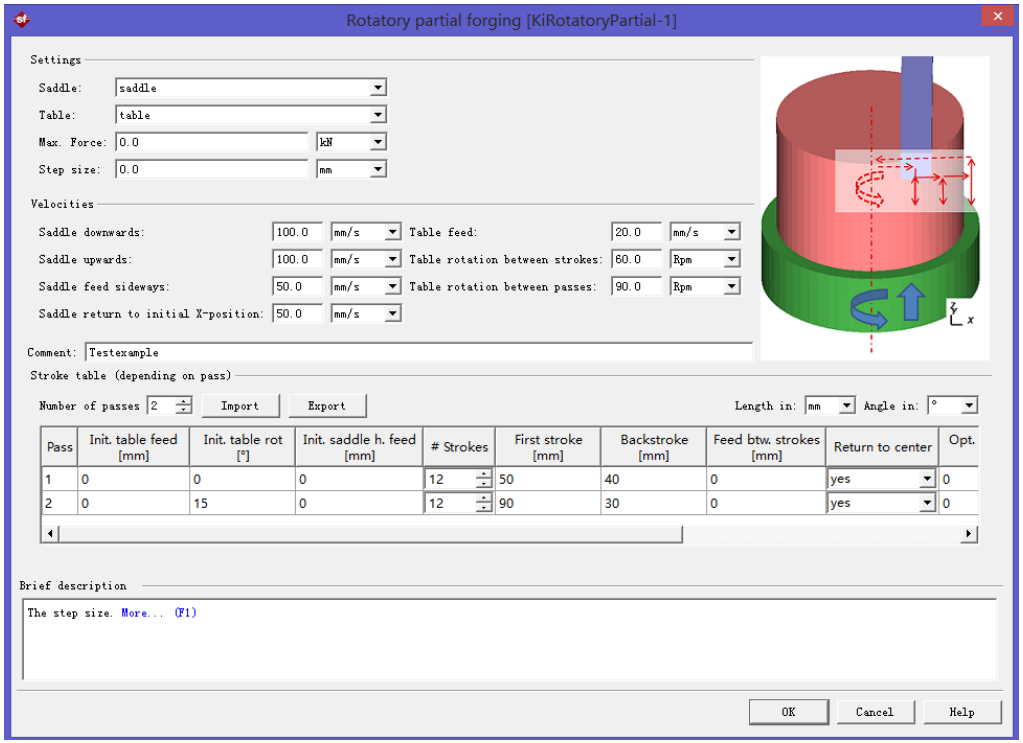


Simufact具有马杠扩孔模块。采用shellforge2设备可以很容易对马杠扩孔整个工艺进行仿真模拟。

碾压模拟

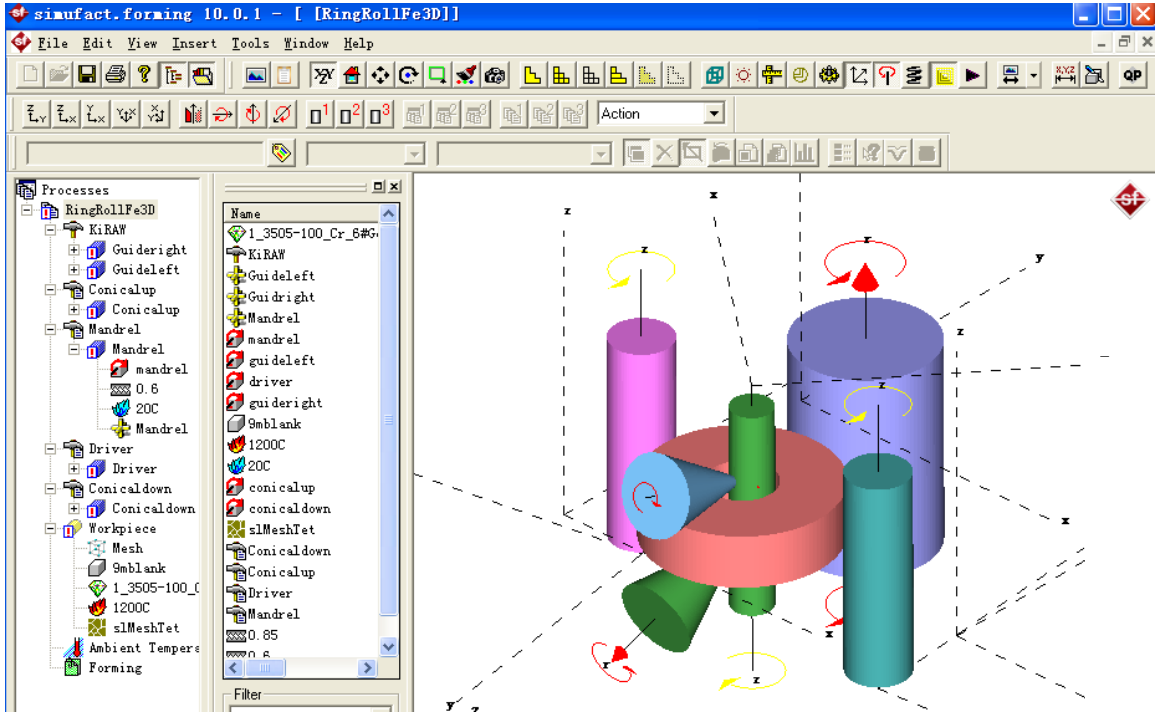


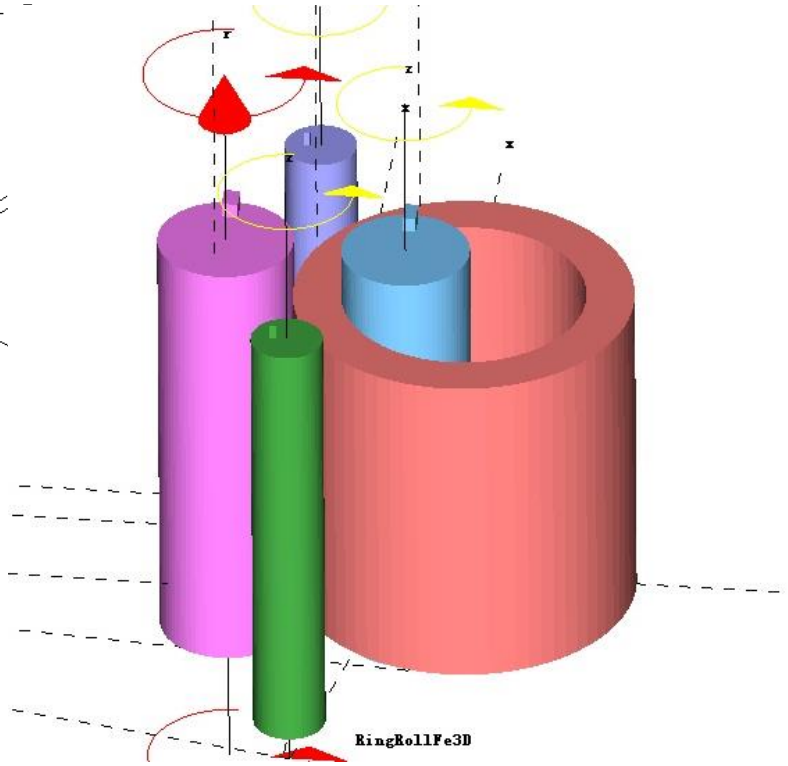




Simufact集成碾压设备，极易对碾压过程进行建模仿真

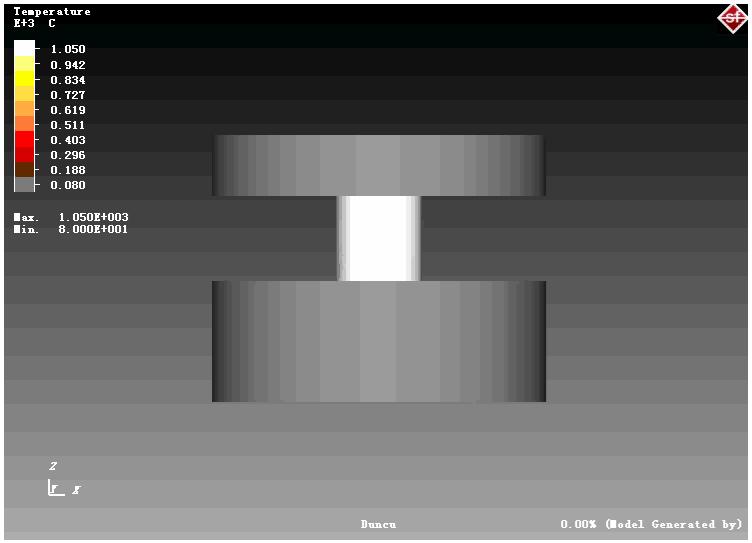
开放性环轧仿真建模

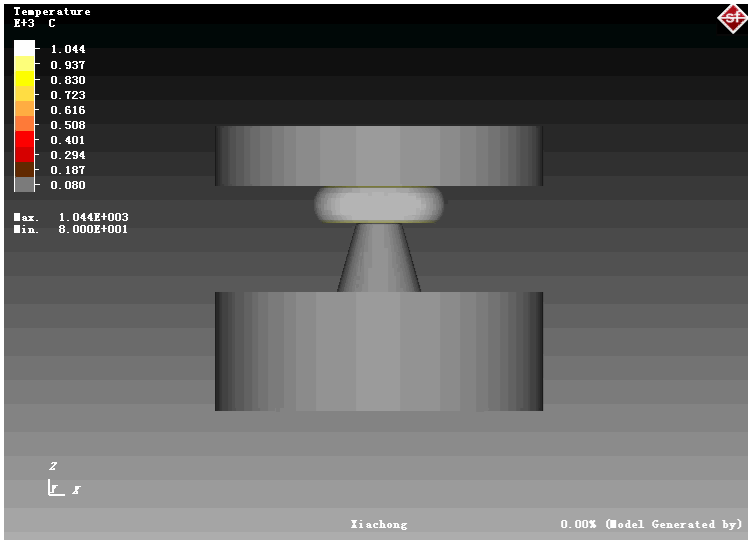


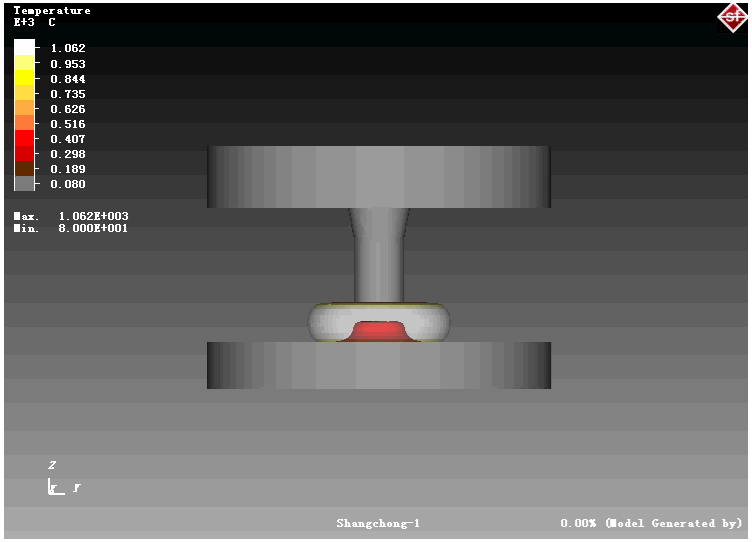


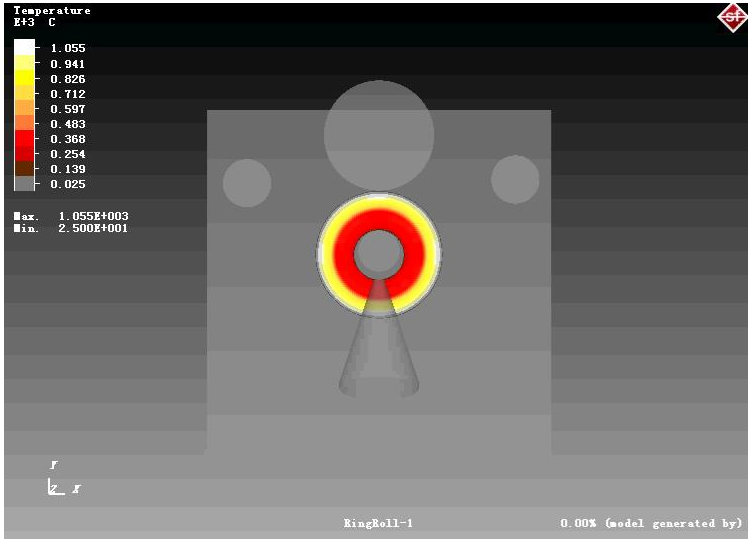
Simufact基本上可以实现目前所有环轧工艺的仿真，且从制坯、扩孔、冲孔、环轧整个工艺流程可以进行一体化模拟。考虑条件充分。

环轧全工艺模拟

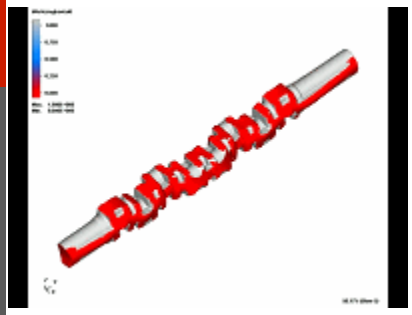
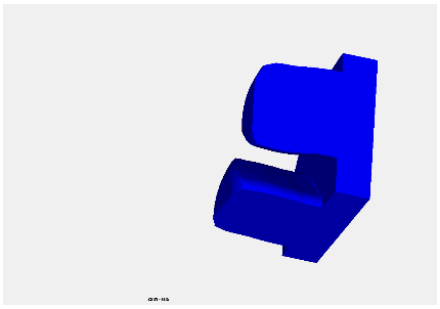
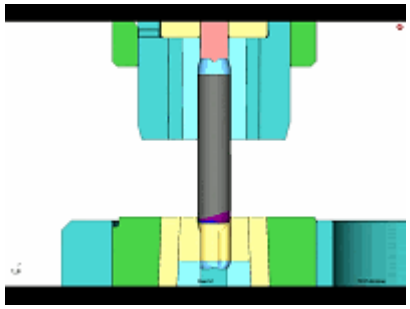
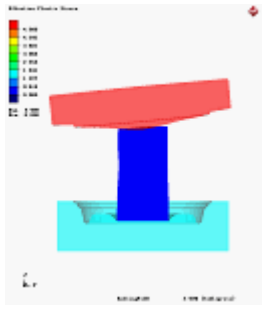




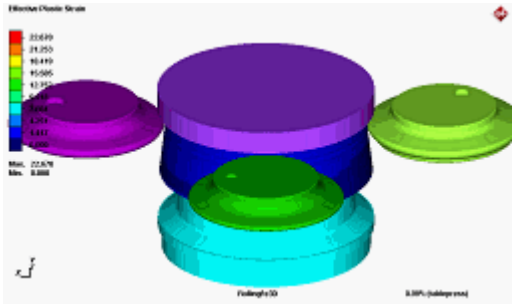
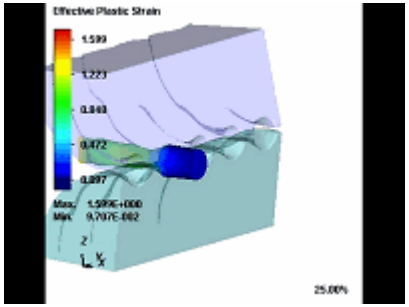




锻造挤压成形工艺模拟

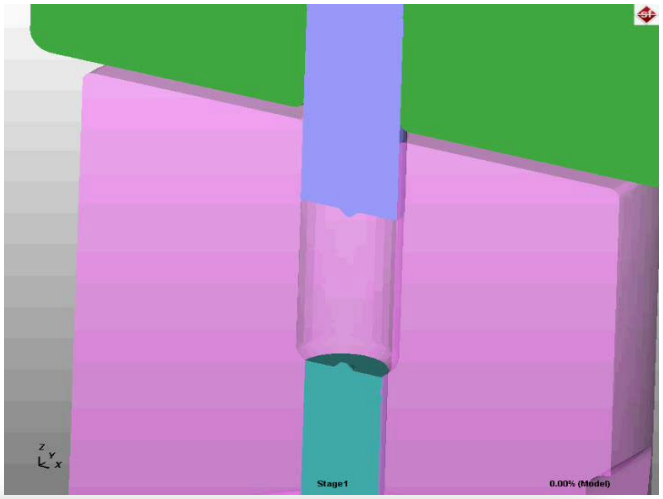





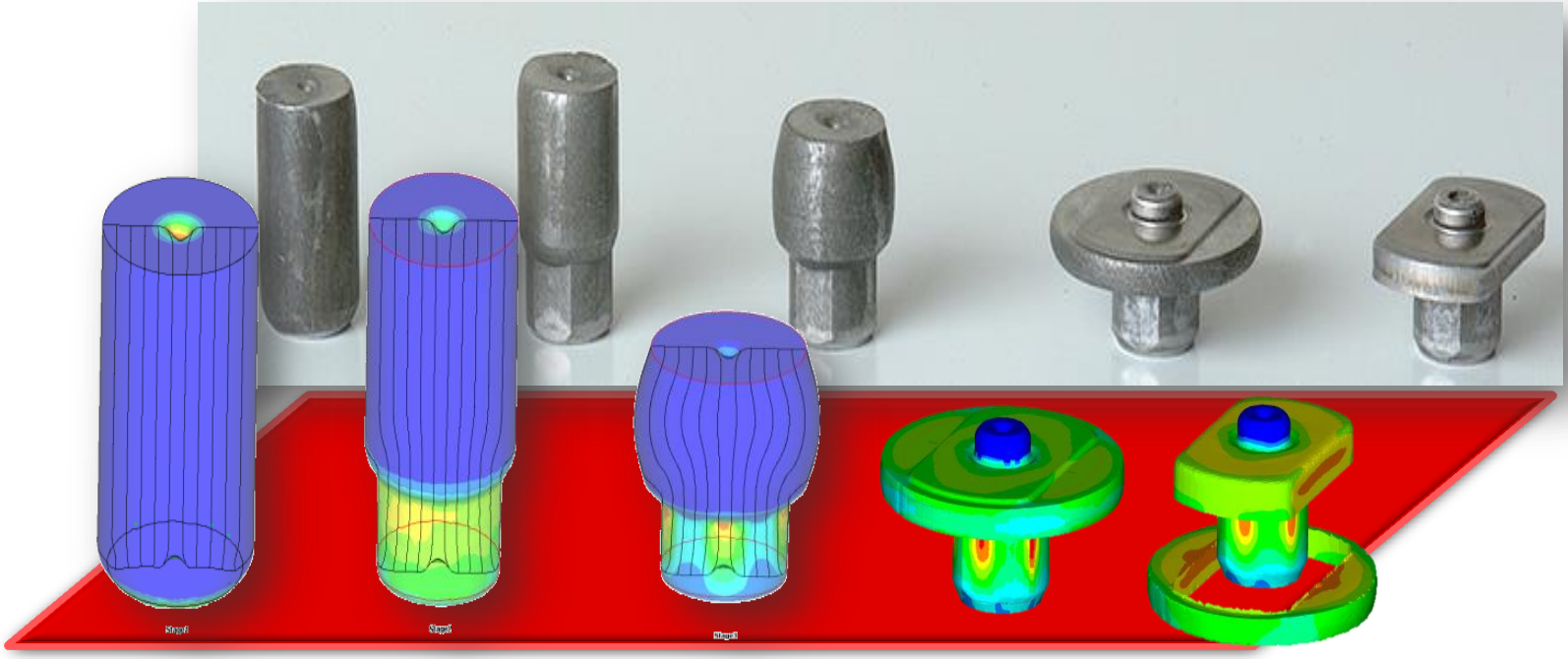
- FE有限元法+FV有限体积法
- 预测锻造缺陷
- 设备吨位预估
- 辅助优化模具设计
- 工艺参数优化
- 模具应力分析
- 简便的多工序连续分析
- 多窗口联动对比分析
- 2D结果转3D继续分析

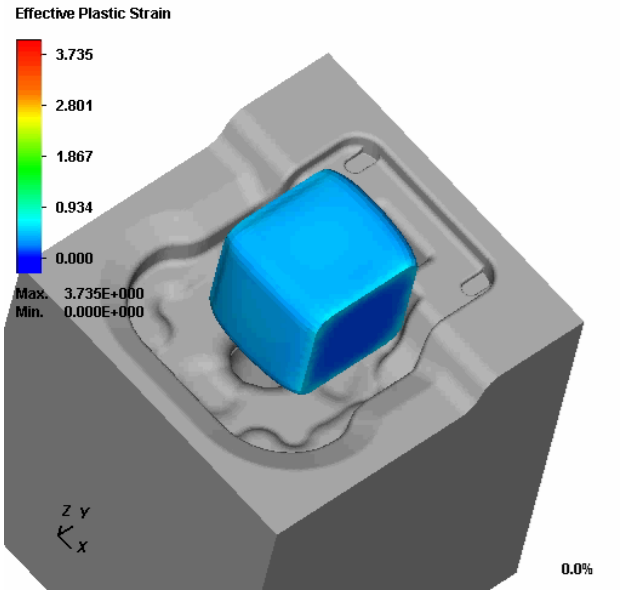
冷成形模拟分析

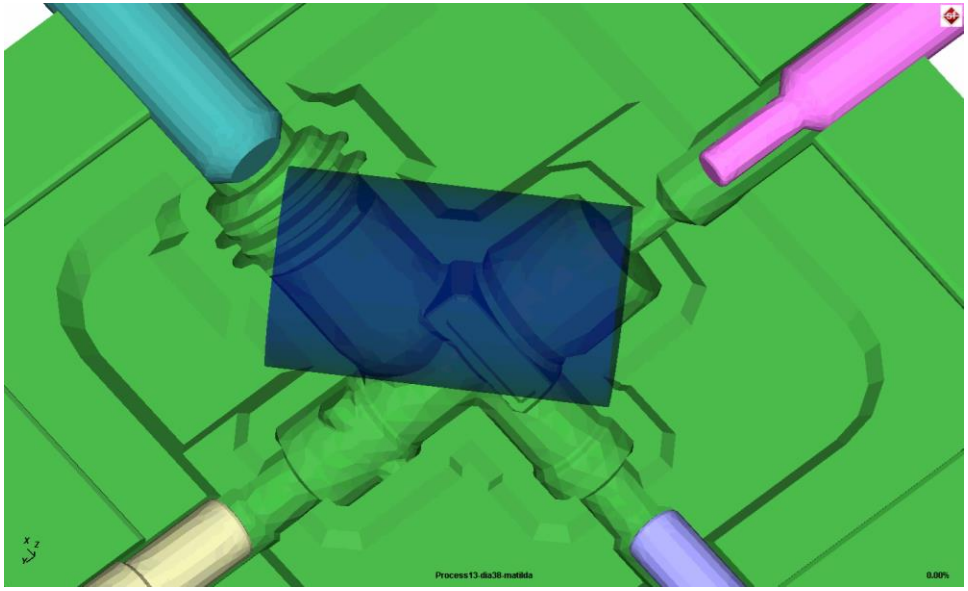
- 全自动过渡
- 2D-3D任意切换
- 集成2D和3D仿真
- 工艺成形性分析

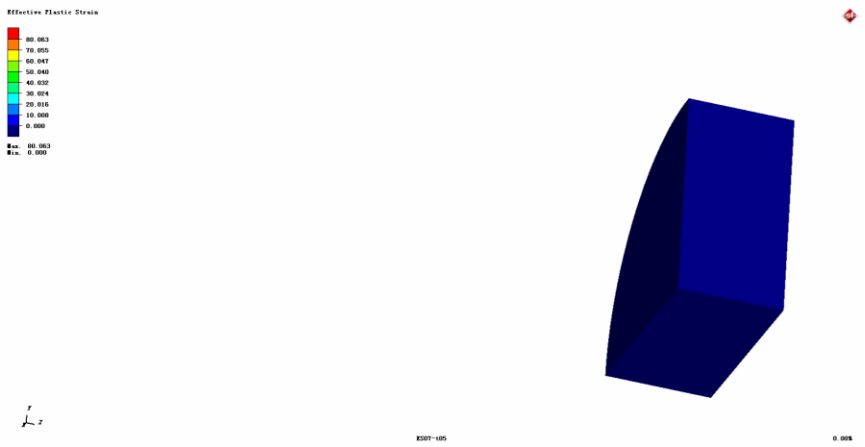


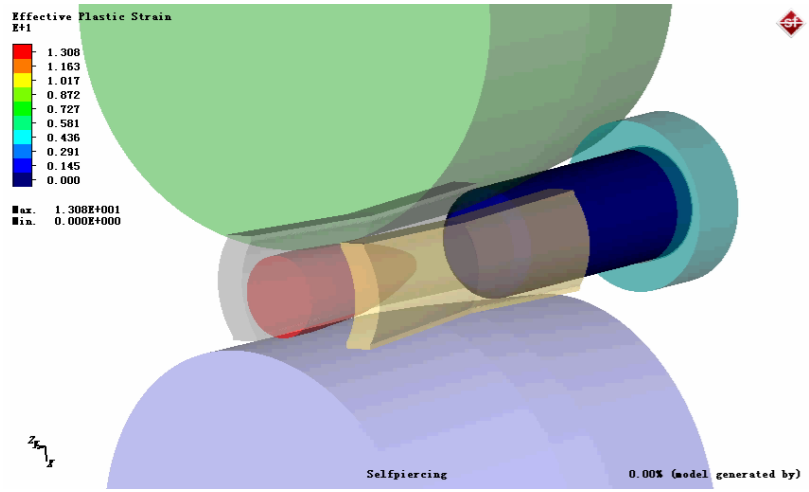


Simufact.forming复杂材料流动



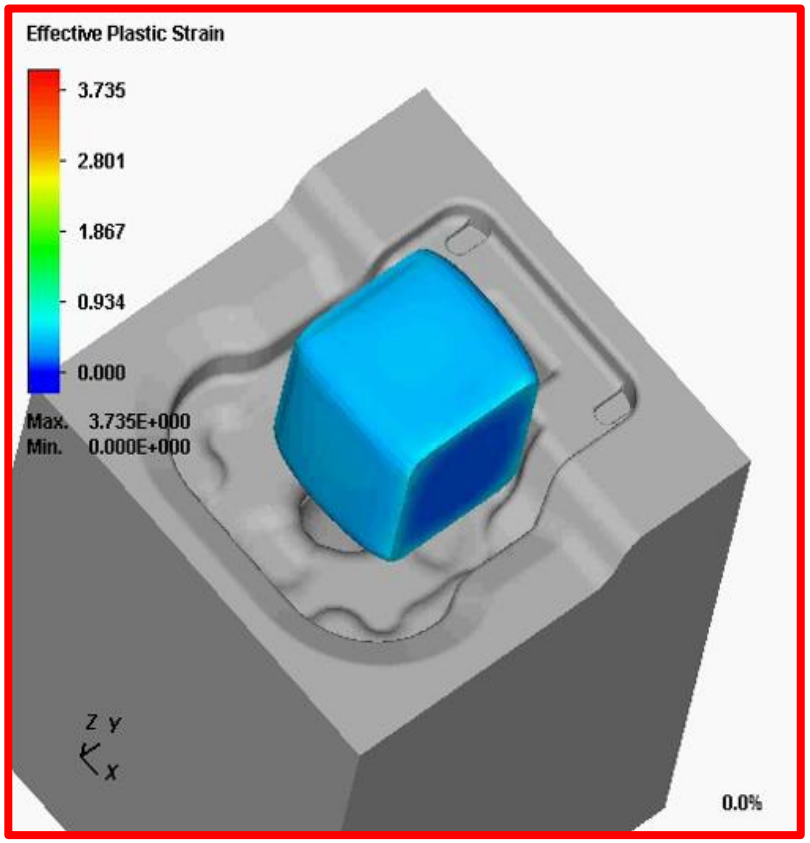


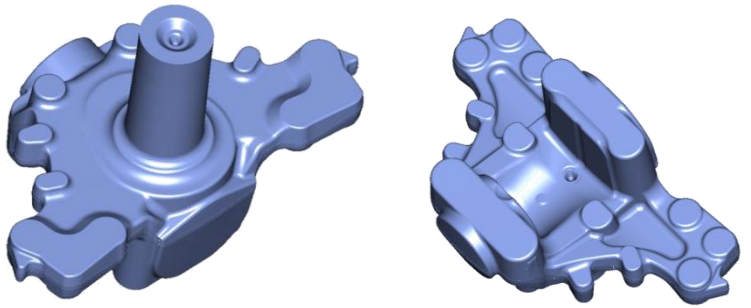


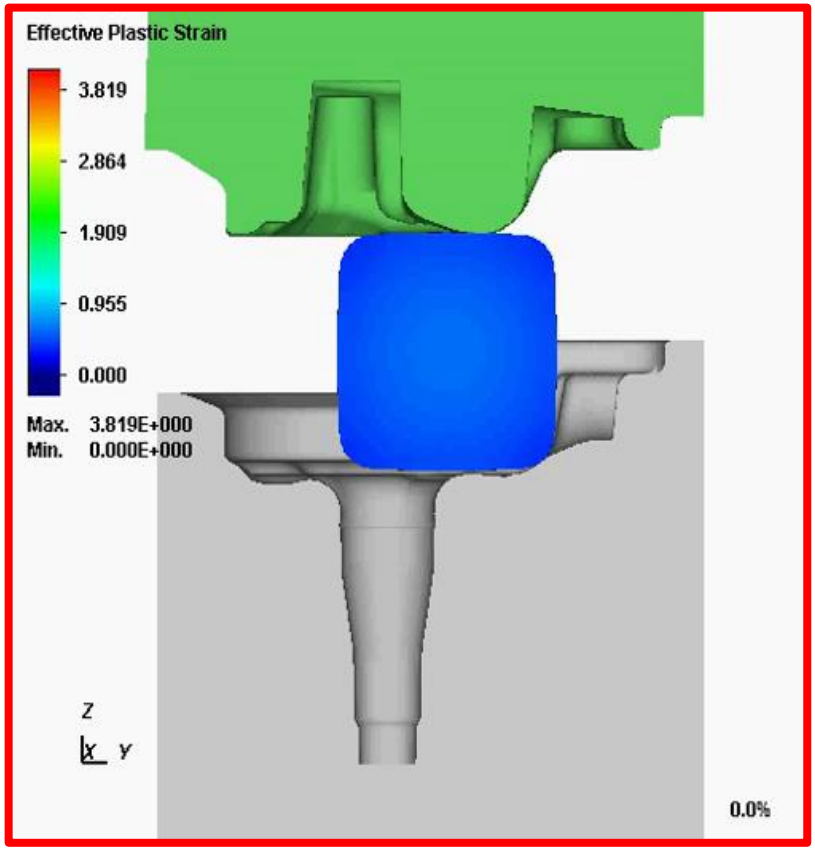


MSC Software

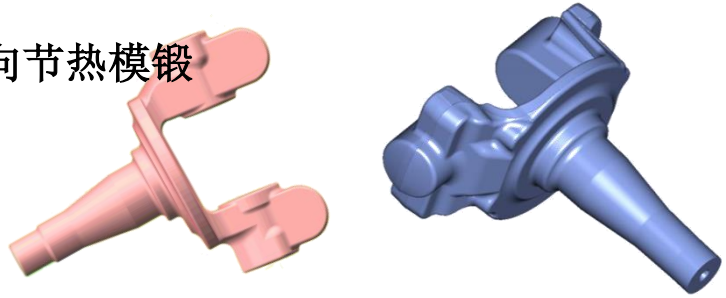
热加工工艺仿真





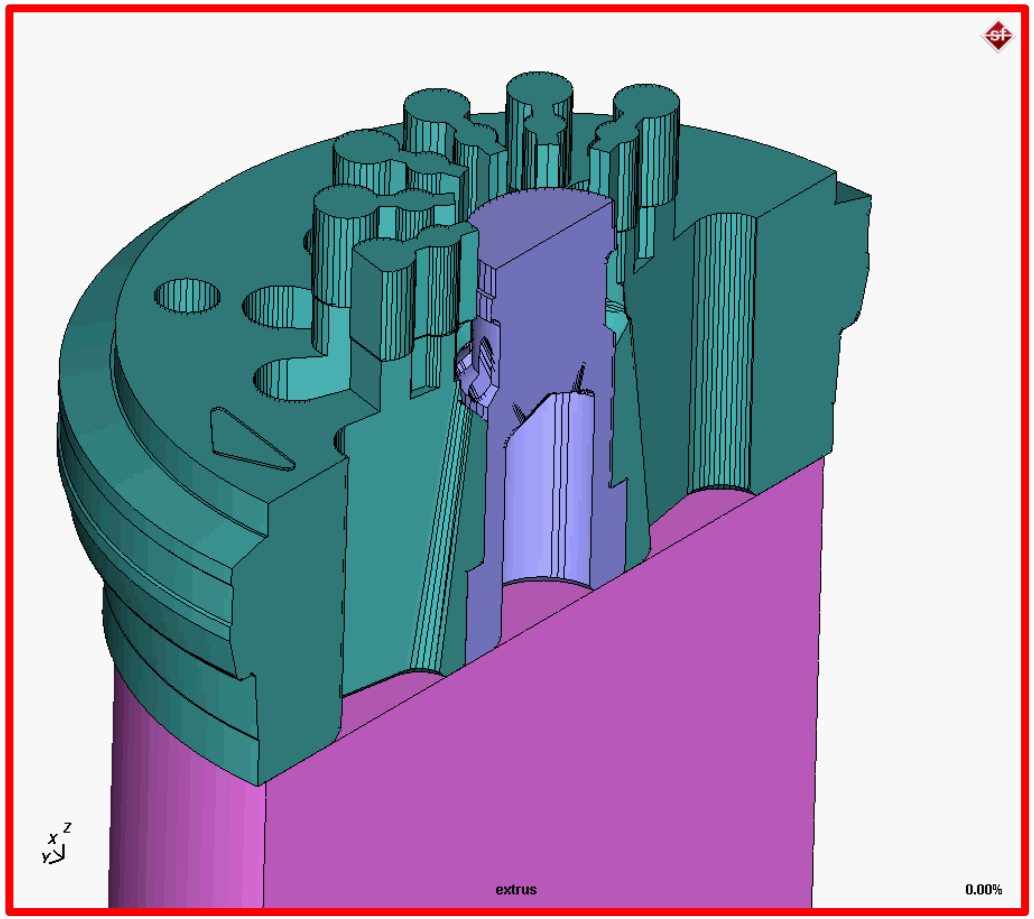


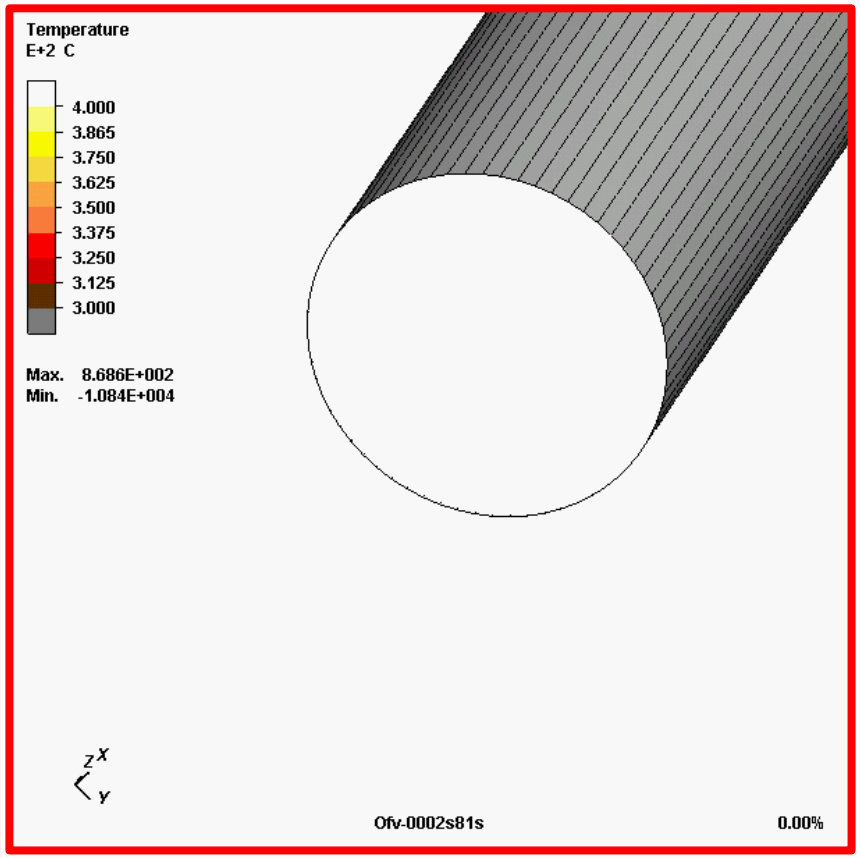
转向节热模锻



分流模挤压案例

分流模挤压





连杆热加工仿真案例

连杆热加工工艺链仿真

连杆热加工仿真案例

连杆热加工工艺链仿真

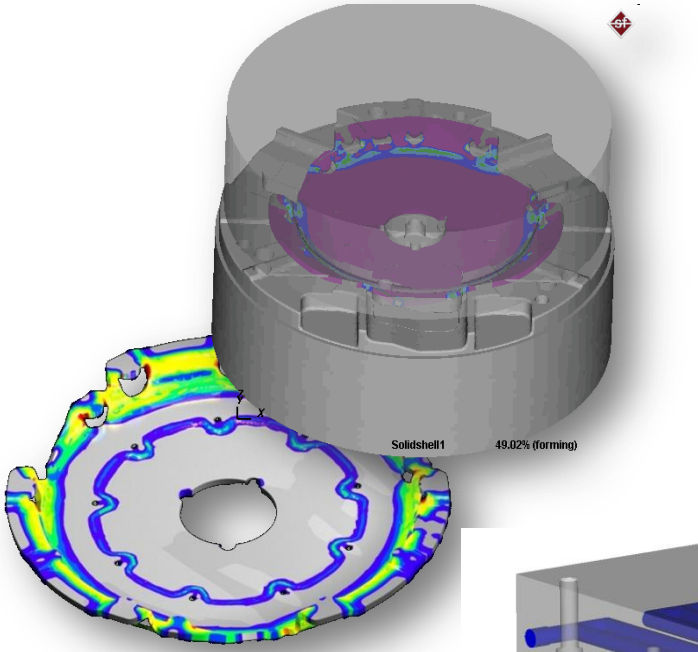
连杆热加工仿真案例

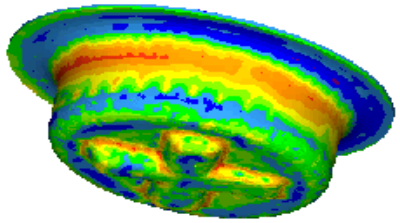
连杆热加工工艺链仿真

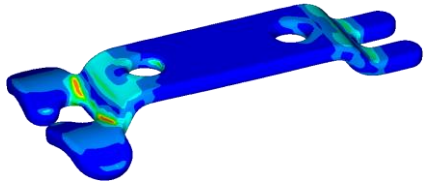
钣金成形工艺模拟

传统钣金冲压

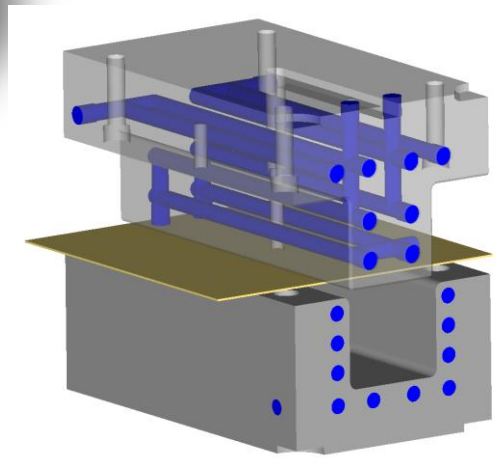
厚板冲压

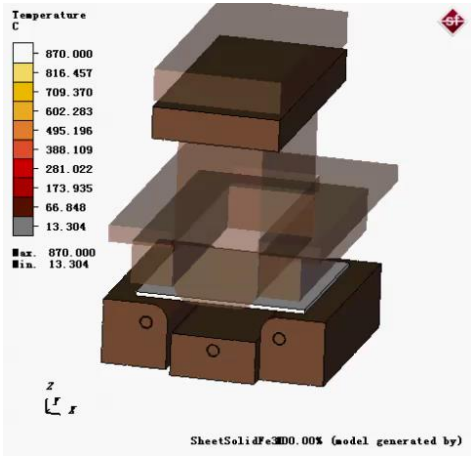






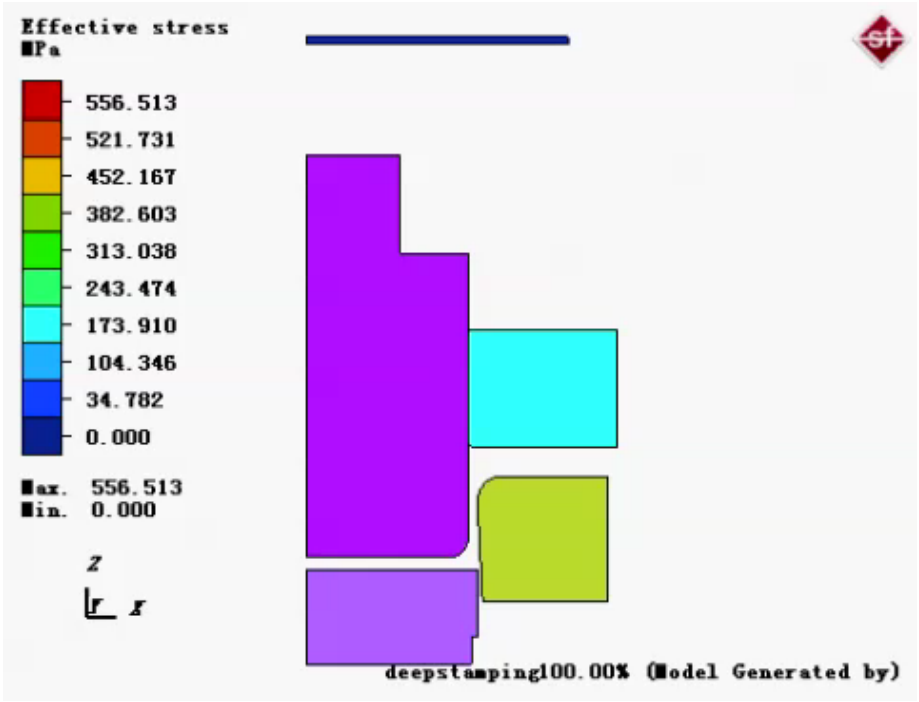
热成形

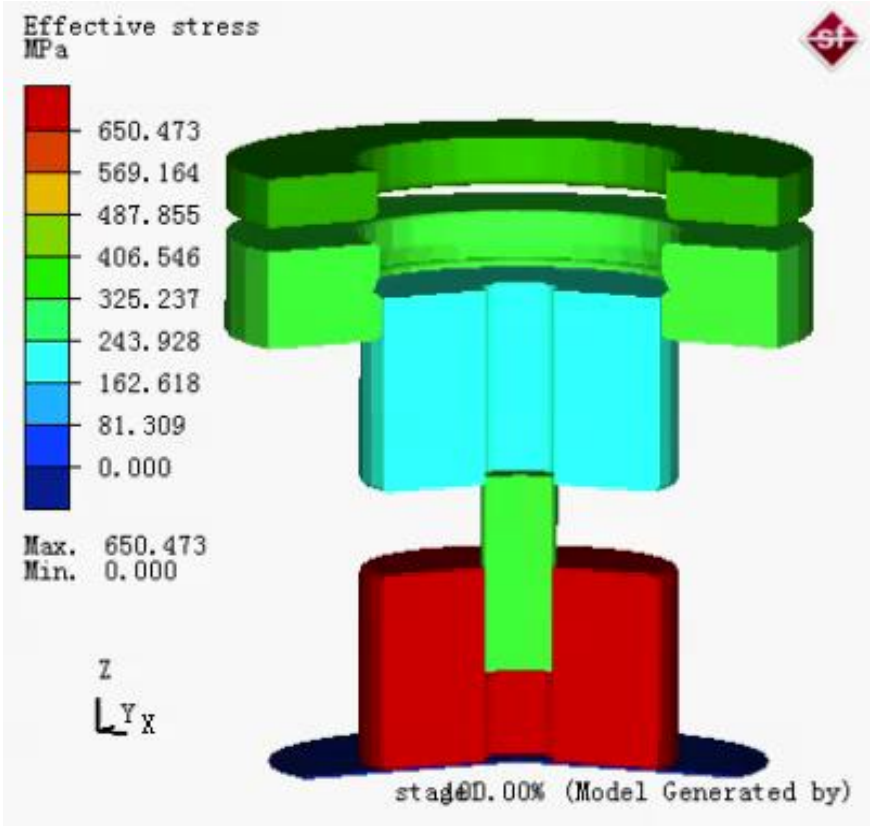




MSC Software

钣金成形工艺模拟

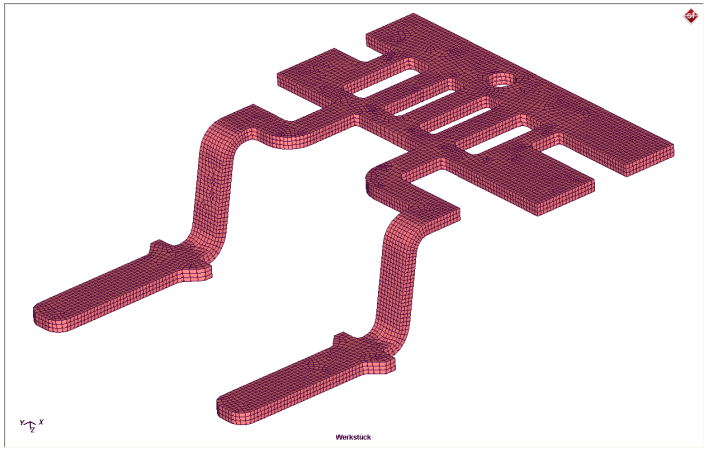


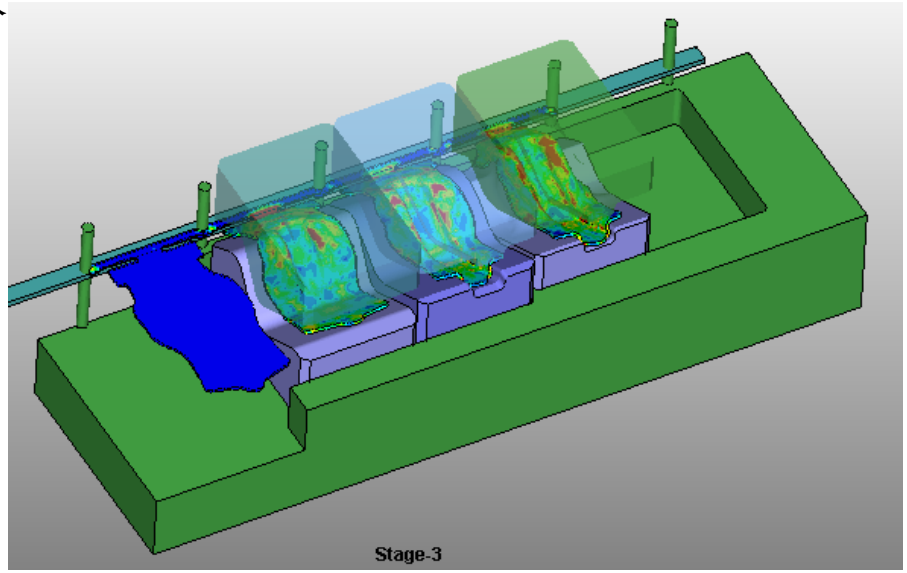


钣金成形工艺模拟

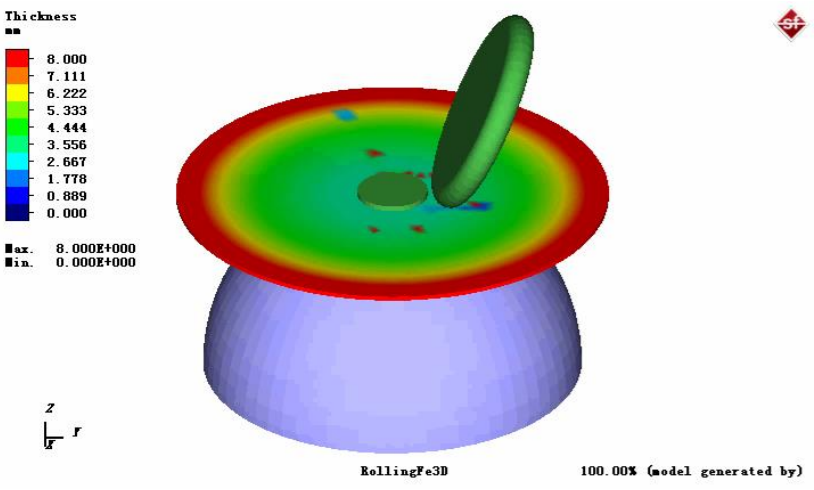
通用网格划分技术
- 壳单元
- 表面三角形/四边形单元划分

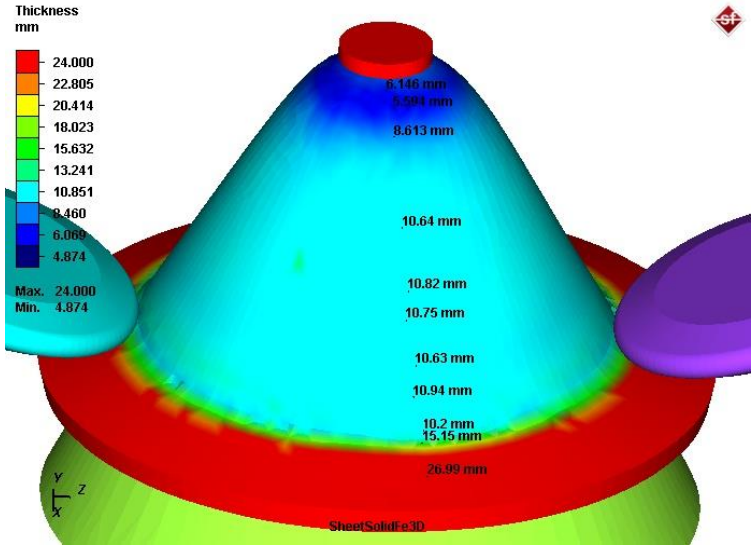
其它网格划分技术
- 体单元
- 六面体和四面体单元
- 来自MSC和SimLab的四面体网格全自动划分技术
- Simufact自己开发:
  六面体单元网格自动划分
- 实体壳单元

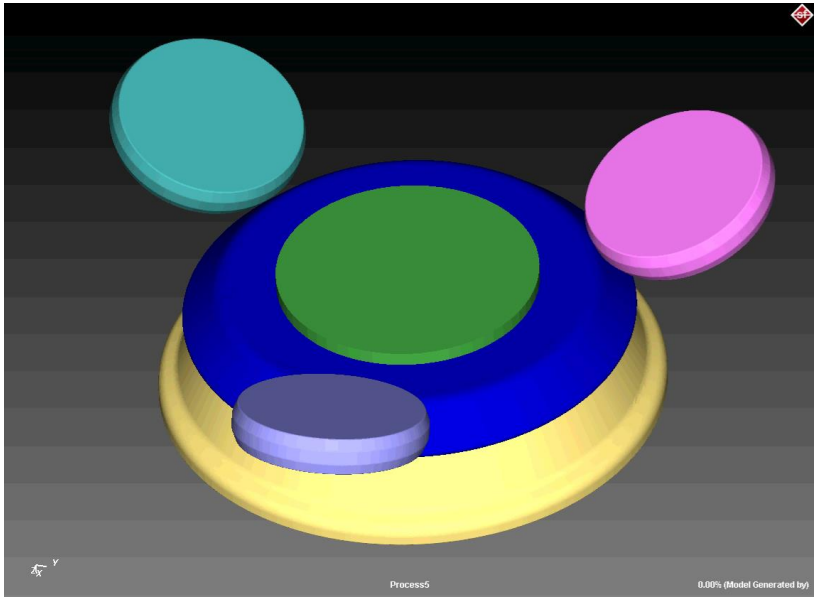


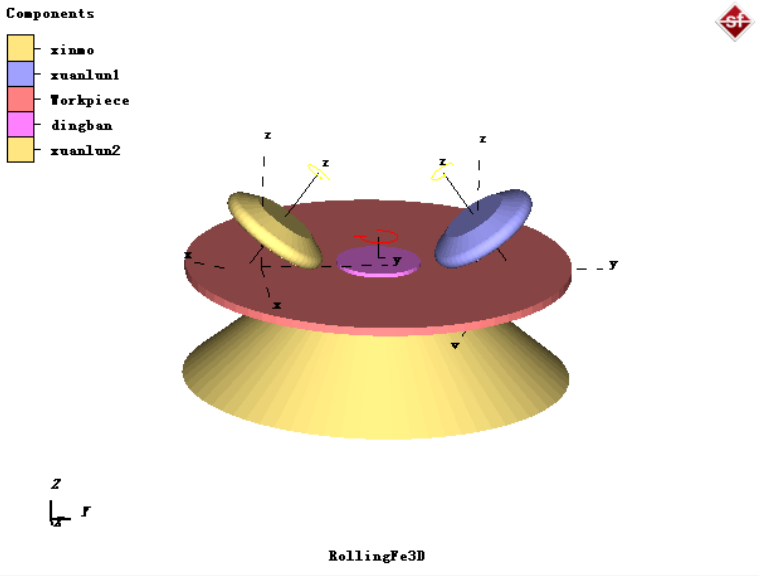


钣金成形工艺模拟

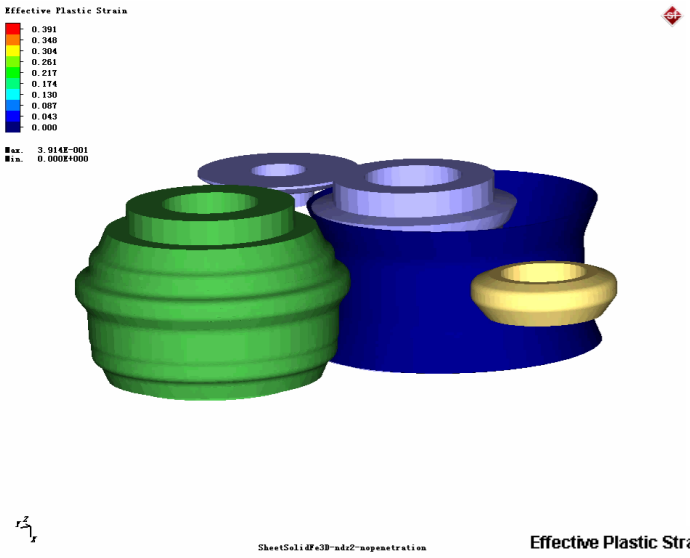

Thickness
8.000
7.111
6.222
5.333
4.444
3.556
2.667
1.778
0.889
0.000
Max. 8.000E+000
Min. 0.000E+000
RollingFe3D
100.00% (model generated by)

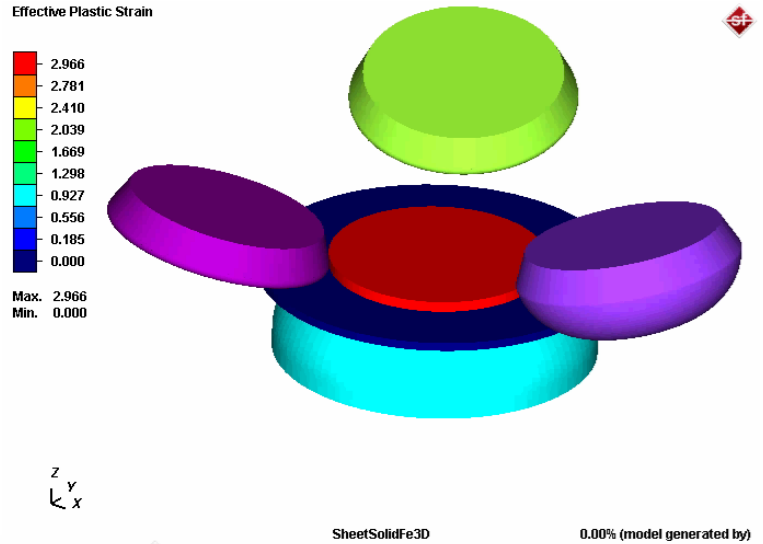

Thickness
mm
24.000
22.805
20.414
18.023
15.632
13.241
10.851
8.460
6.069
4.874
Max. 24.000
Min. 4.874
6.146 mm
5.594 mm
8.613 mm
10.64 mm
10.82 mm
10.75 mm
10.63 mm
10.94 mm
10.2 mm
15.15 mm
26.99 mm
SheetSolidFe3D

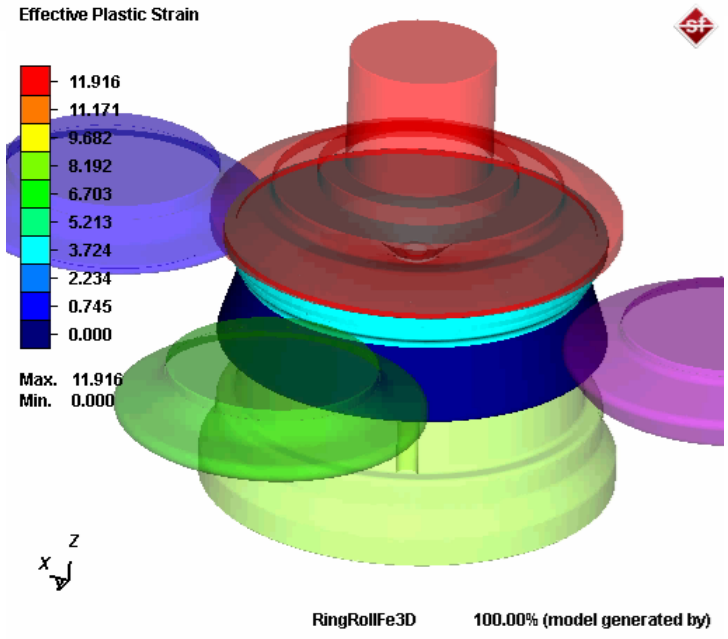

Process5
0.00% (Model Generated by)


Components
xinmo
xuanlun1
Workpiece
dingban
xuanlun2
RollingFe3D

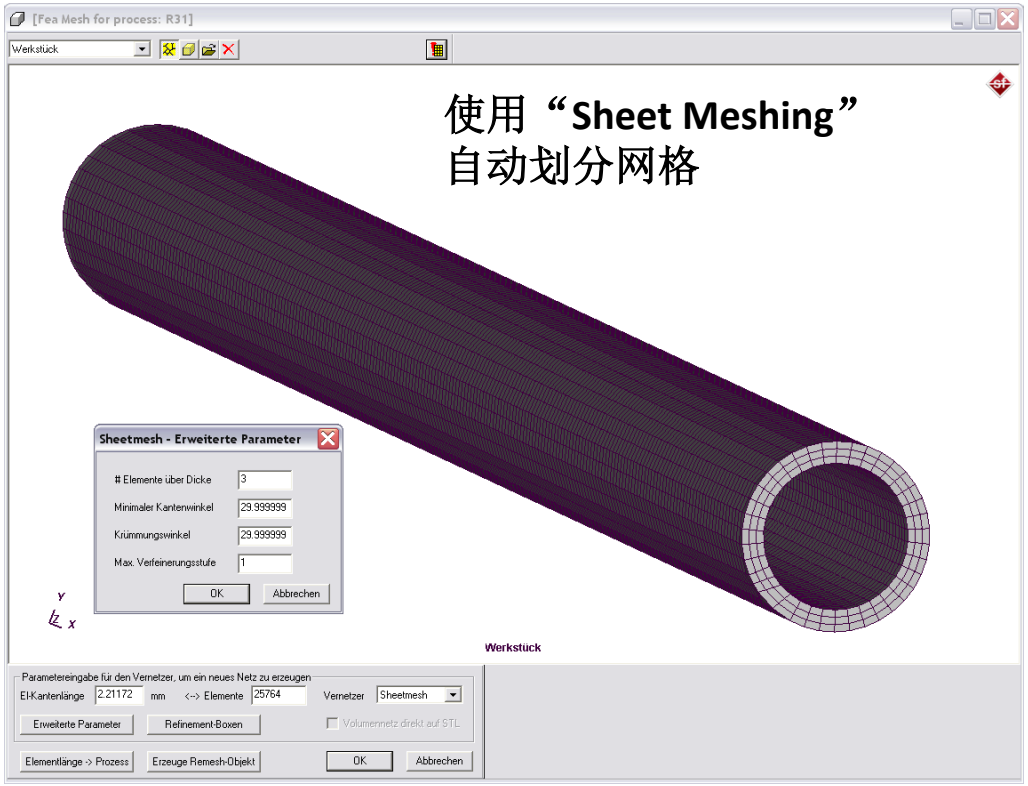
车轮滚型及旋压

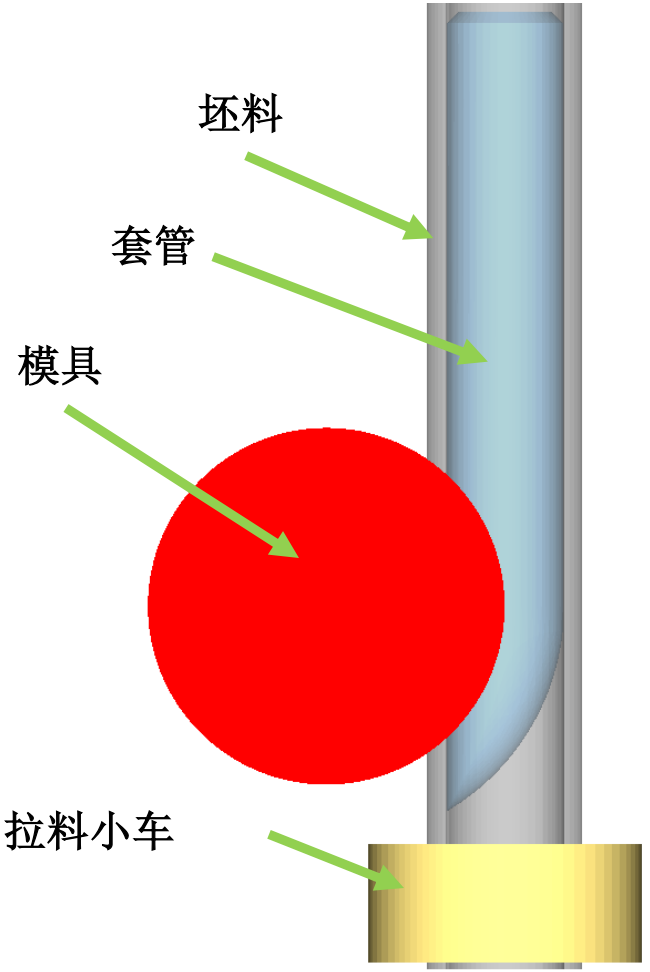

Effective Plastic Strain
0.391
0.348
0.304
0.261
0.217
0.174
0.130
0.087
0.043
0.000


Effective Plastic Strain
2.966
2.781
2.410
2.039
1.669
1.298
0.927
0.556
0.185
0.000
Max. 2.966
Min. 0.000
SheetSolidFe3D
0.00% (model generated by)

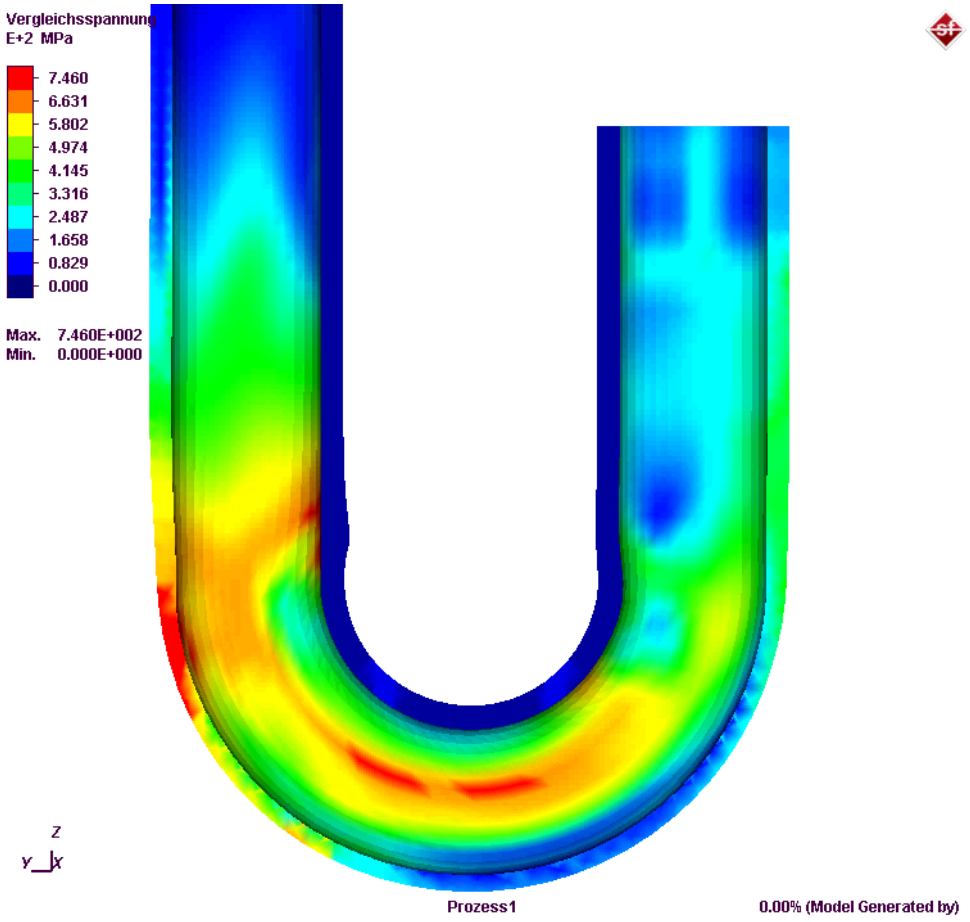

Effective Plastic Strain
11.916
11.171
9.682
8.192
6.703
5.213
3.724
2.234
0.745
0.000
Max. 11.916
Min. 0.000
RingRollFe3D
100.00% (model generated by)

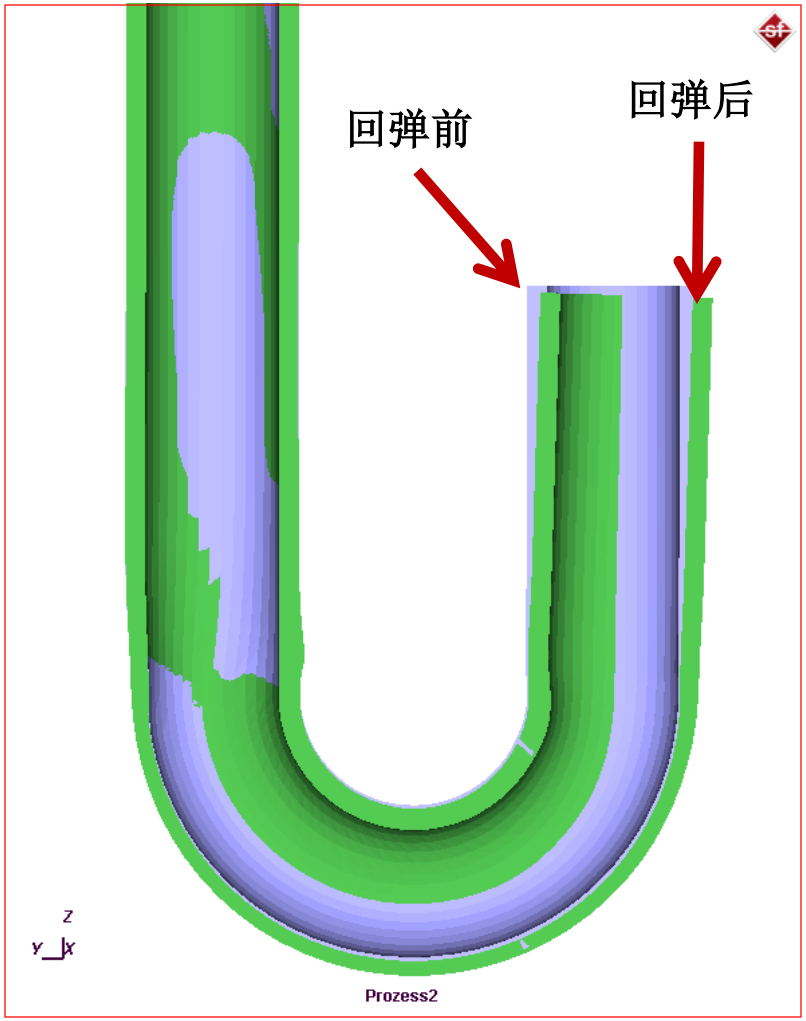
管材弯曲模拟



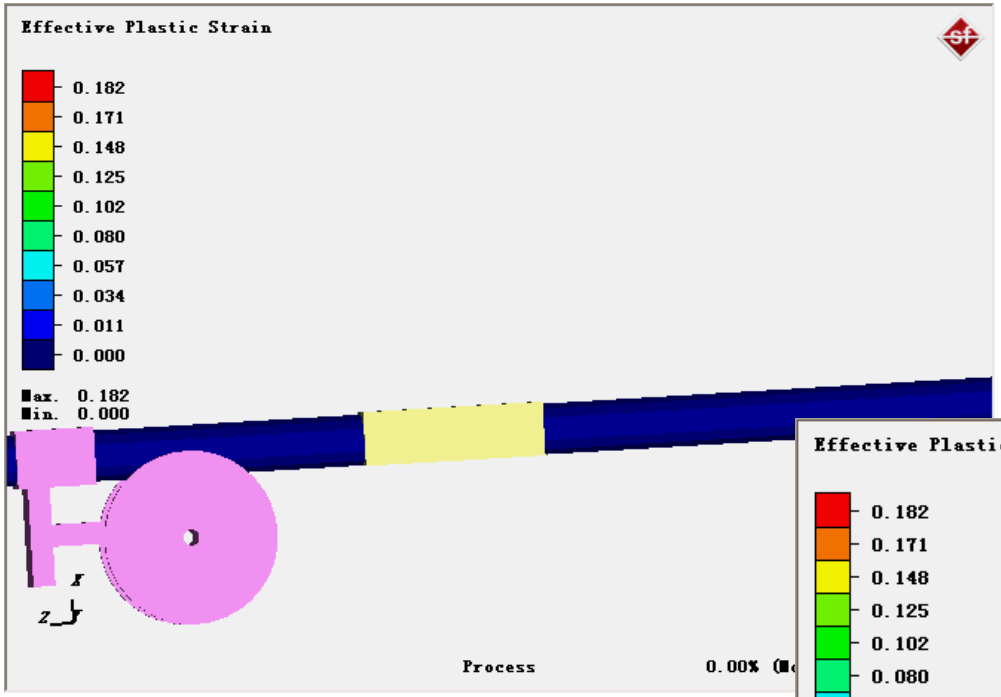


回弹预测

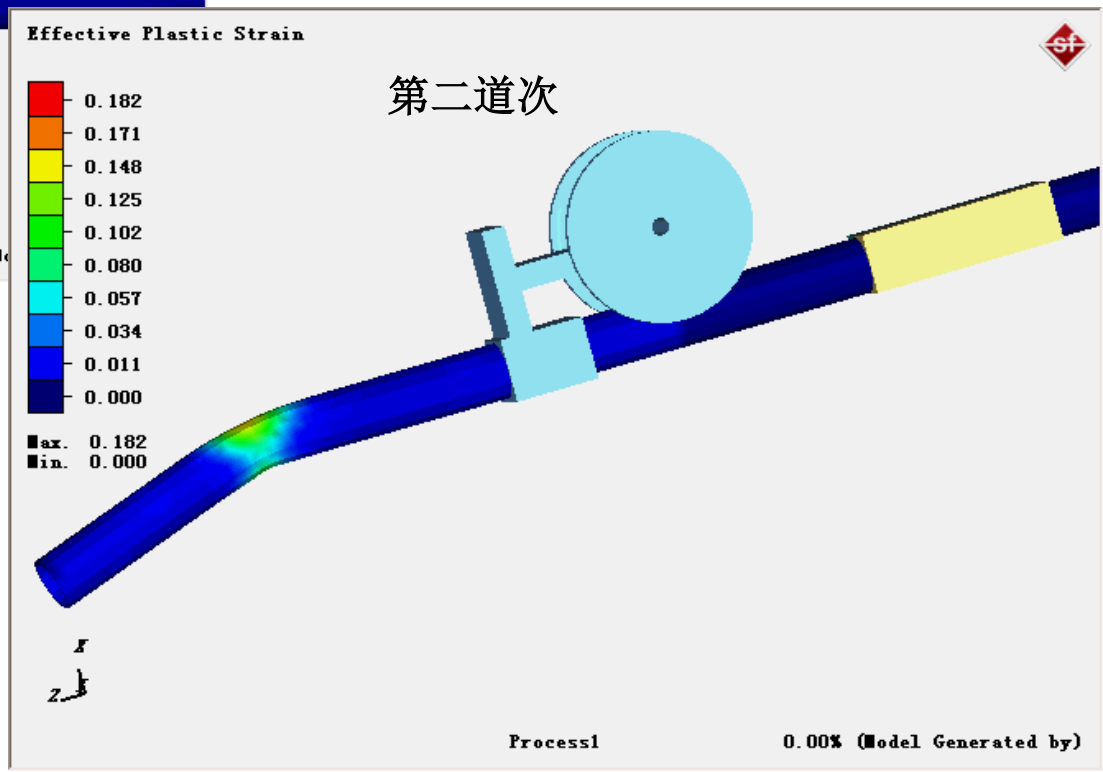




管材多道次弯曲

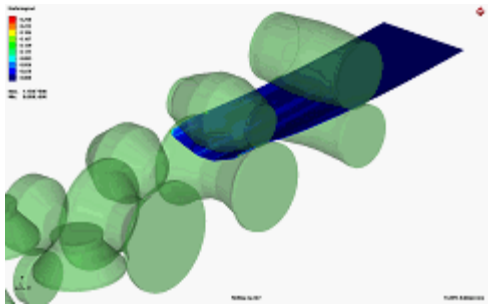


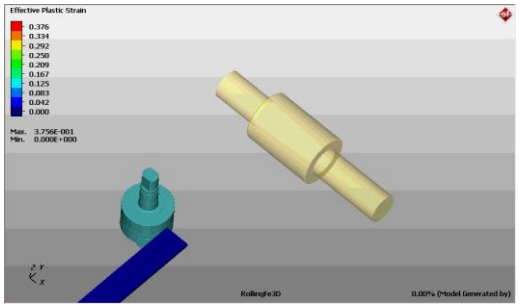
第一道次

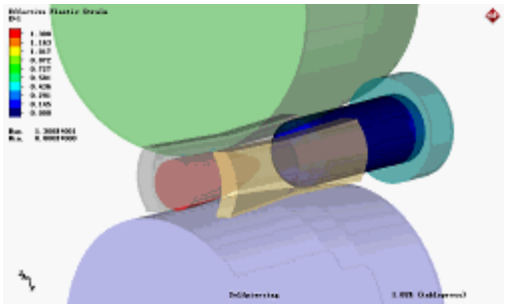


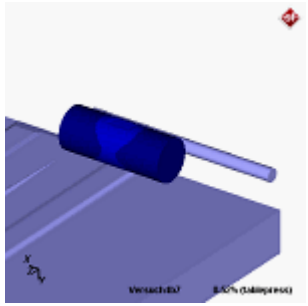
第二道次

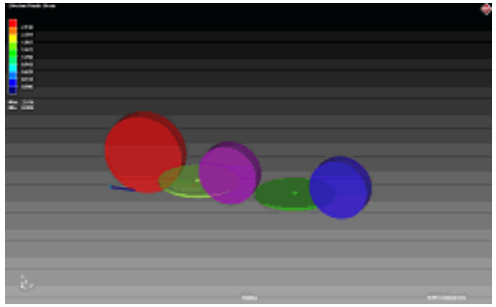
轧制成形工艺模拟

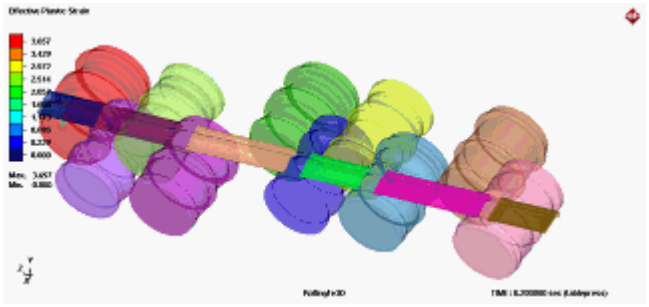








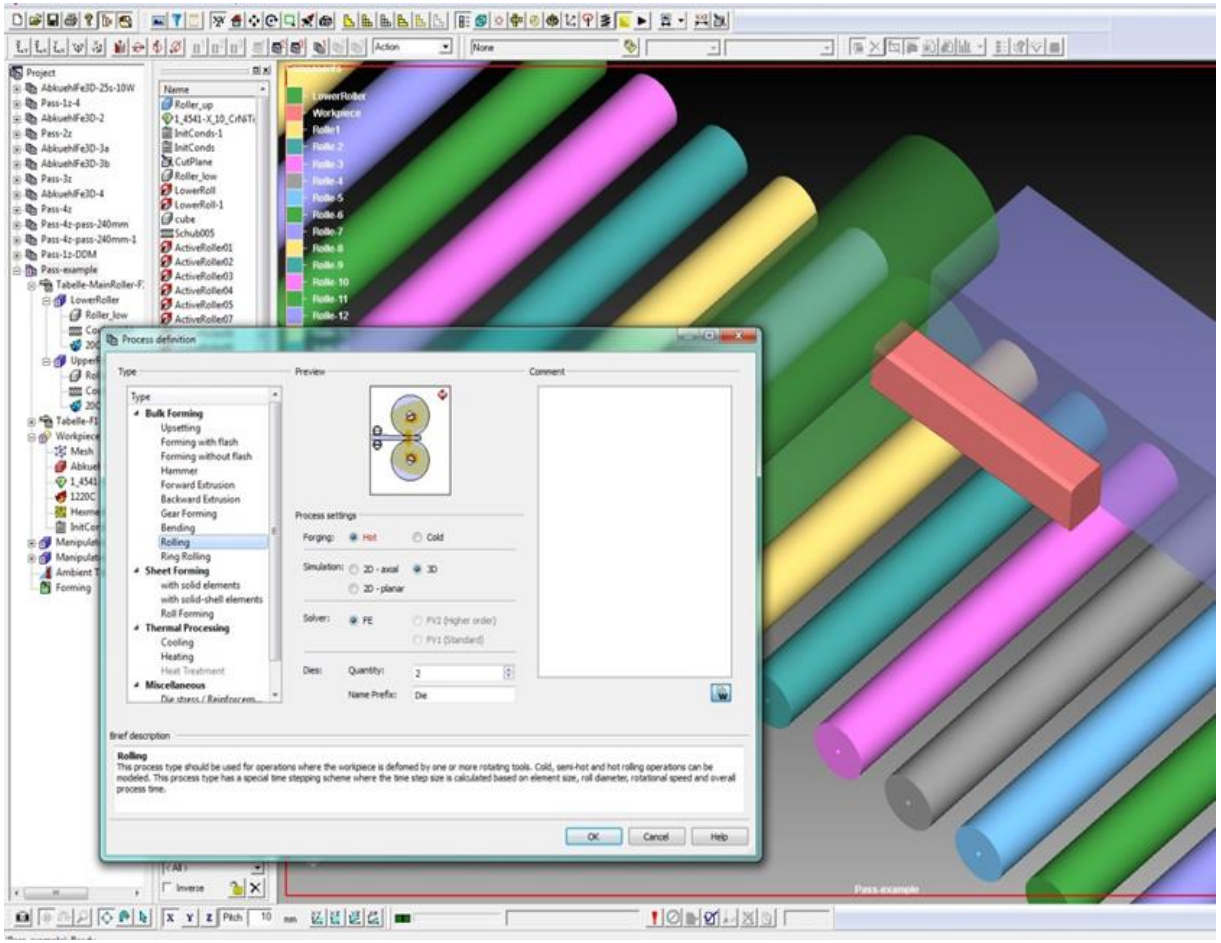




- 极易定义旋转运动
- 六面体、实体壳单元网格划分
- 多辊连轧仿真无任何限制
- 全开放的运动定义

轧制工艺仿真

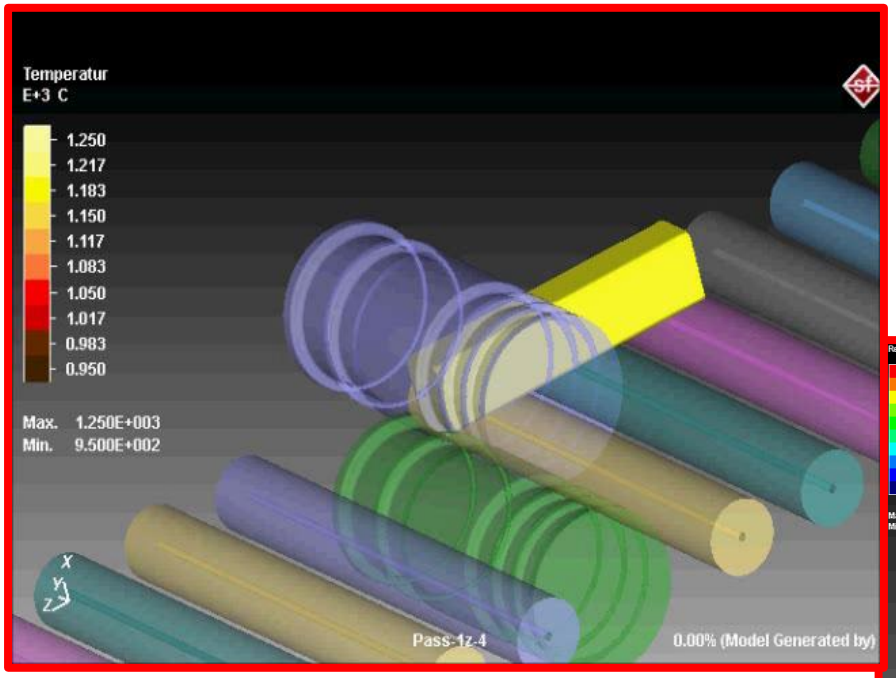
快速建模、极易使用的用户界面



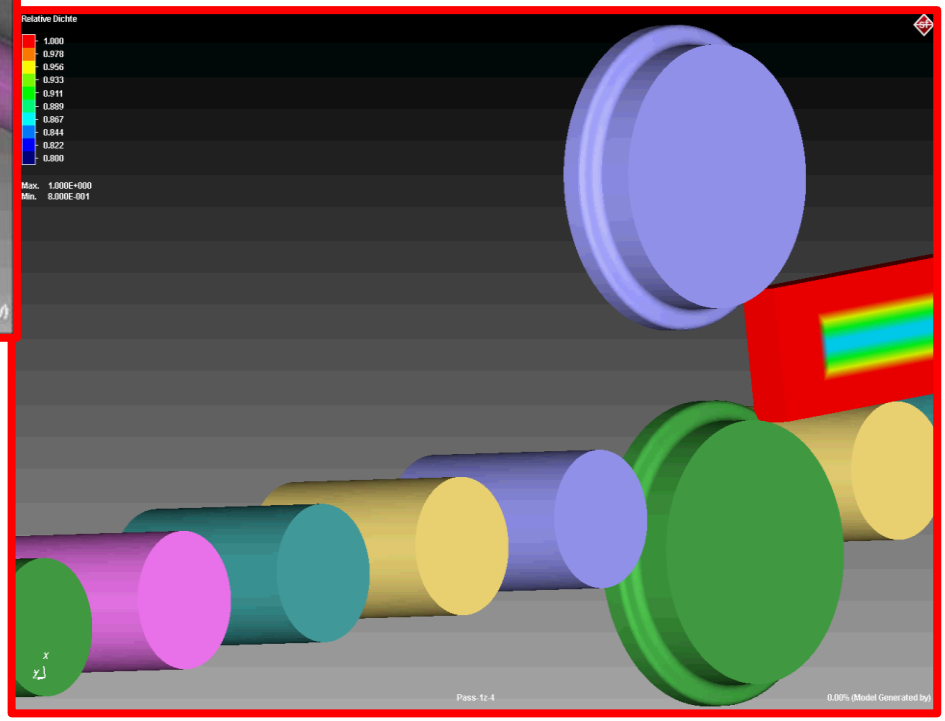
- 直观
- 灵活
- 模板 & 向导
- 高级模式
- 其它工艺仿真接口(铸态结构分析)

轧制工艺仿真

多道次铁轨轧制...



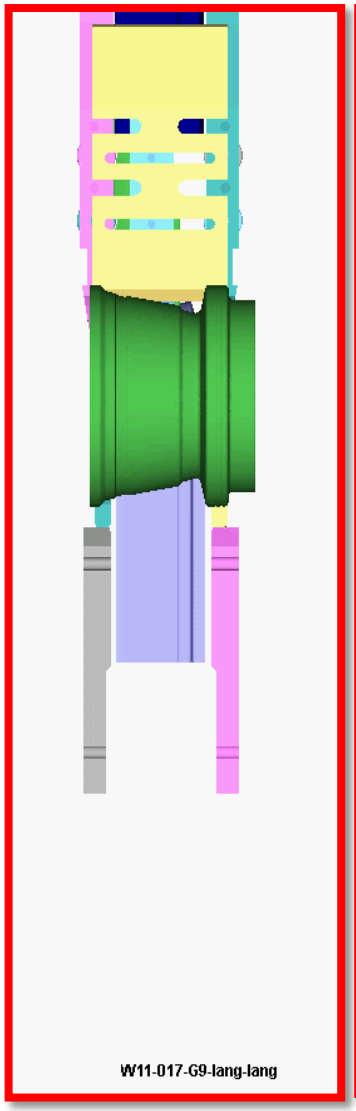
... 预测芯部缺陷 (孔洞闭合)

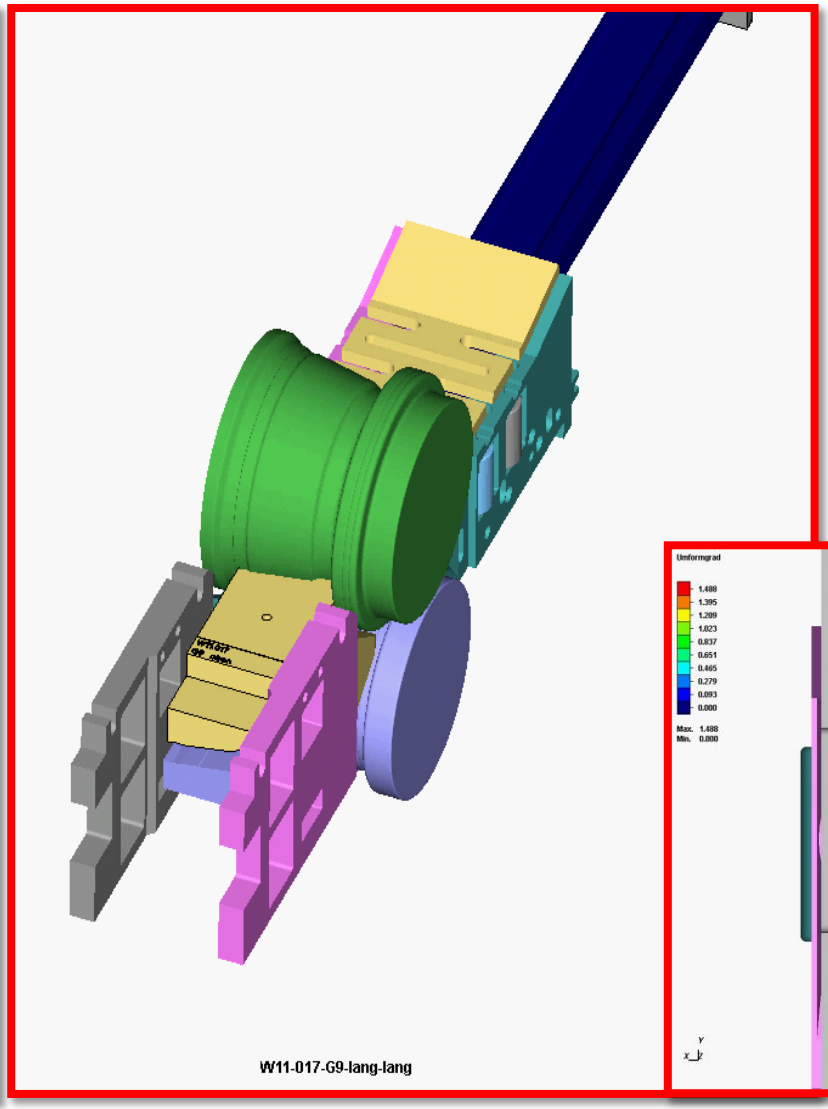


MSC Software

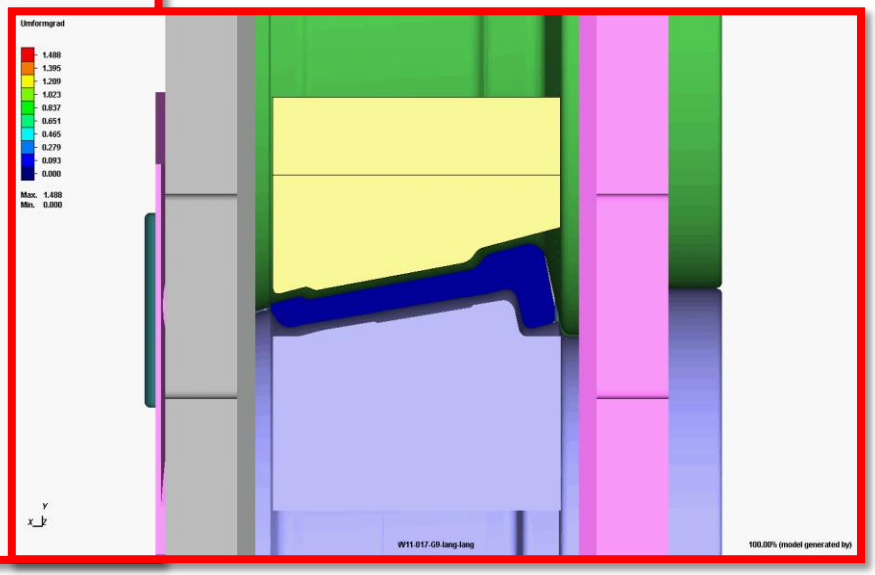
轧制工艺仿真

扭曲– 优化前

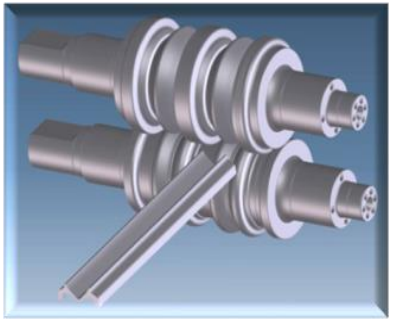


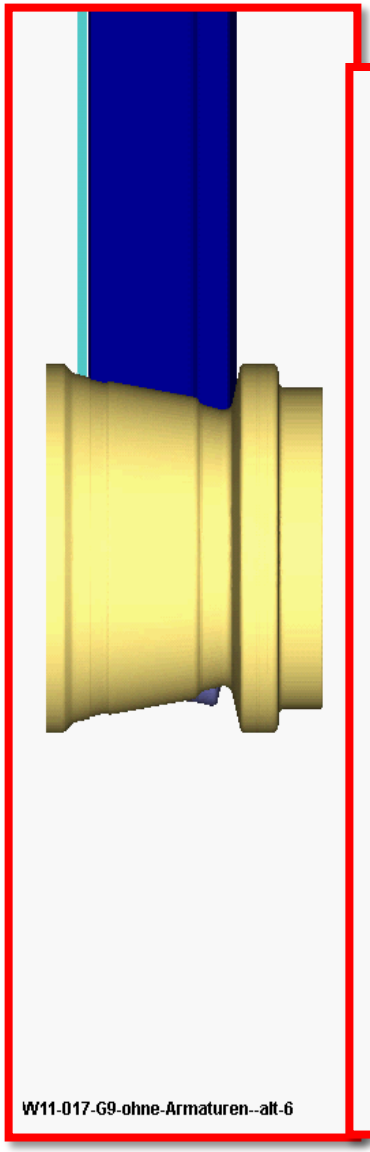


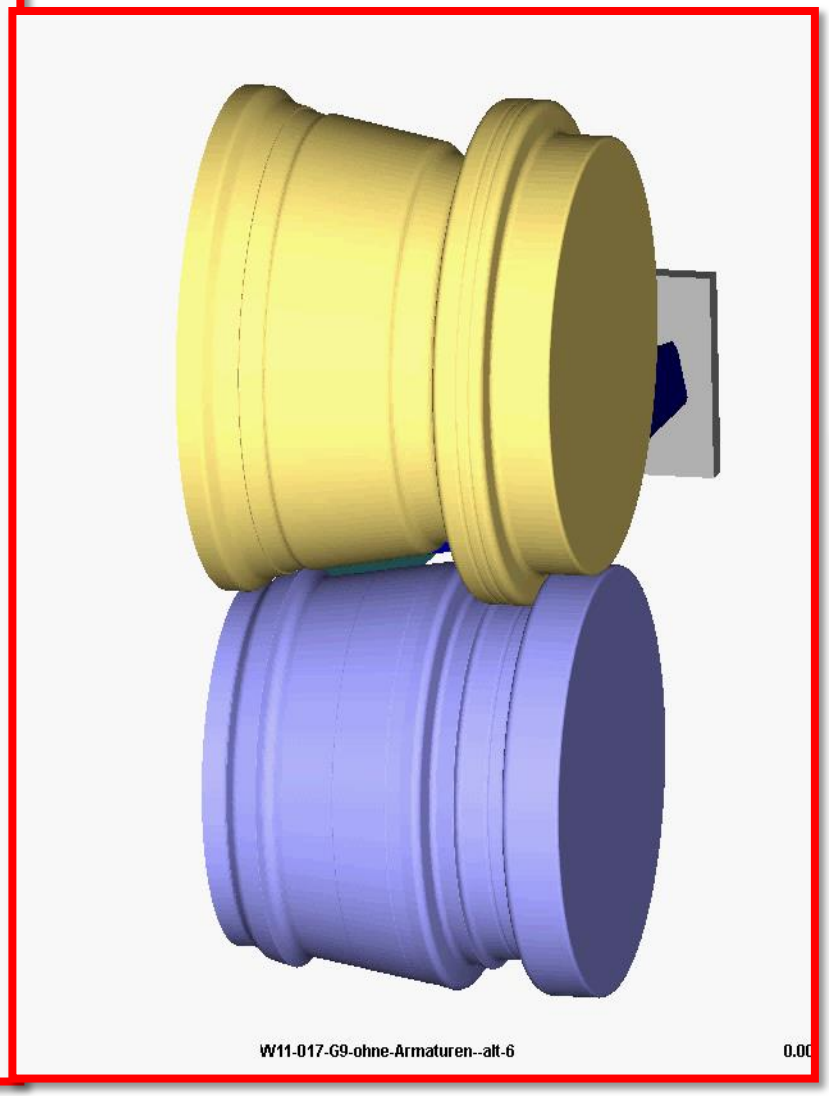
由仿真可以看出，扭曲不仅和轧辊缝隙有关，而且与后续矫形模具相关

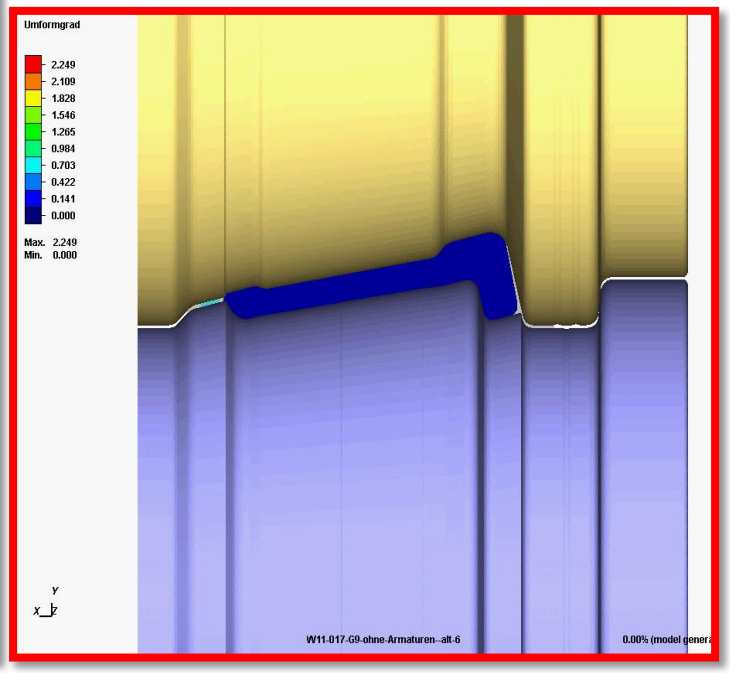


轧制工艺仿真



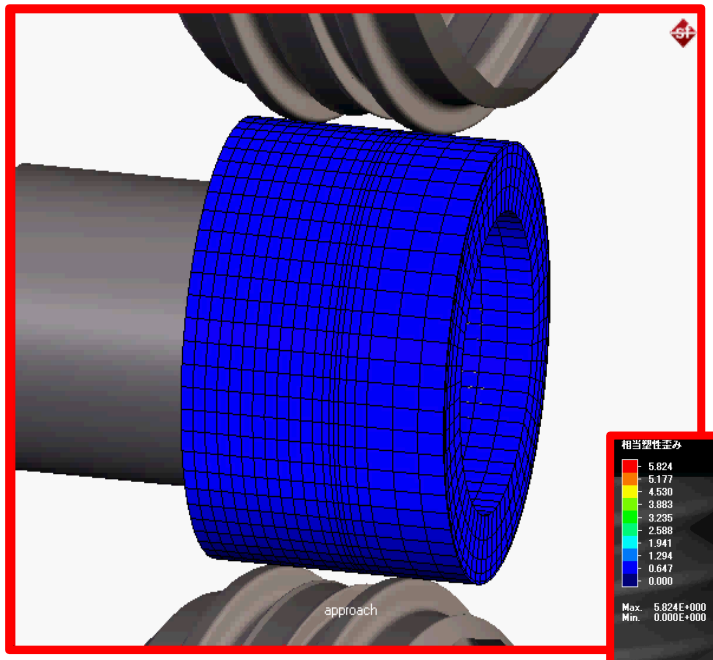




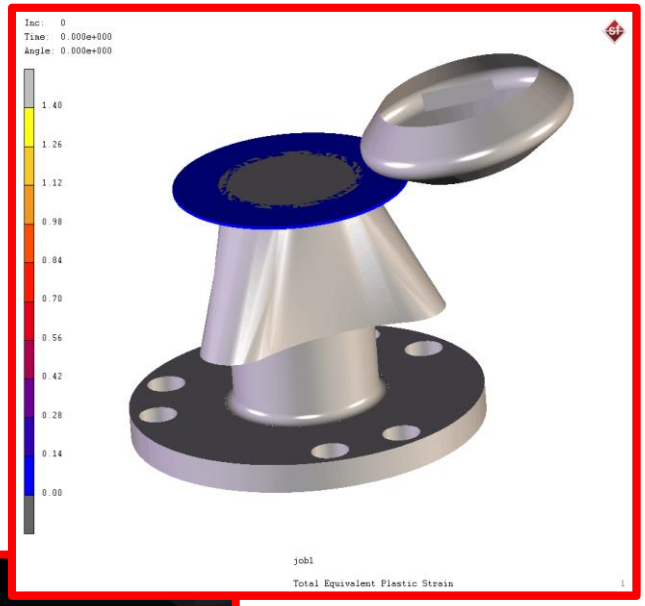


轧制工艺仿真

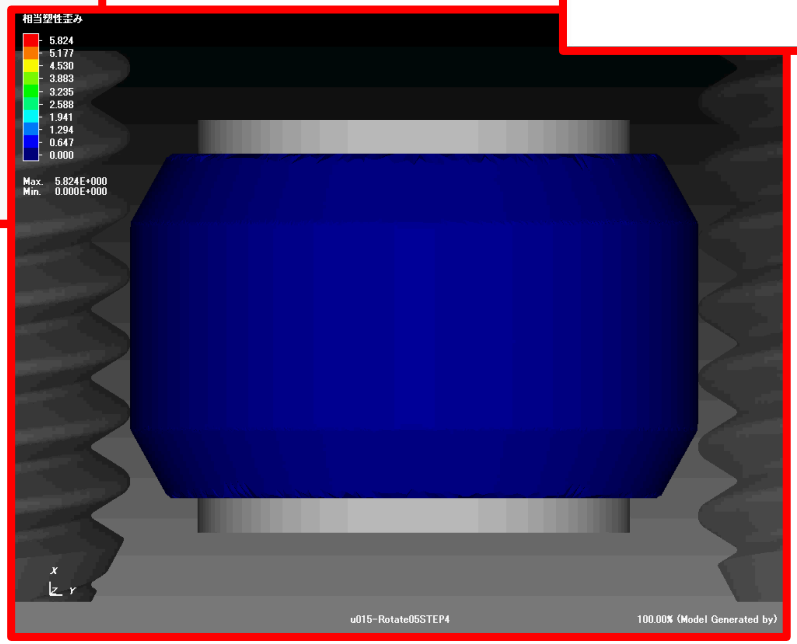
其它轧制工艺



辊轧...



非对称旋压...



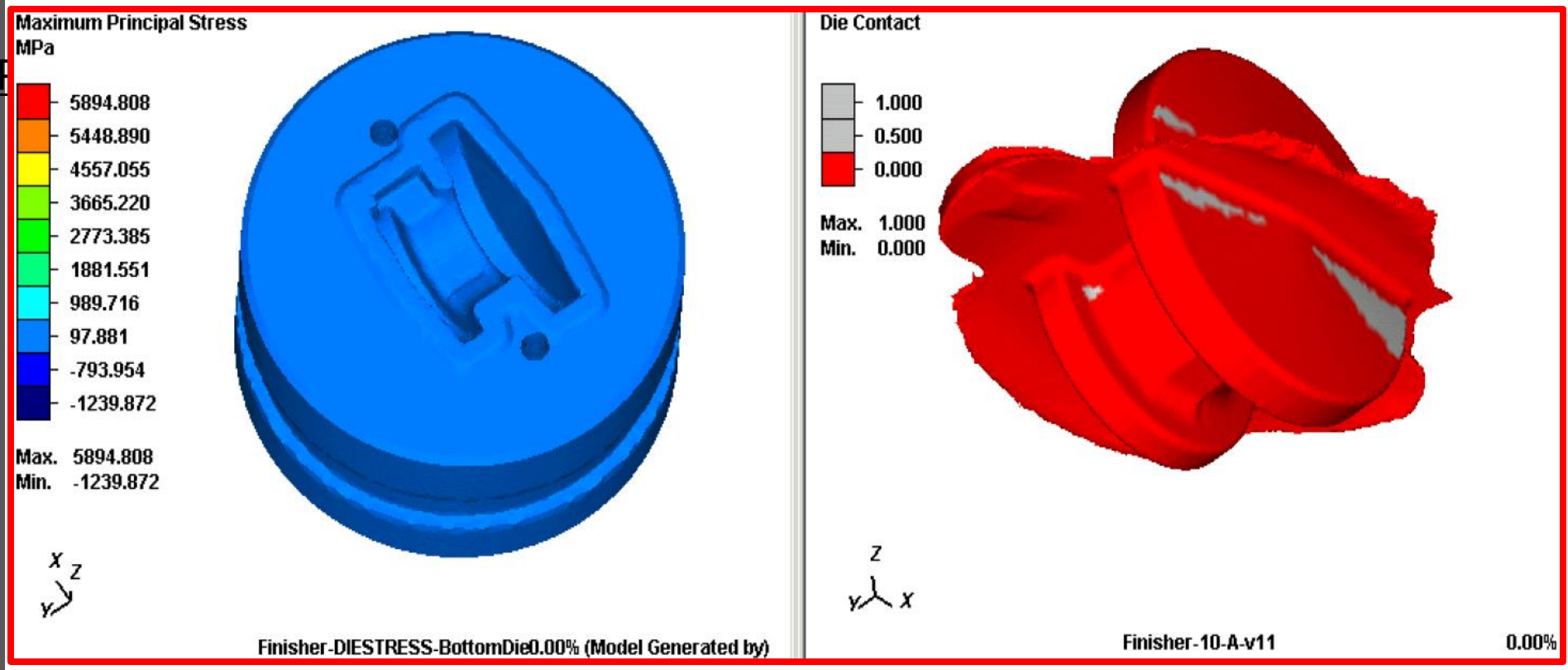
搓牙...

模具应力分析

问题: 模具损伤

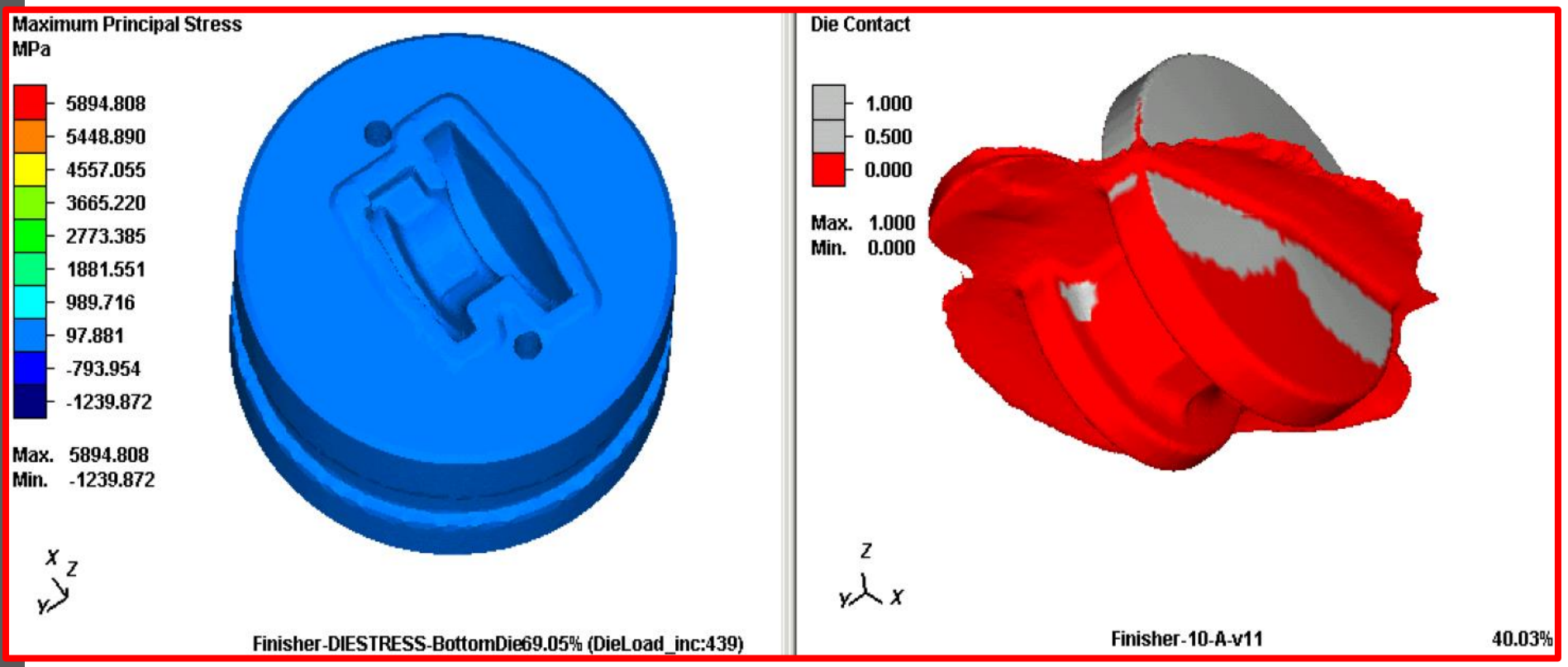
凹模经常损坏

模具应力分析



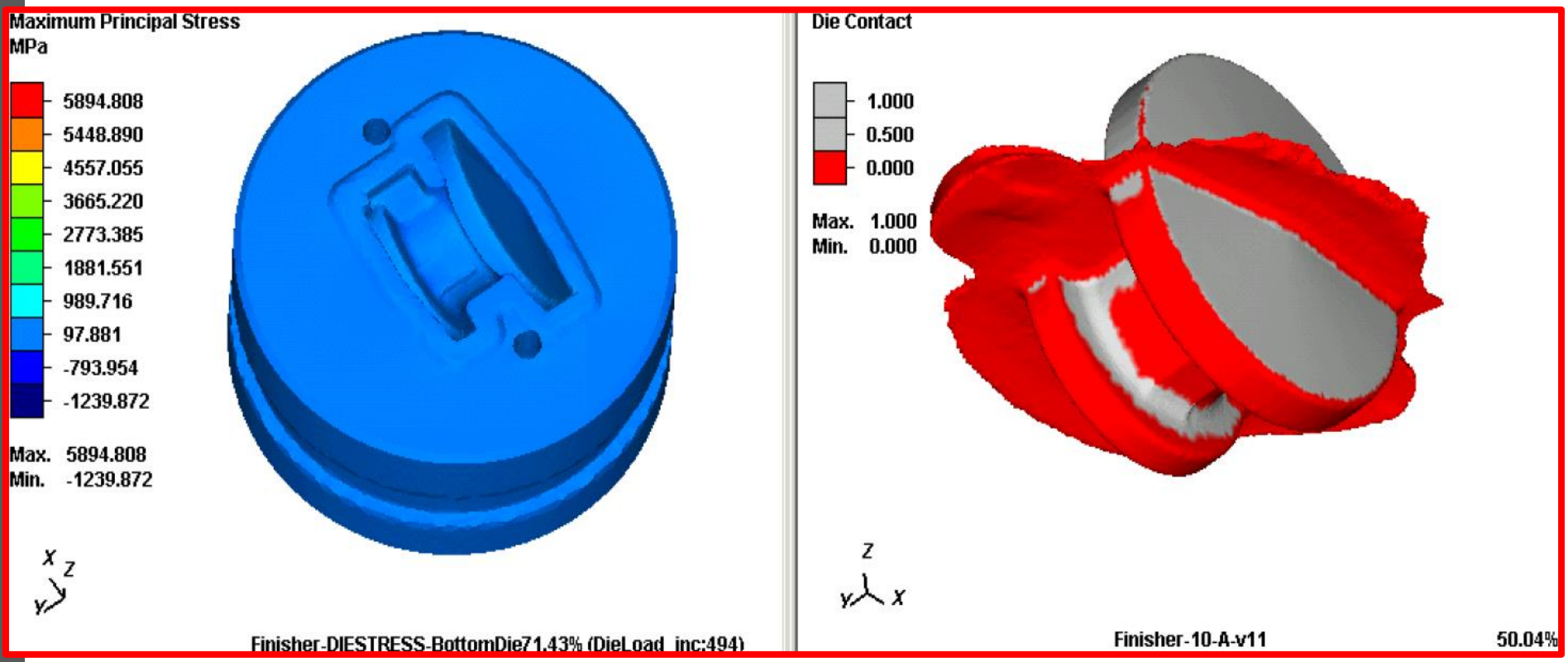
模具应力(左侧) 模具接触 行程 = 0%

模具应力分析



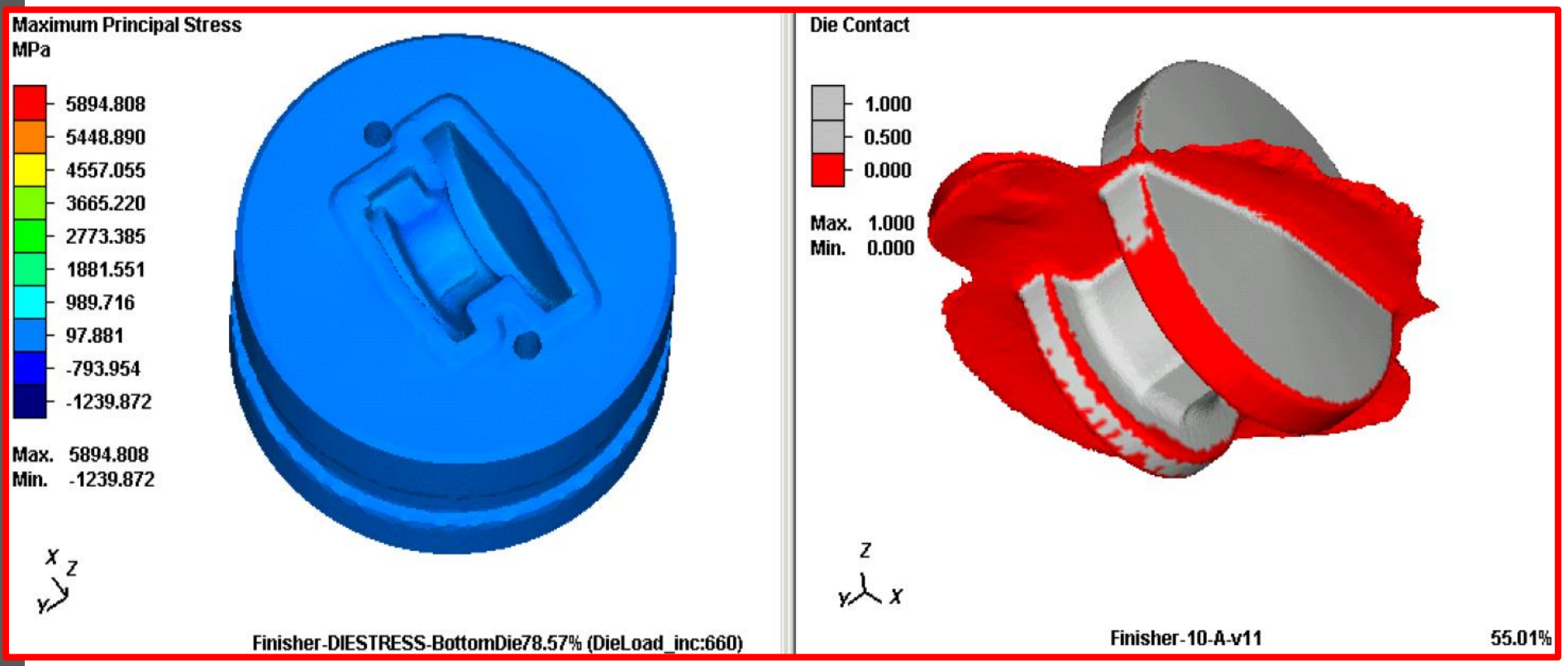
模具应力(左侧) 模具接触 行程 = **40%**

模具应力分析



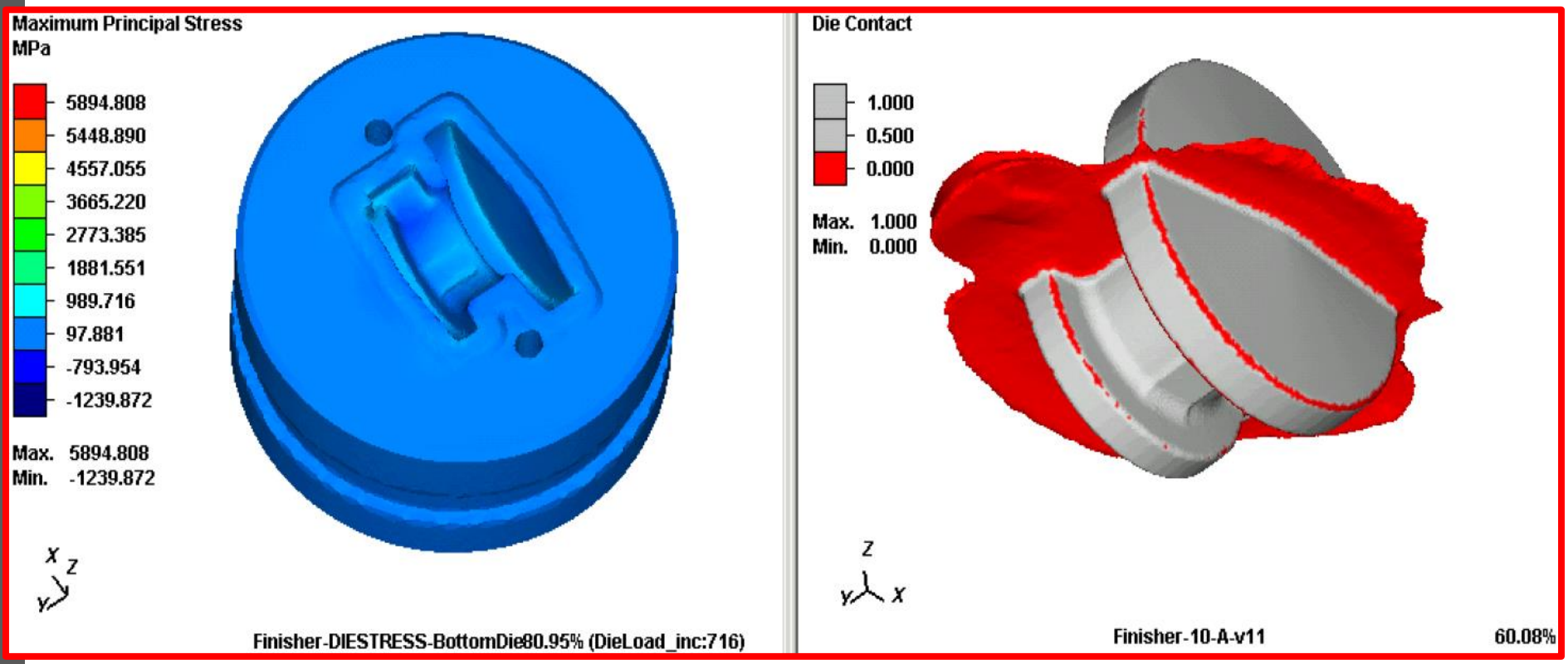
模具应力(左侧) 模具接触 行程 = **50%**

模具应力分析



模具应力(左侧) 模具接触 行程 = **55%**

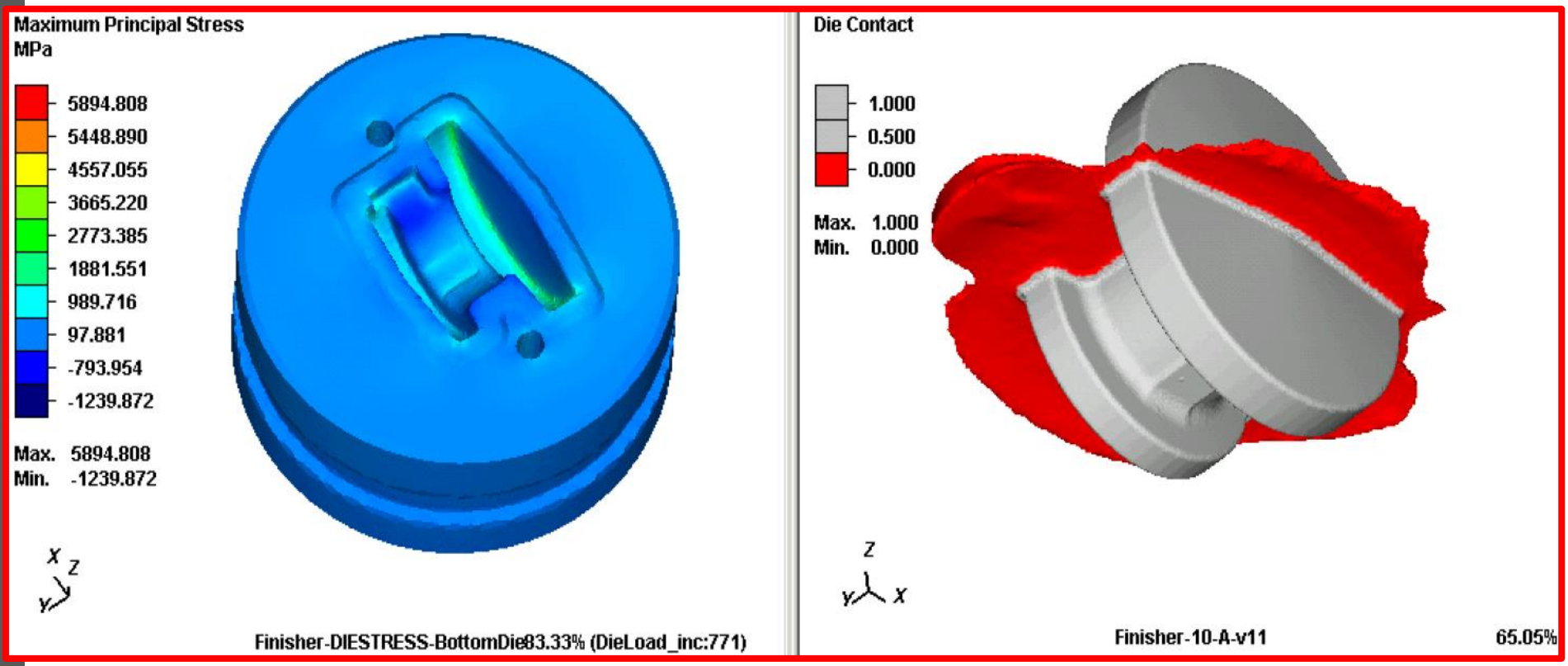
模具应力分析



模具应力(左侧) 模具接触 行程 = **60%**

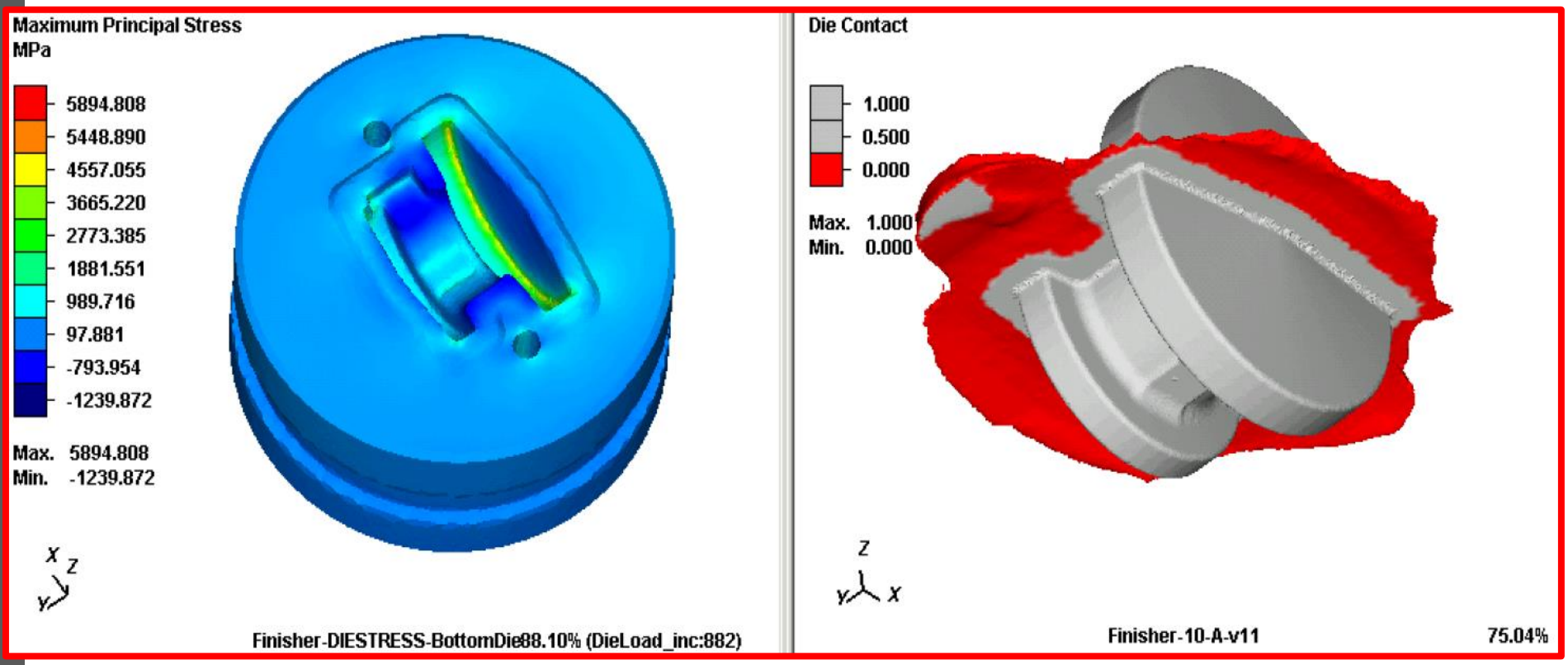
模具应力分析

模具填充完整



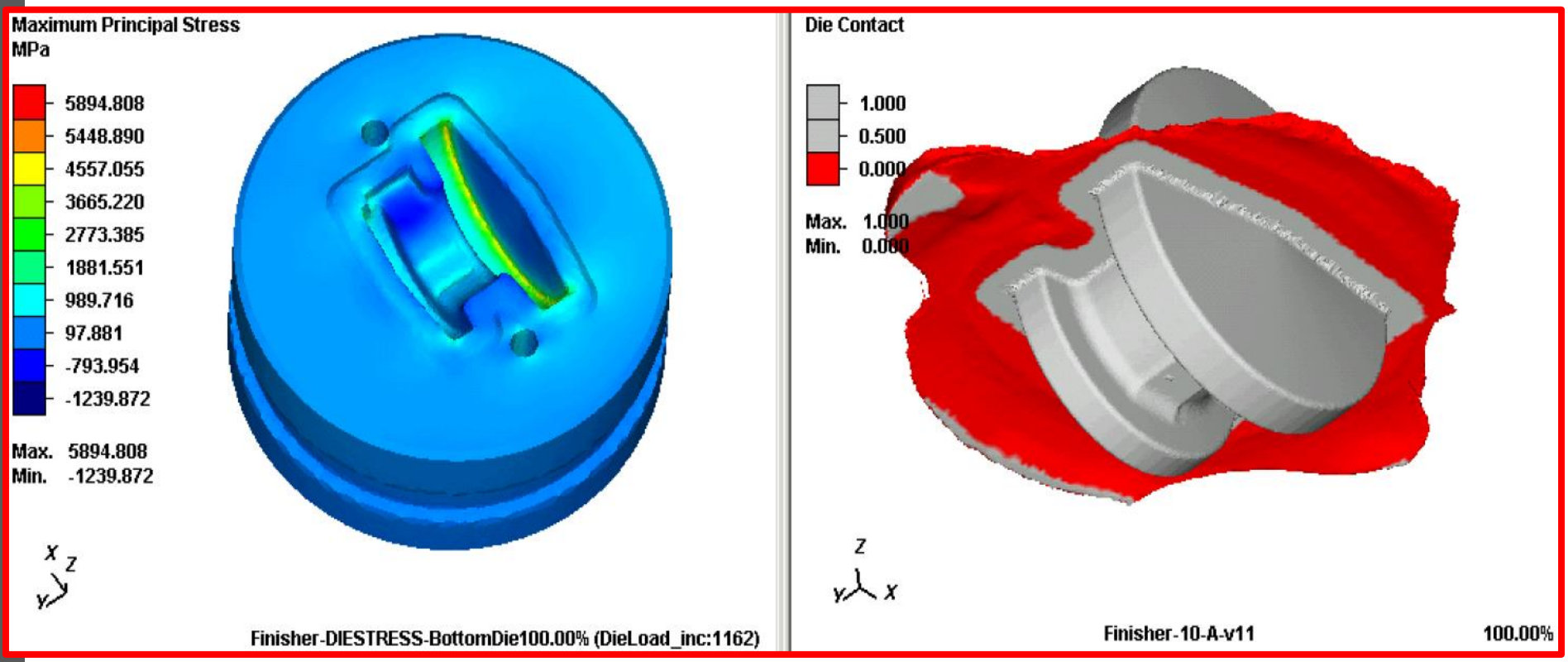
模具应力(左侧) 模具接触 行程 = **65%**

模具应力分析



模具应力(左侧) 模具接触 行程 = **75%**

模具应力分析



模具应力(左侧) 模具接触 行程 = **100%**

模具应力分析

从仿真结果可知，模具应力急剧增大的主要原因是：在进行到65%行程时，模具已经填充完整，如果继续下压2mm至下死点，将会导致较高的应力。

- 对现实加工过程进行虚拟仿真(模具损伤)

仿真软件所做工作!

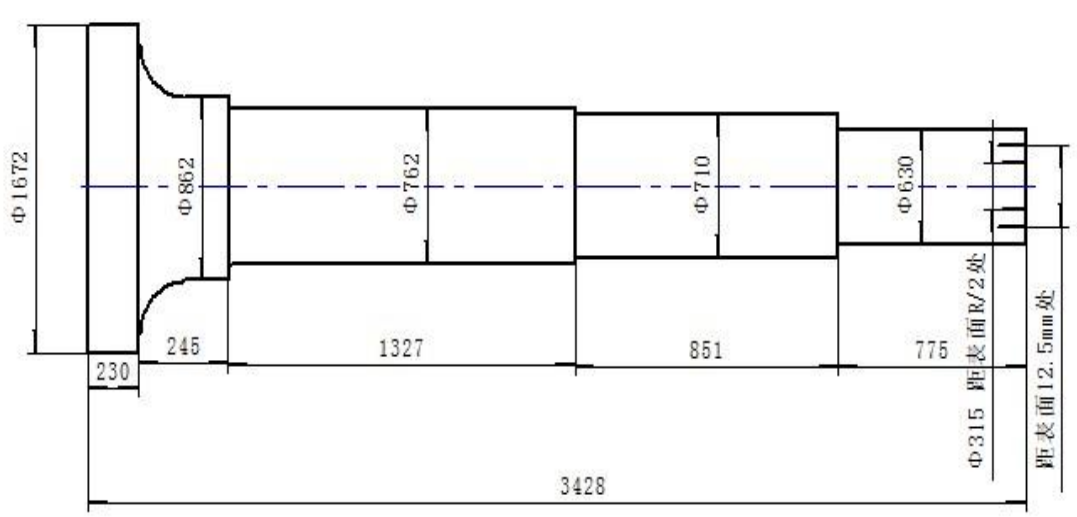
- 但是: 什么原因导致这个问题？如何解决？

你需要完成的工作!

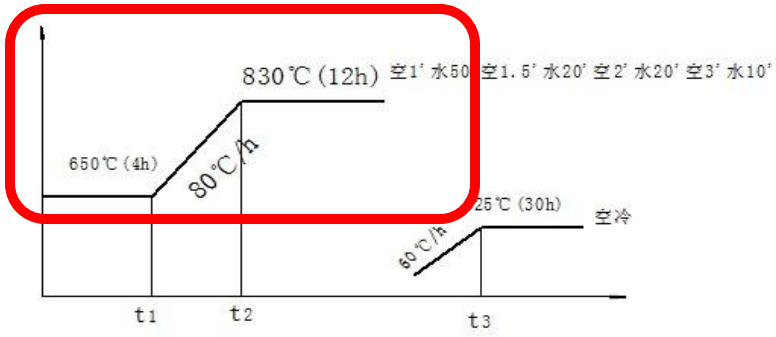
热处理工艺模拟

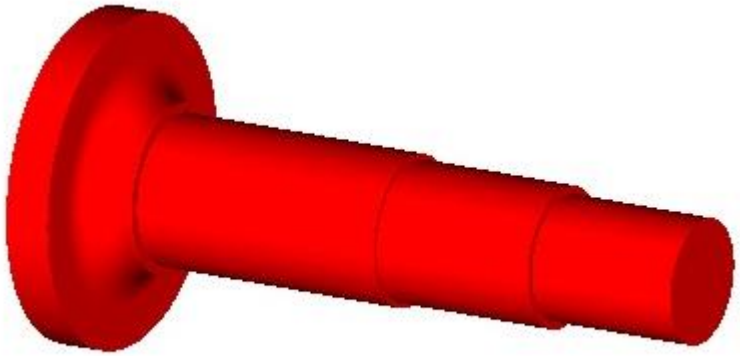
- 可对正火、退火、淬火、感应加热、感应淬火等典型热处理工艺进行仿真
- 按照实际热处理工艺开发的界面，极易使用，即使没有CAE软件使用经验，也能很快掌握使用
- 预置空气、水、油及常用淬火油属性，用户也可手动导入新的淬火介质

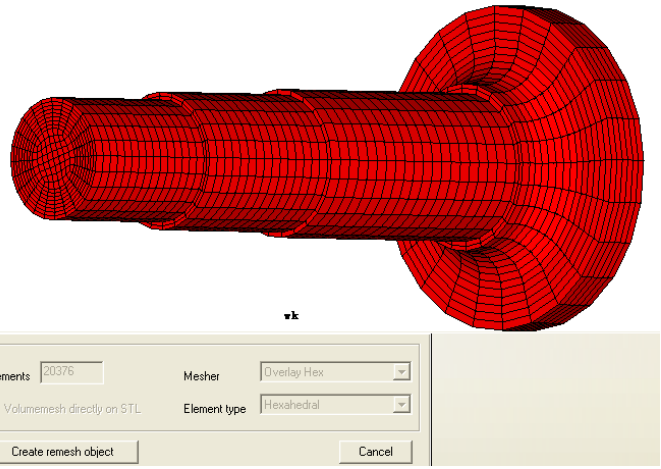
风机主轴热处理模拟



材料：42CrMoA（42CrMo4）

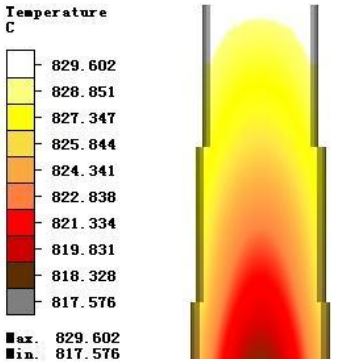


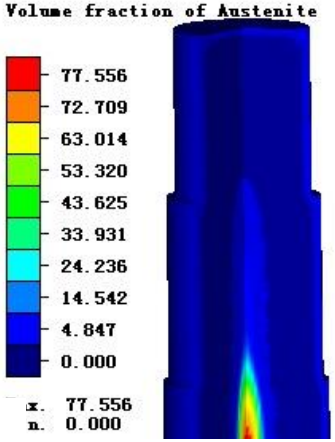


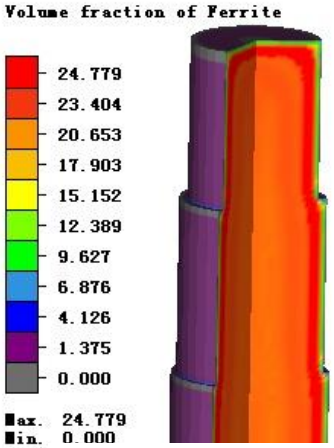


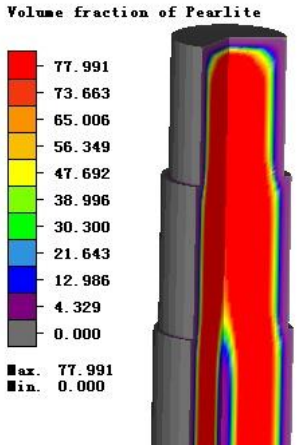
MSC Software

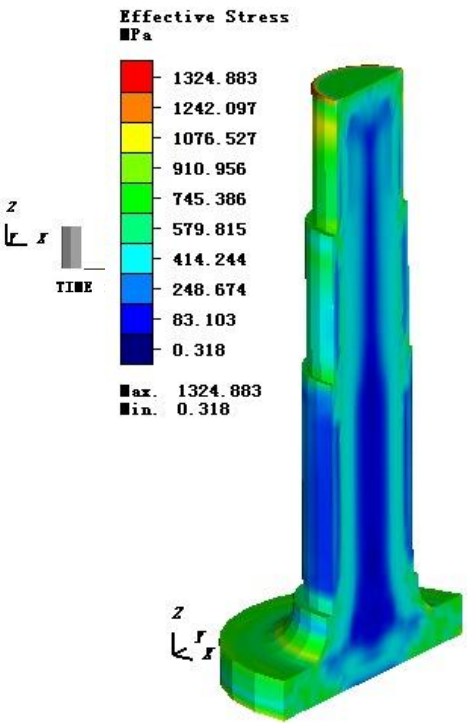
风机主轴热处理模拟

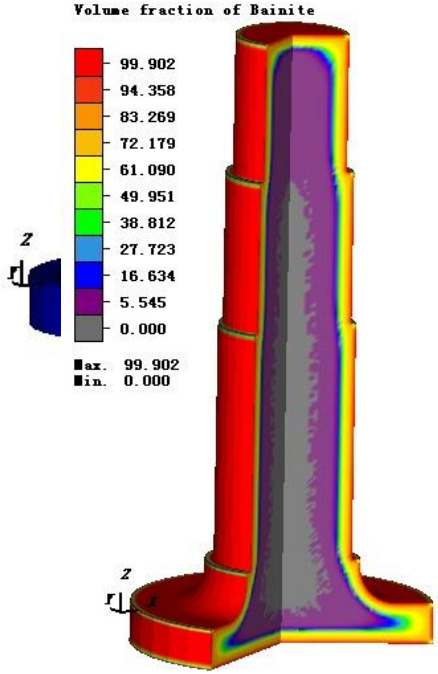


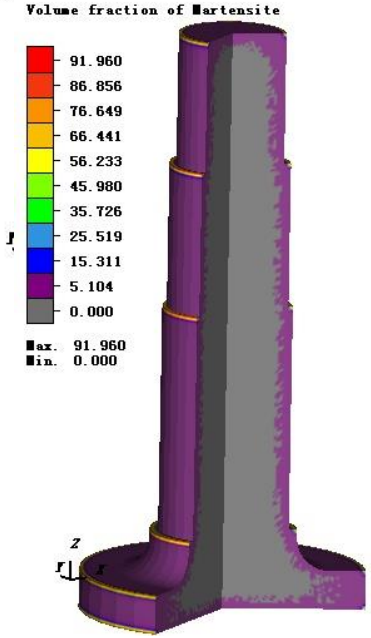


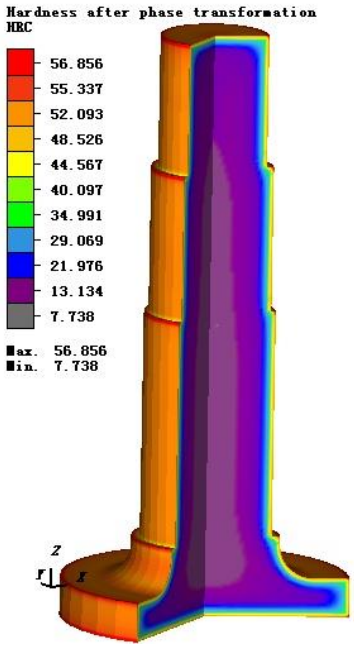






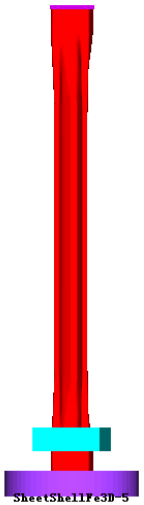


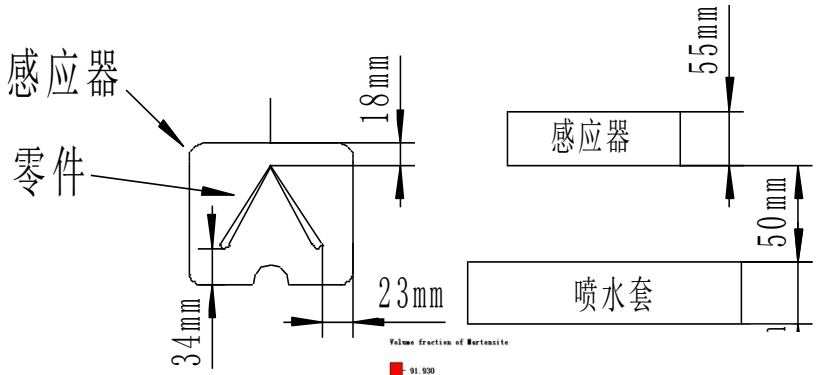


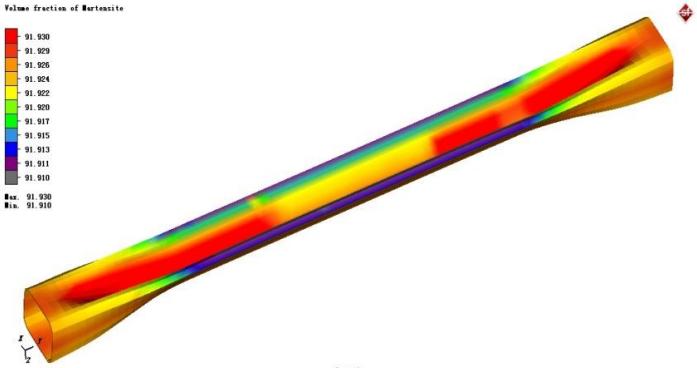


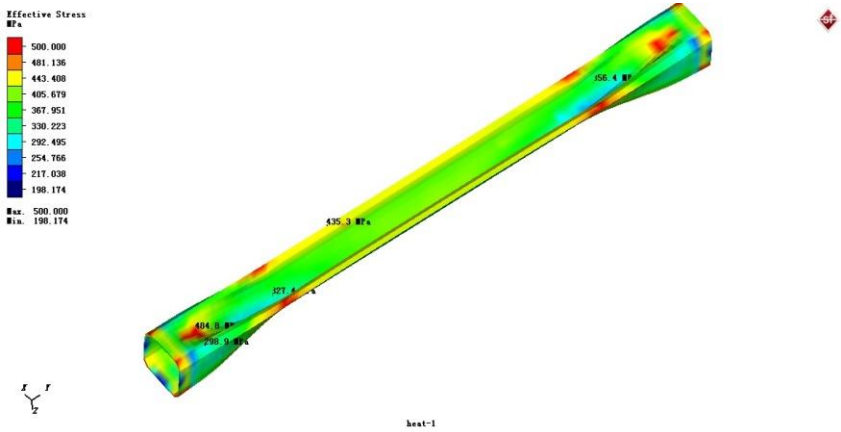
MSC Software

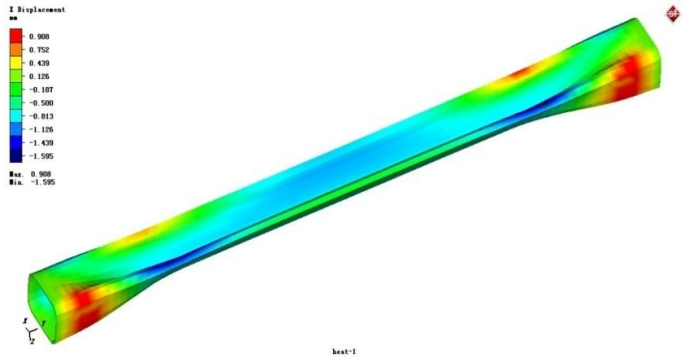
感应淬火工艺模拟











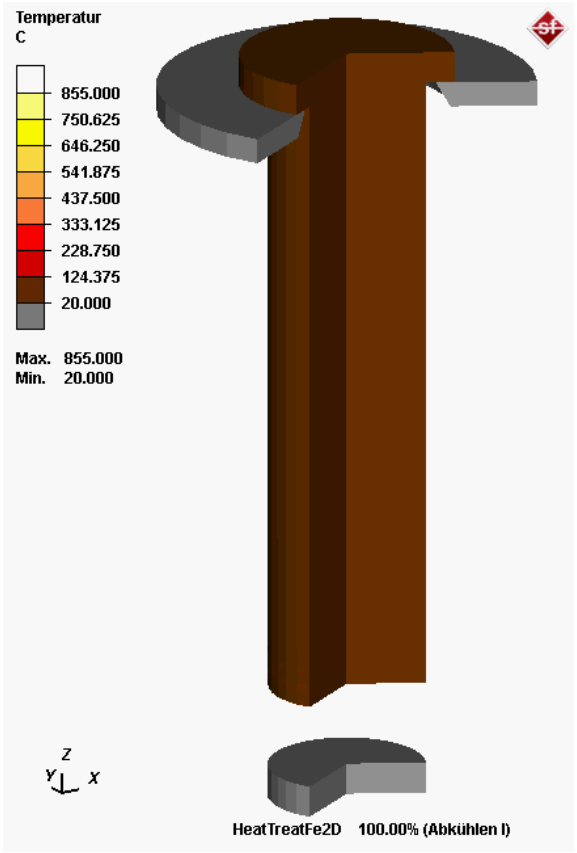
MSC Software

相变模拟

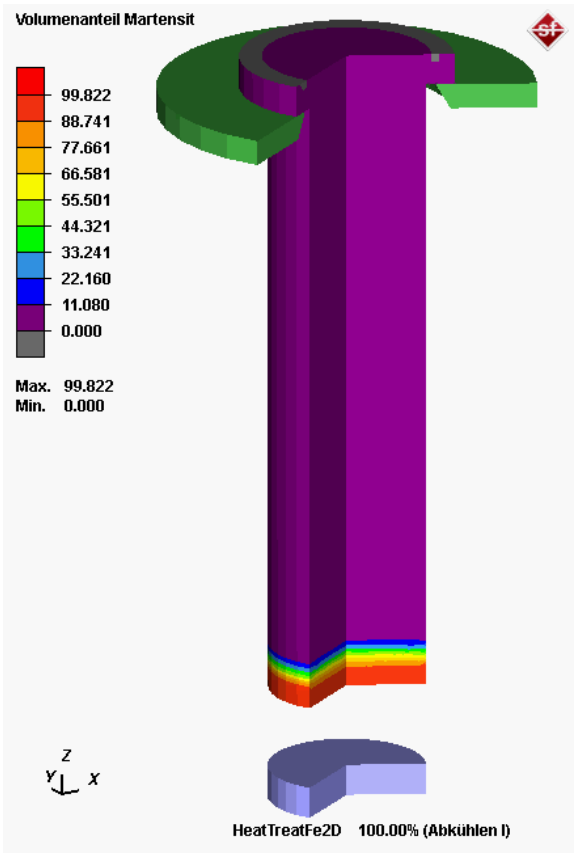
端淬试验

- 前端局部冷却
- 碳素钢

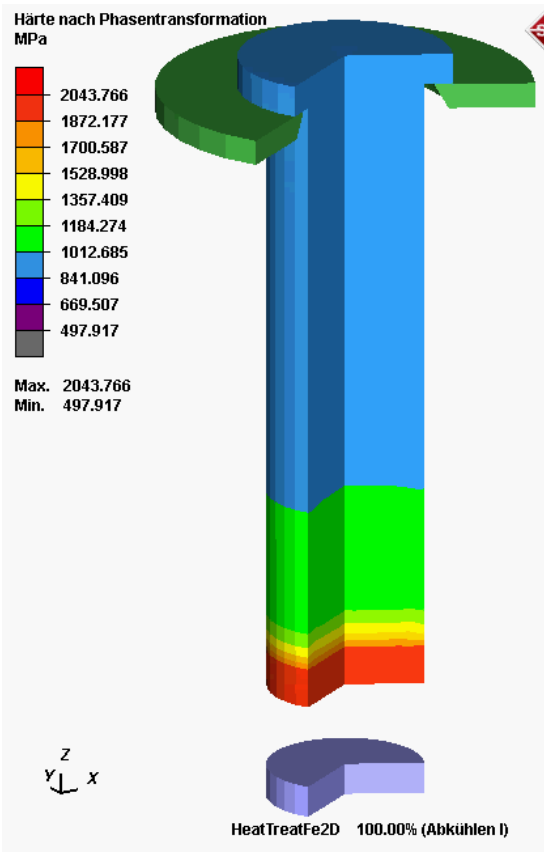
温度 [° C]



马氏体体积份数 [%]



硬度 [MPa]



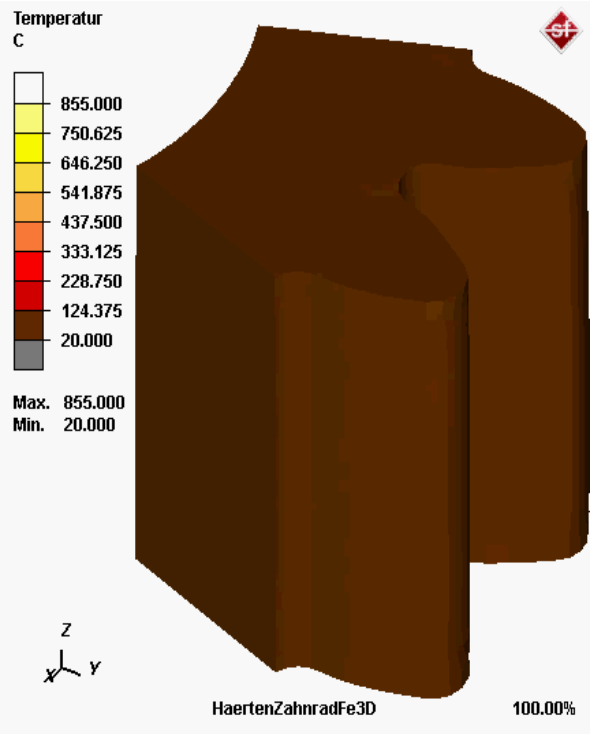
MSC Software

热处理仿真 (相变)

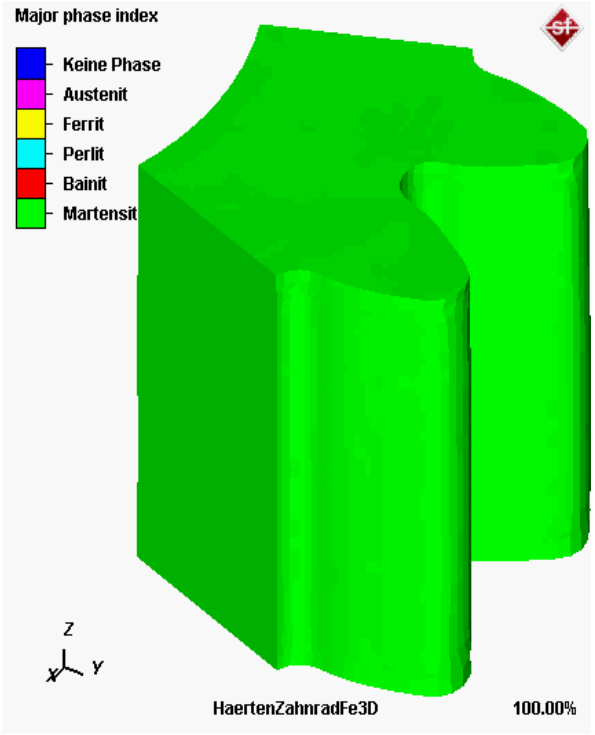
相变：齿轮强化

- 总体冷却
- 碳素钢
- 对称模型

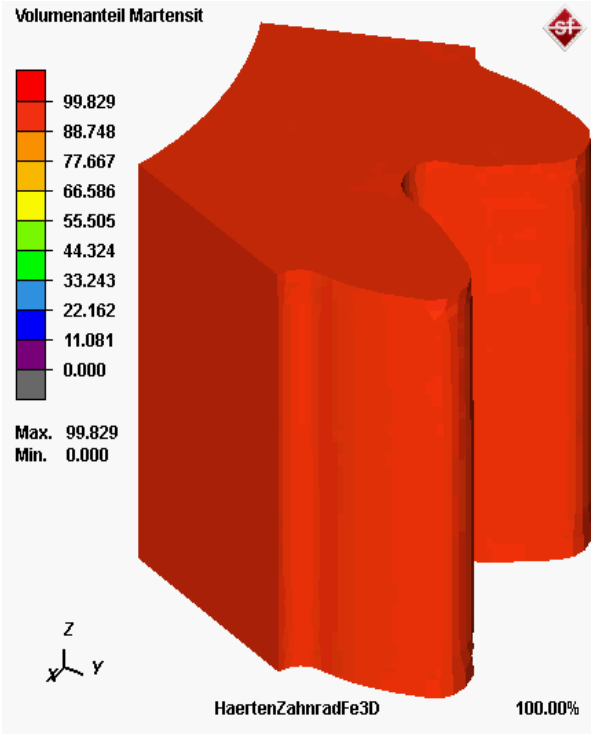
温度 [° C]



总体相成份

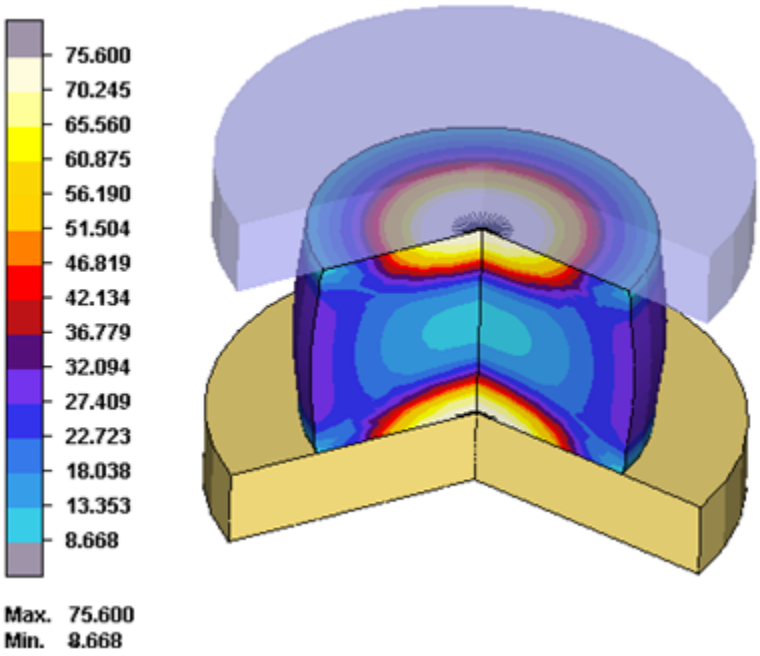


马氏体体积份数[%]

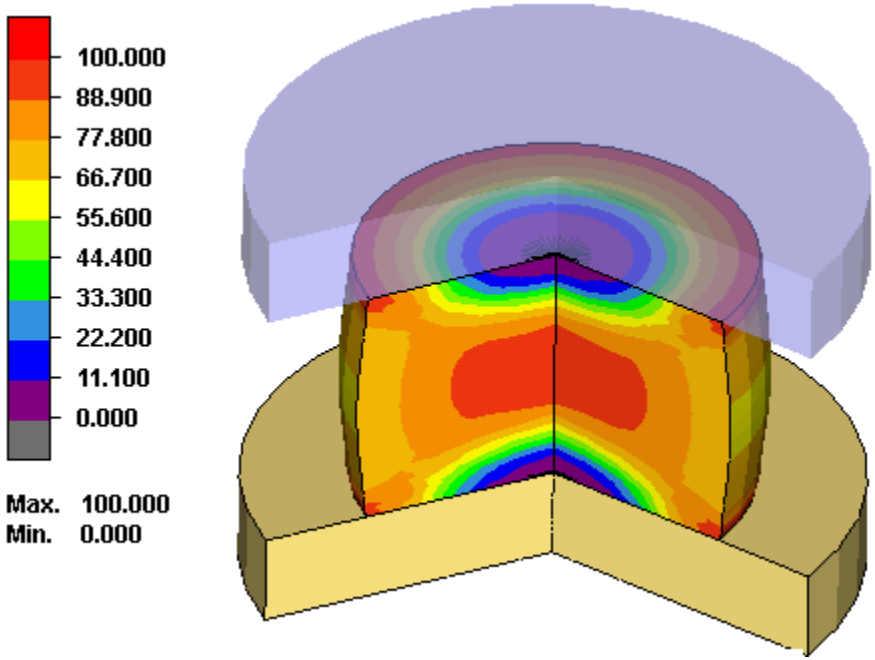


微观组织演变仿真

晶粒尺寸 [μm]

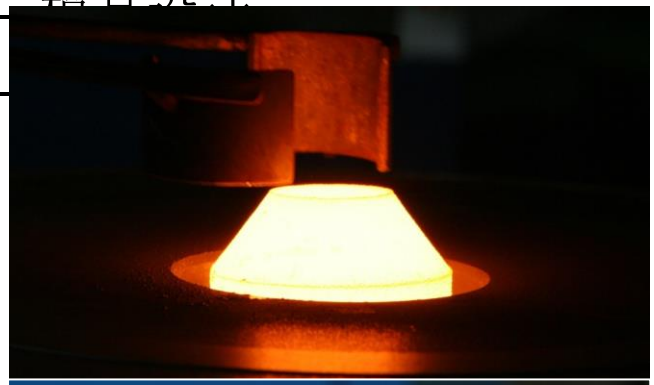


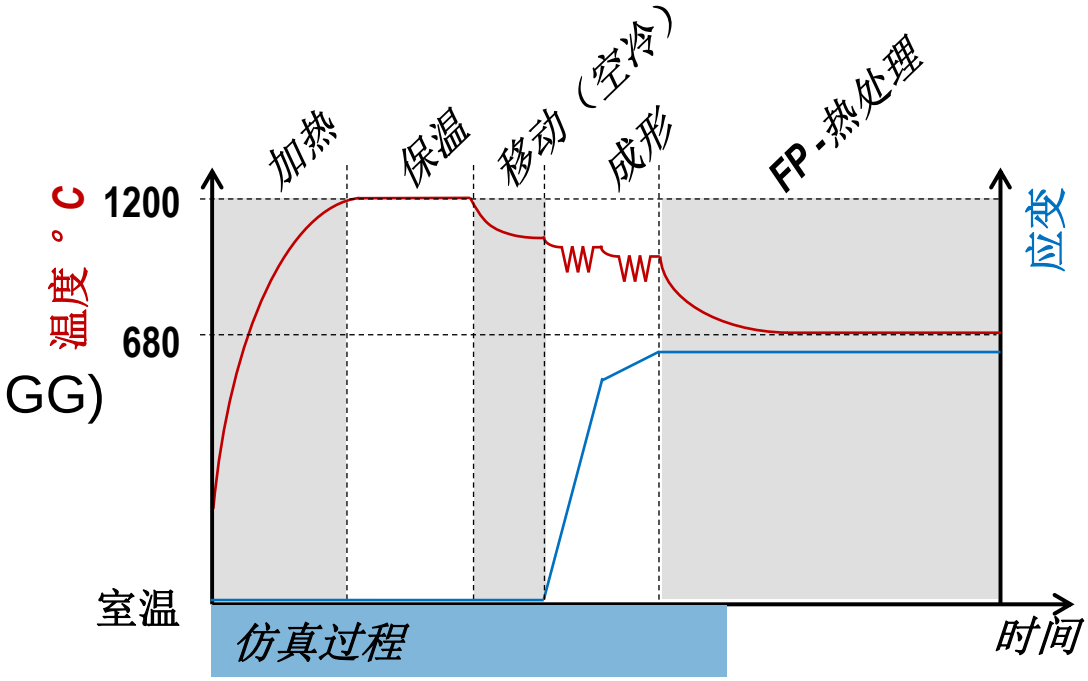
动态再结晶体积份数 [%]



热处理仿真 (微观组织演变)

- 锥形齿轮工艺设计
  - 成形工艺
  - 模具设计
  - GG)

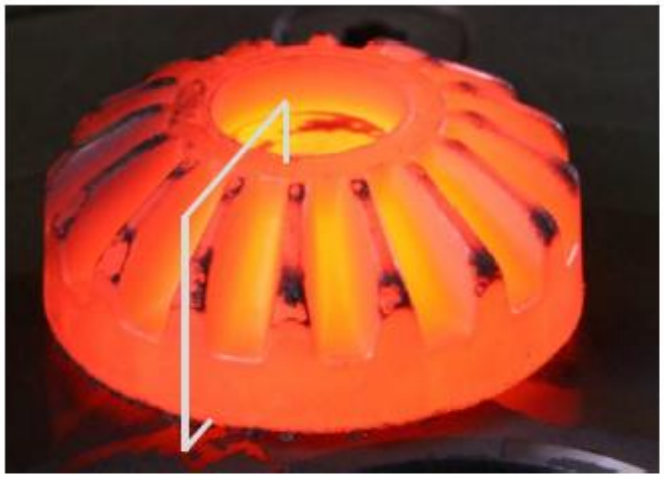


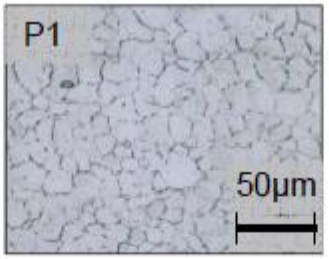


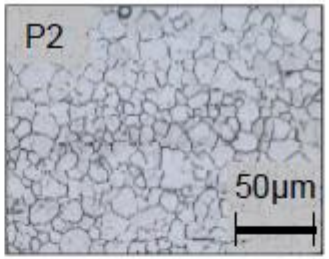
来源: IBF, RWTH Aachen

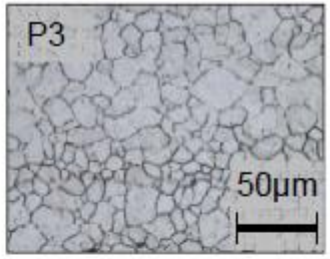
热处理仿真 (微观组织演变)

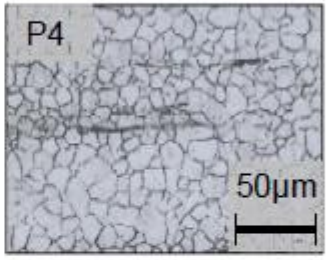
- 均匀且细致的晶粒组织分布

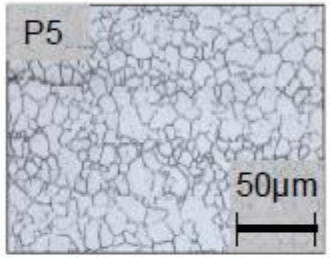


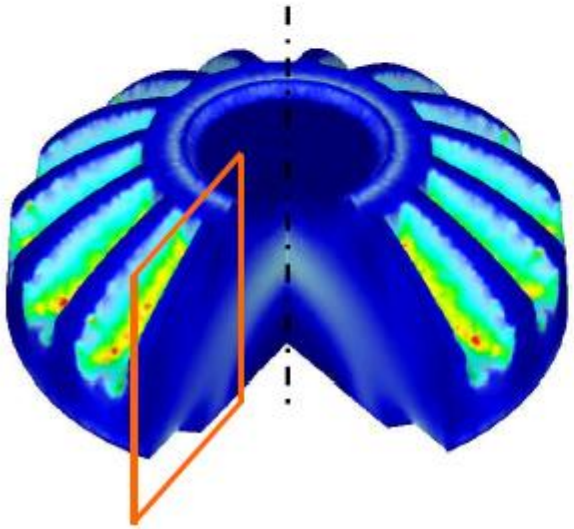


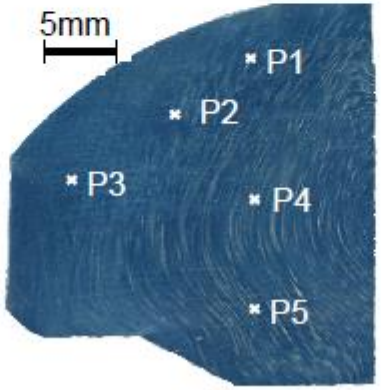










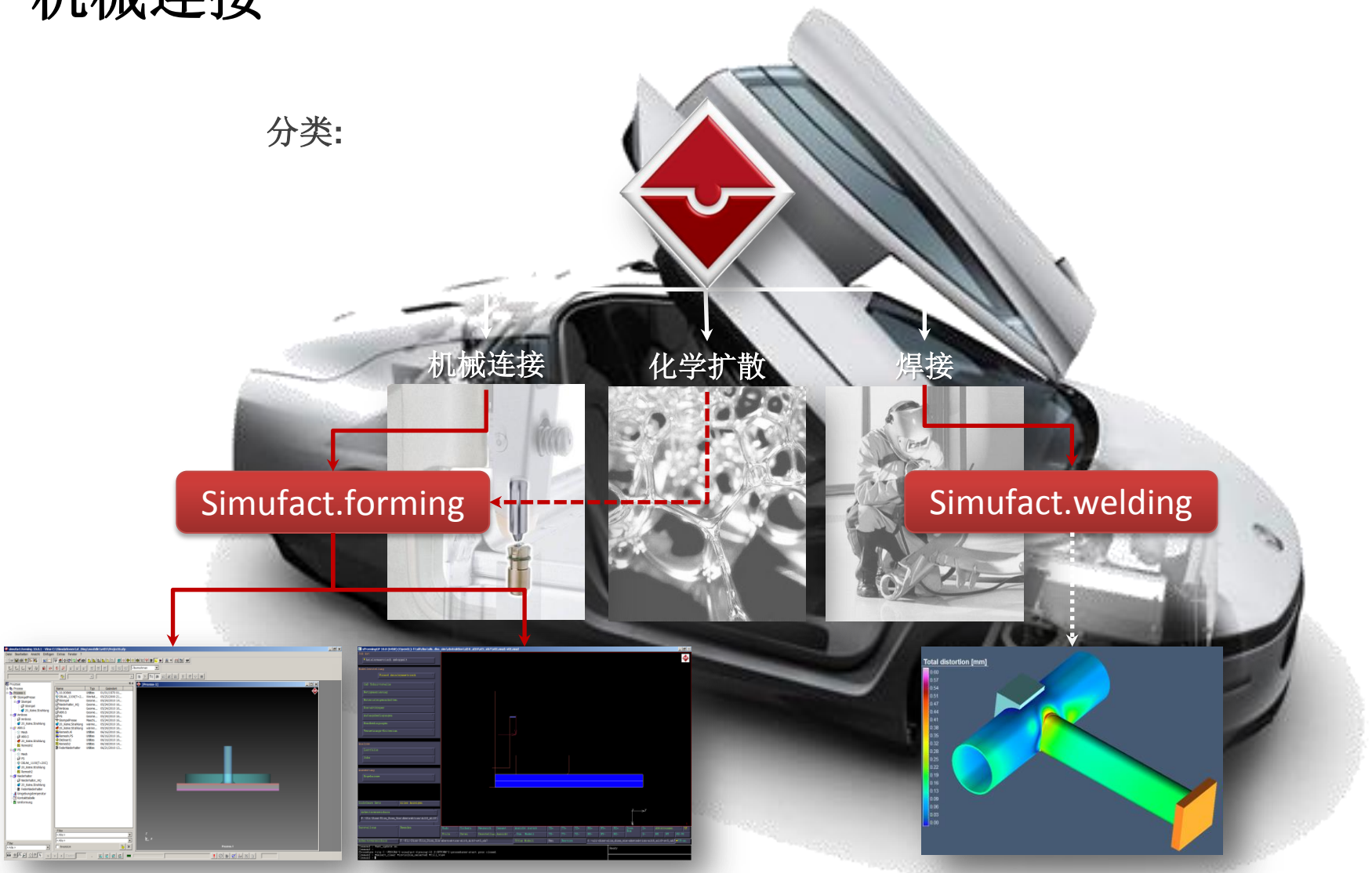


	Measured grain size in *µm*	Calculated grain size in *µm*
P1	12,3	13,6
P2	12,8	11,2
P3	12,6	10,2
P4	15,2	12,9
P5	14,2	13,4

来源: IBF, RWTH Aachen

机械连接

分类:

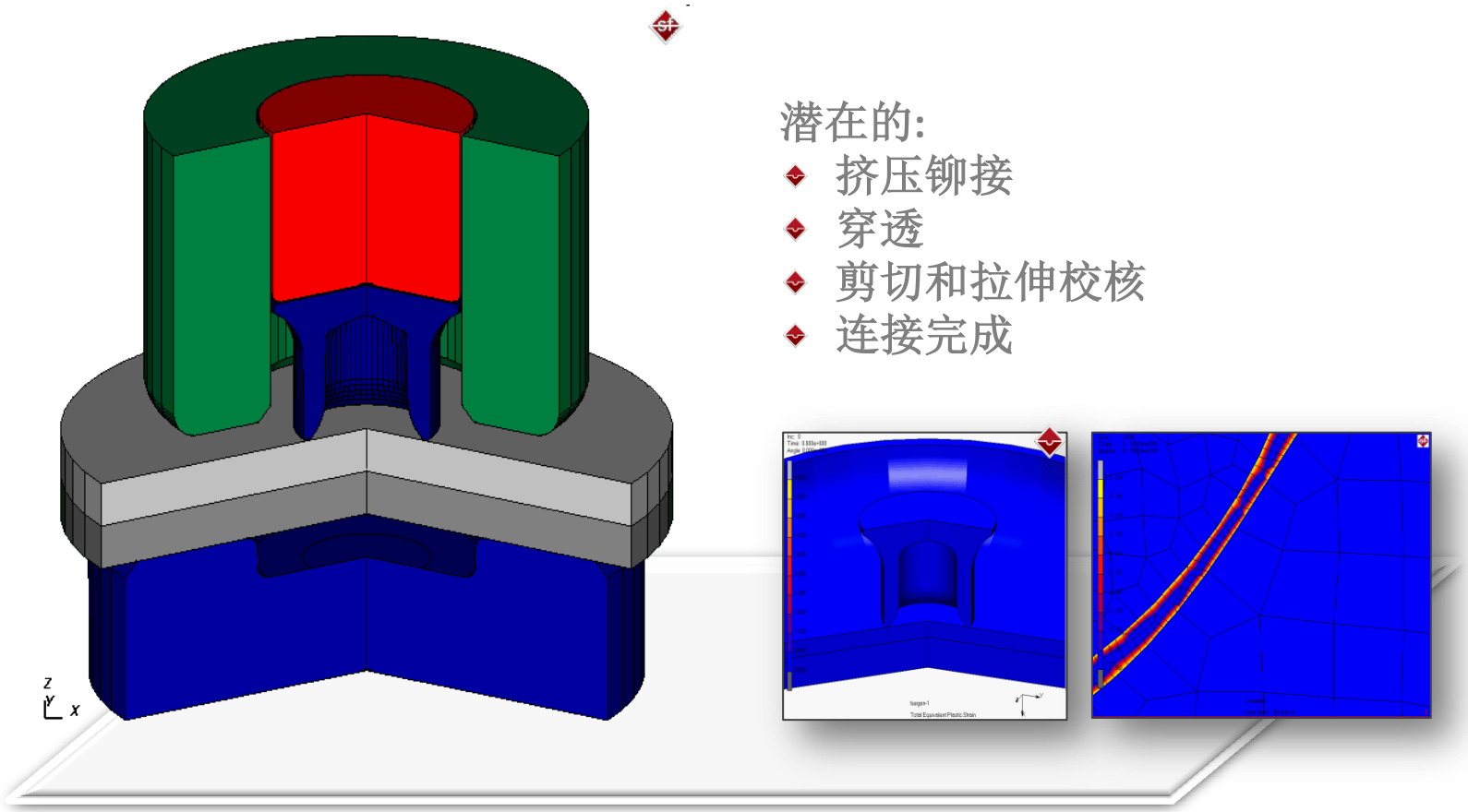


… 每种类型均有对应解决方案 …

机械连接

管状铆钉铆接

结合构件负载计算



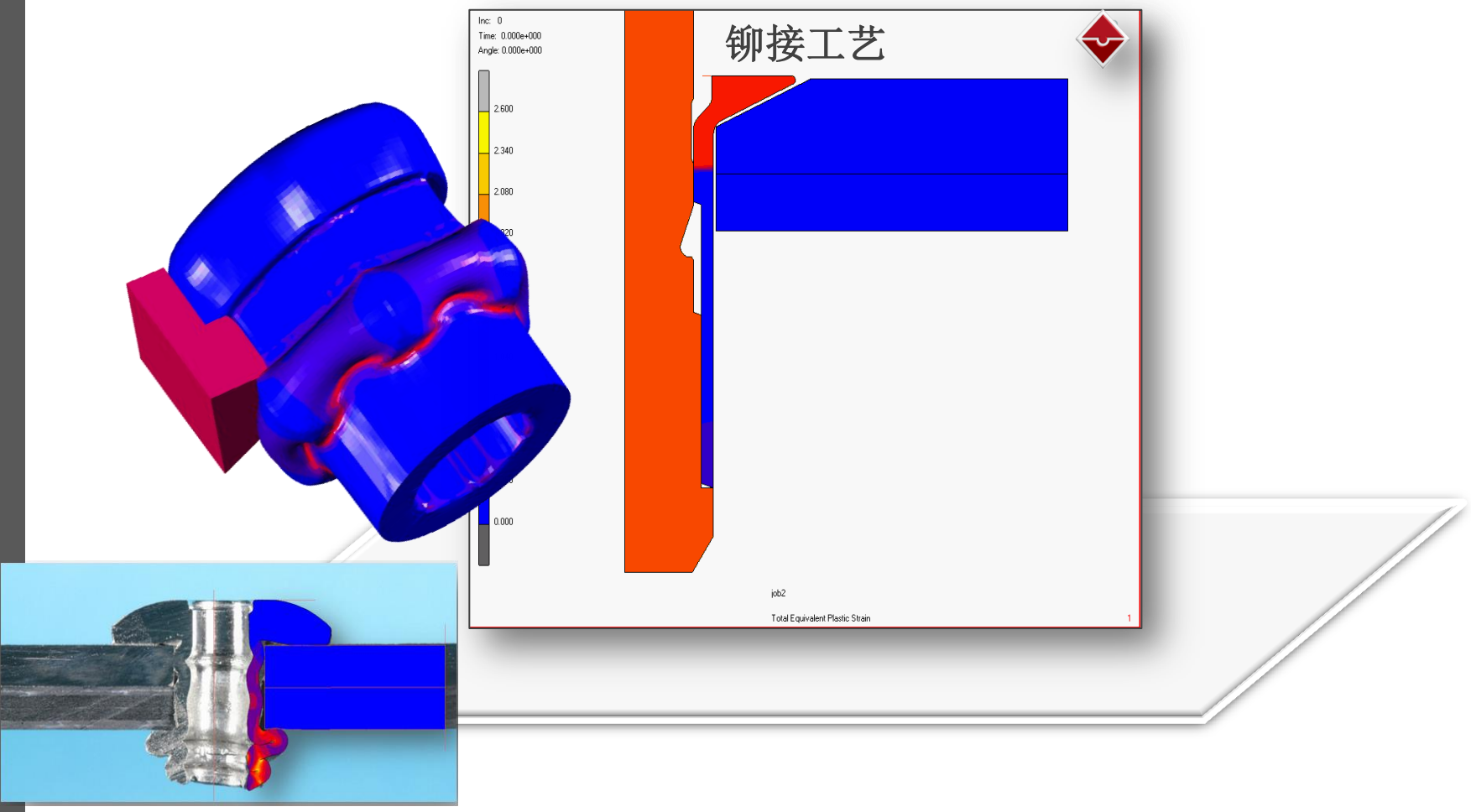
潜在的:

- 挤压铆接
- 穿透
- 剪切和拉伸校核
- 连接完成

机械连接

单面铆接

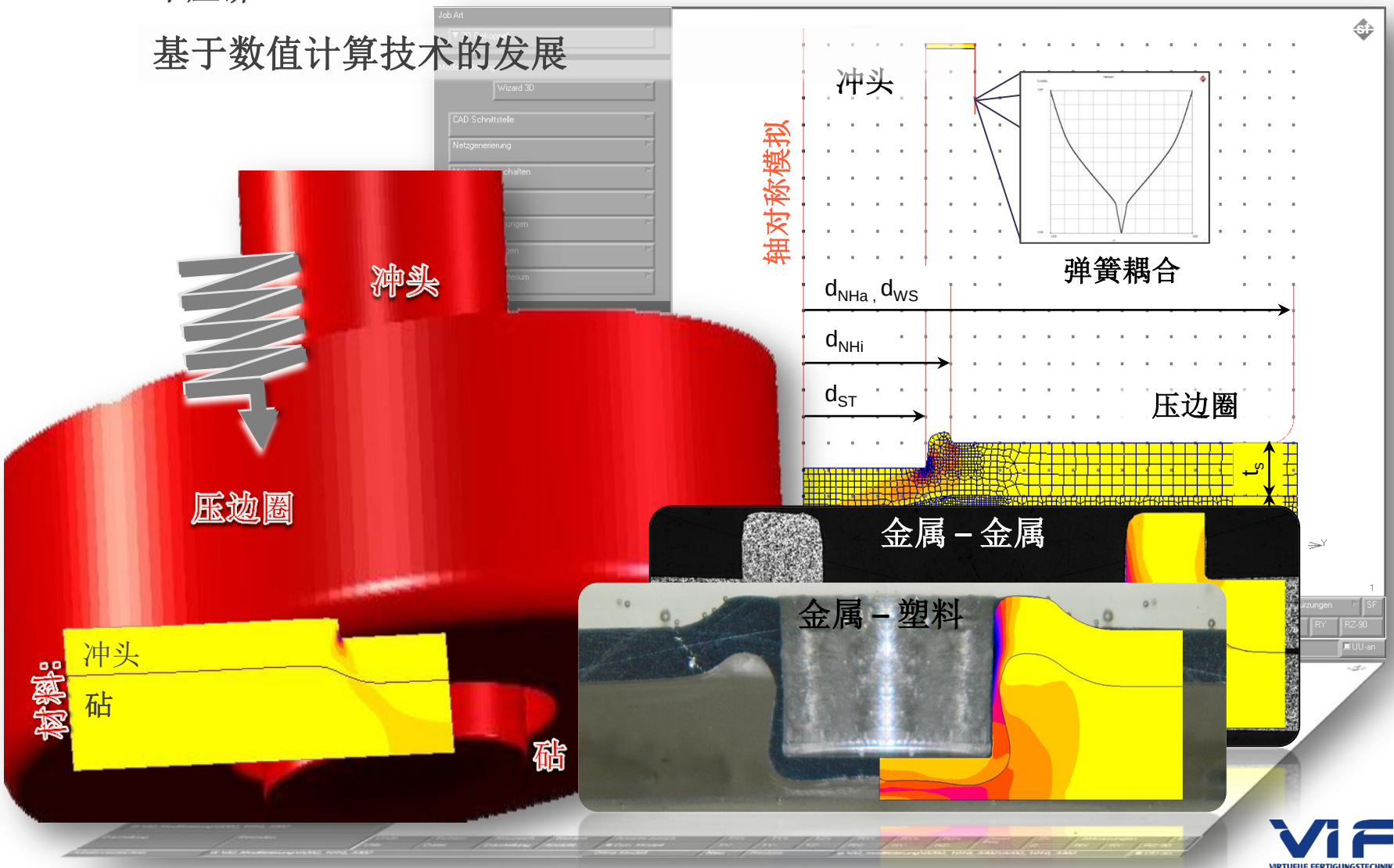
校验



机械连接

平压铆

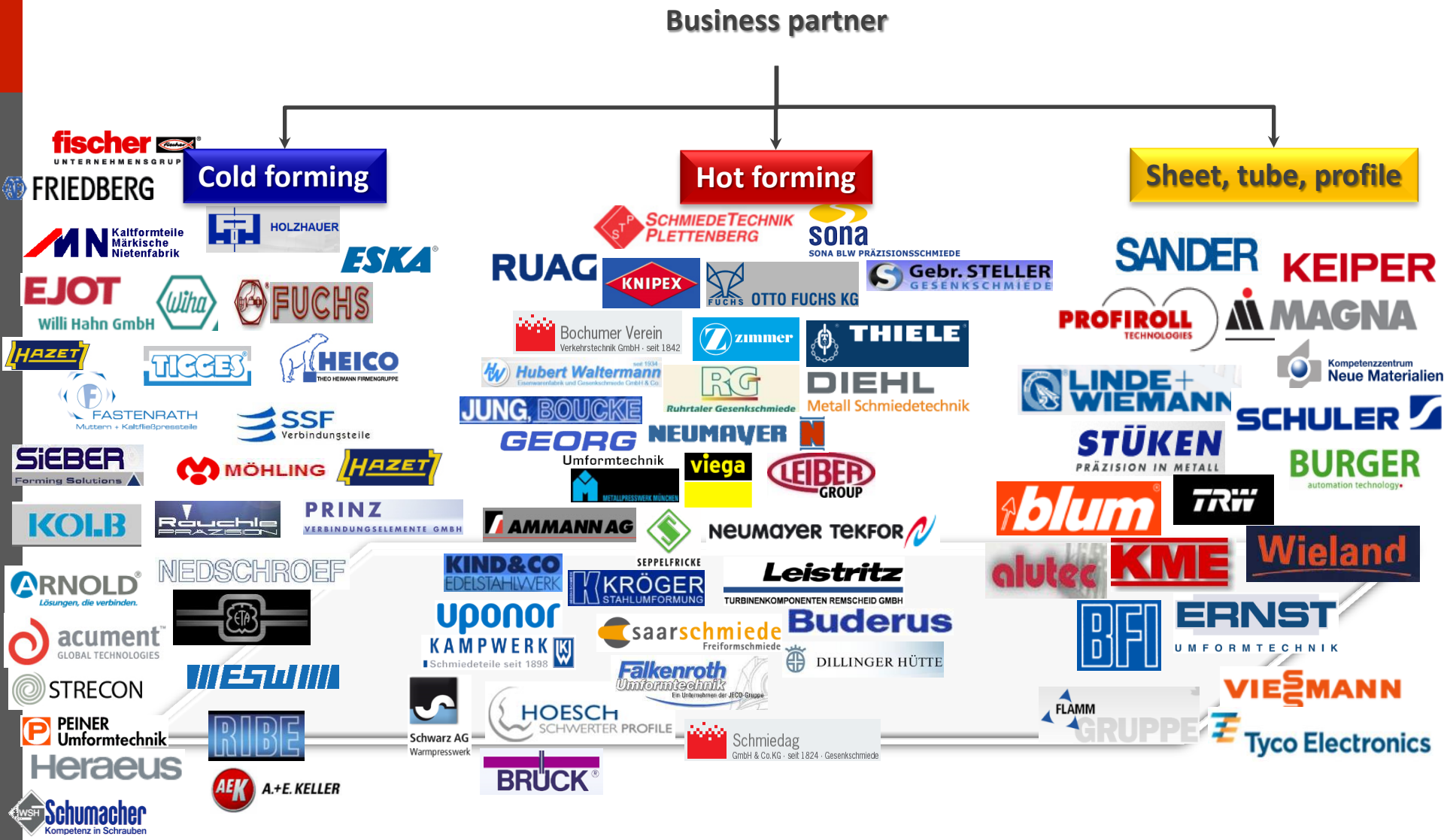
基于数值计算技术的发展



Simufact客户

Business partner → OEM`s

Simufact客户



MSC Software

Simufact合作研发机构

Business partner → Research institution

Thank You!

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