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ICSC2014



基于网格变形的优化设计工具 DEP MeshWorks/Morpher

IDAJ-China
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目录

■ Depmorpher 简介

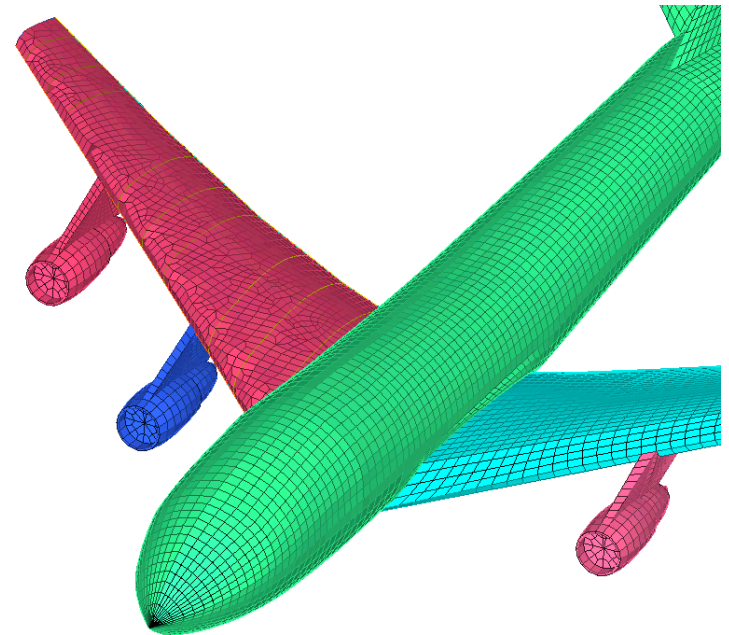
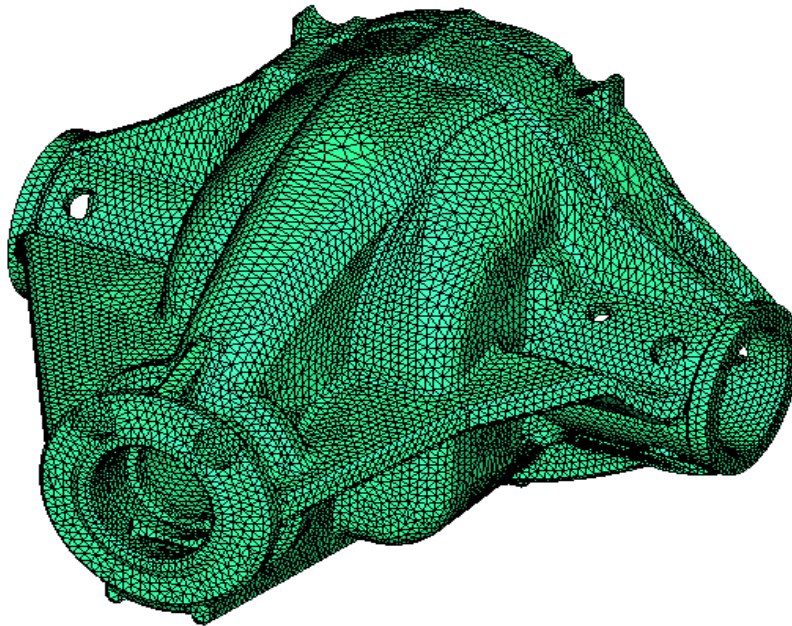
■ 案例介绍

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什么是网格变形

网格变形 (Mesh Morphing)

——不需要改动CAD模型，直接改变网格形态



用户需求

不同设计参数对比计算需要不同外形的网格模型
产品改进提高性能需要计算不同外形的模型
产品探索获取产品知识需要计算不同外形的模型

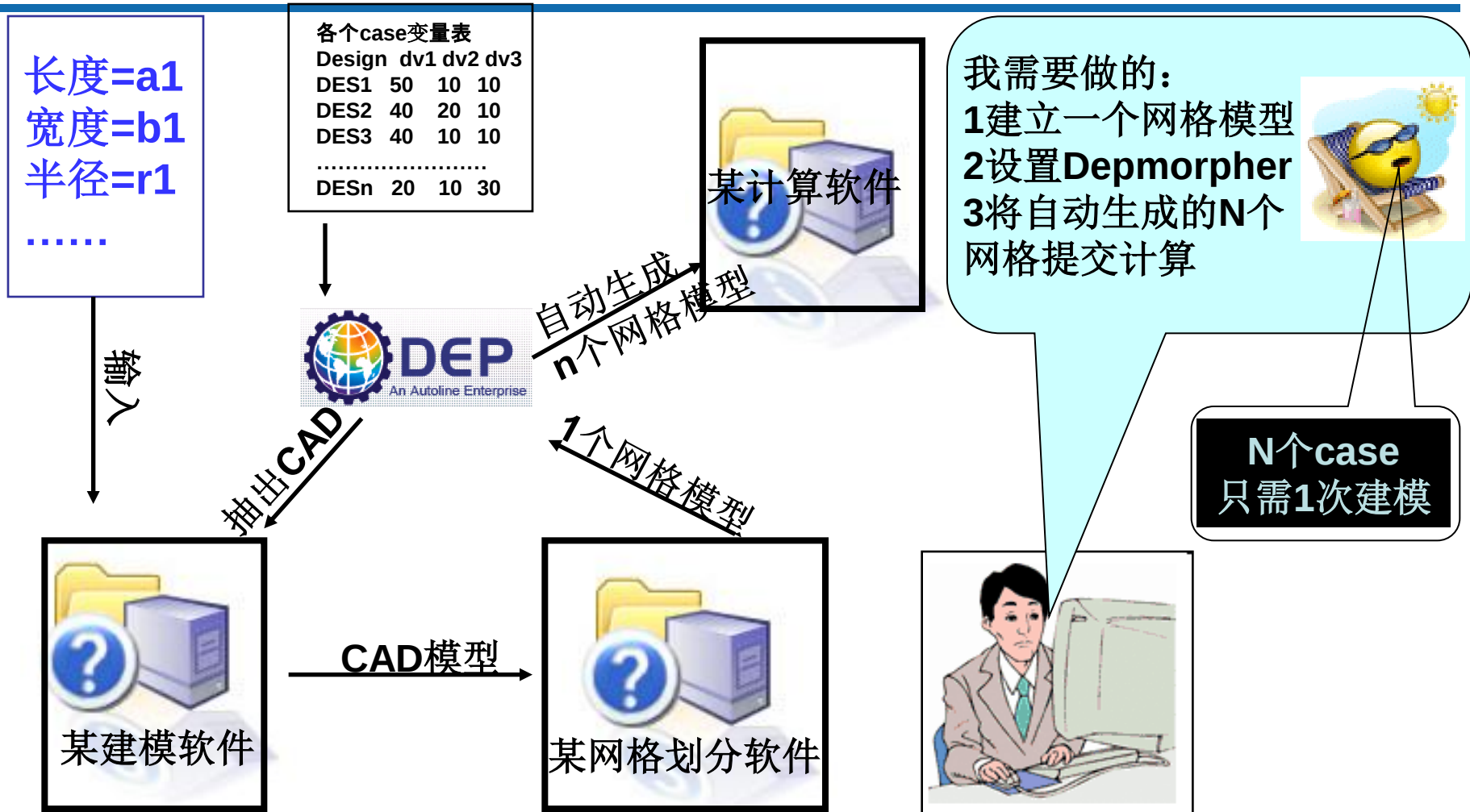
面临的问题

CAD模型改变再重新做网格很麻烦

设计部门与模拟部门需要多次互传信息，增加管理成本

CAD模型很难改变的情况如何改变网格模型形状
只有网格模型，没有CAD模型的情况，如何改变网格模型形状

使用Depmorpher解决问题！

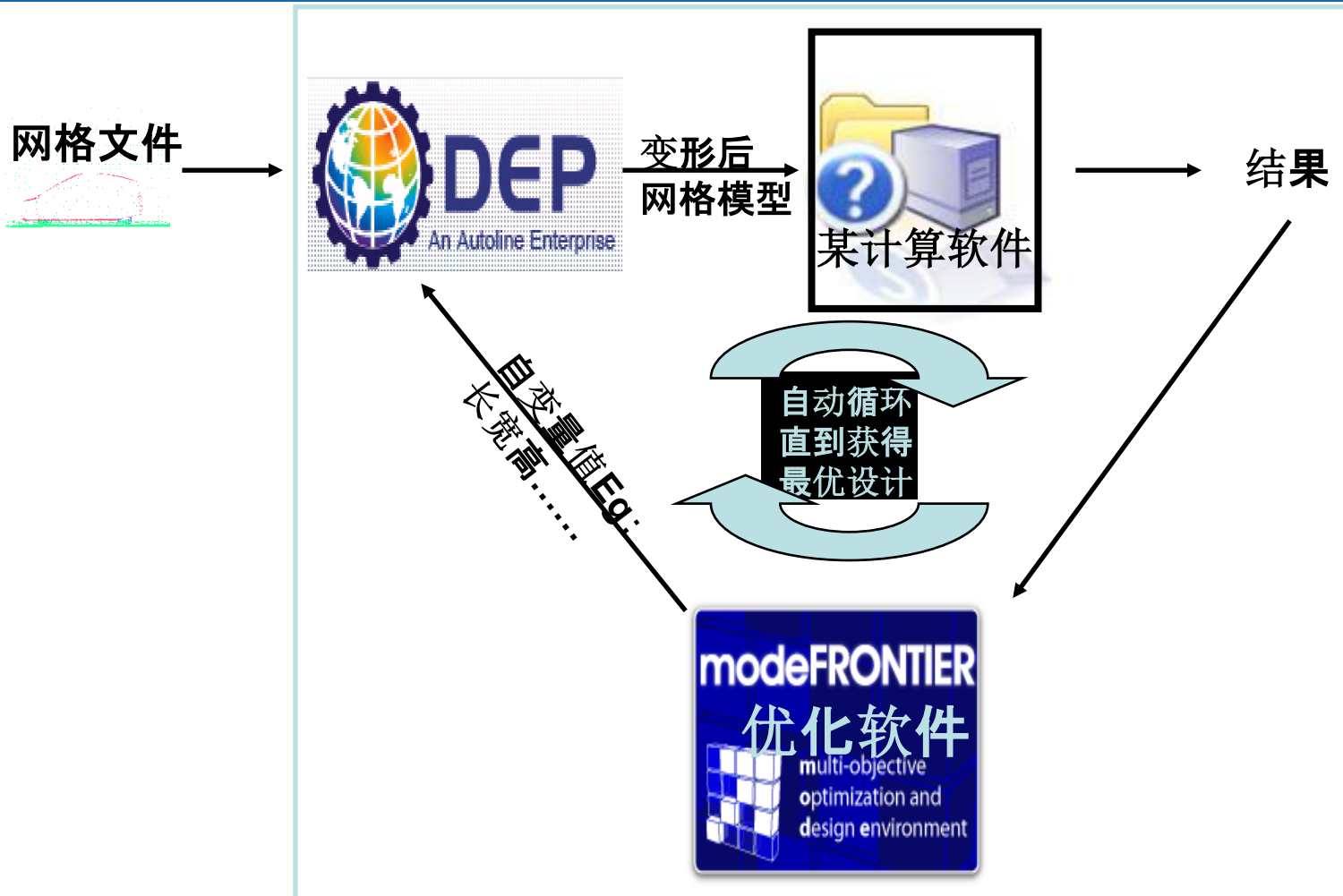


使用Depmorpher配合优化软件

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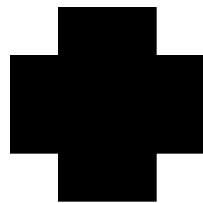
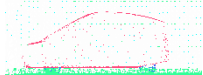


使用Depmorpher解决问题——总结

由一个网格模型方便生成多种形状的网格模型

Depmorpher直接对网格进行操作实现模型参数化+自动化

网格文件



自动化的
参数化的
网格模型

开发商DEP (Detroit Engineered Products Inc.)

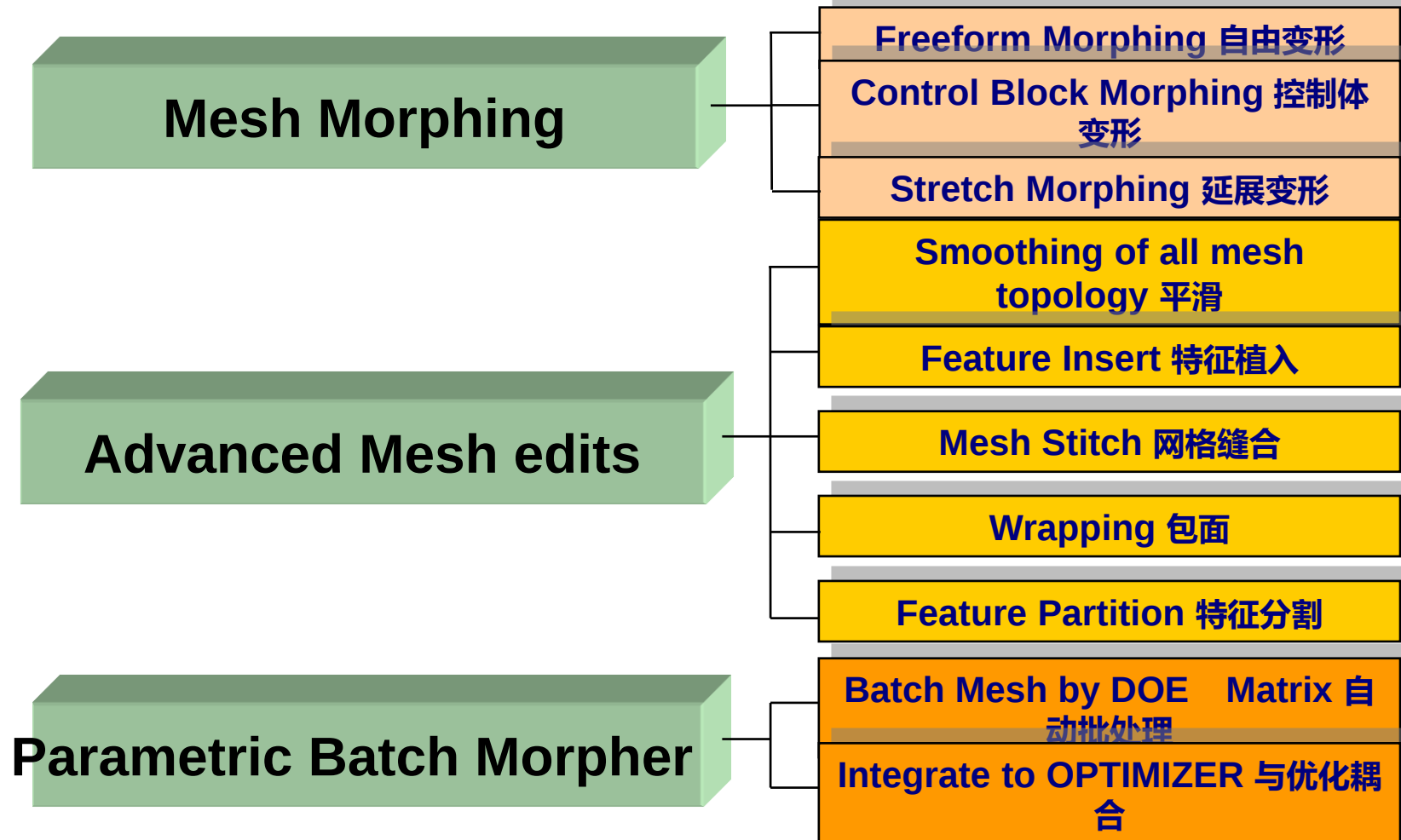
Detroit Engineered Products Inc.

- Main Office : Troy, MI
- Office : San Francisco , India
- Incorporated in 1994
- CAE & Design Consulting , Software Development
- Significant customers include:
 - General Motors, DaimlerChrysler, Ford, Delphi, Visteon, Magna-Drivetrain, Borg Warner, Krupp-Fabco, . . .
 - Aisin, Casio, Hitachi, Hitachi Construction Machinery, Hitachi-koki, Honda, Isuzu, Mitsubishi, Mazda, Nissan, Suzuki, Tokai-Rika, Toyota, YKK, Yokohoma-Rubber, Yumex . . .
 - Mobis, Hyundai, Ssangyong, Samsung , . . .
 - AIRBUS, LMS, Opel, Peugeot, Renault , . . .

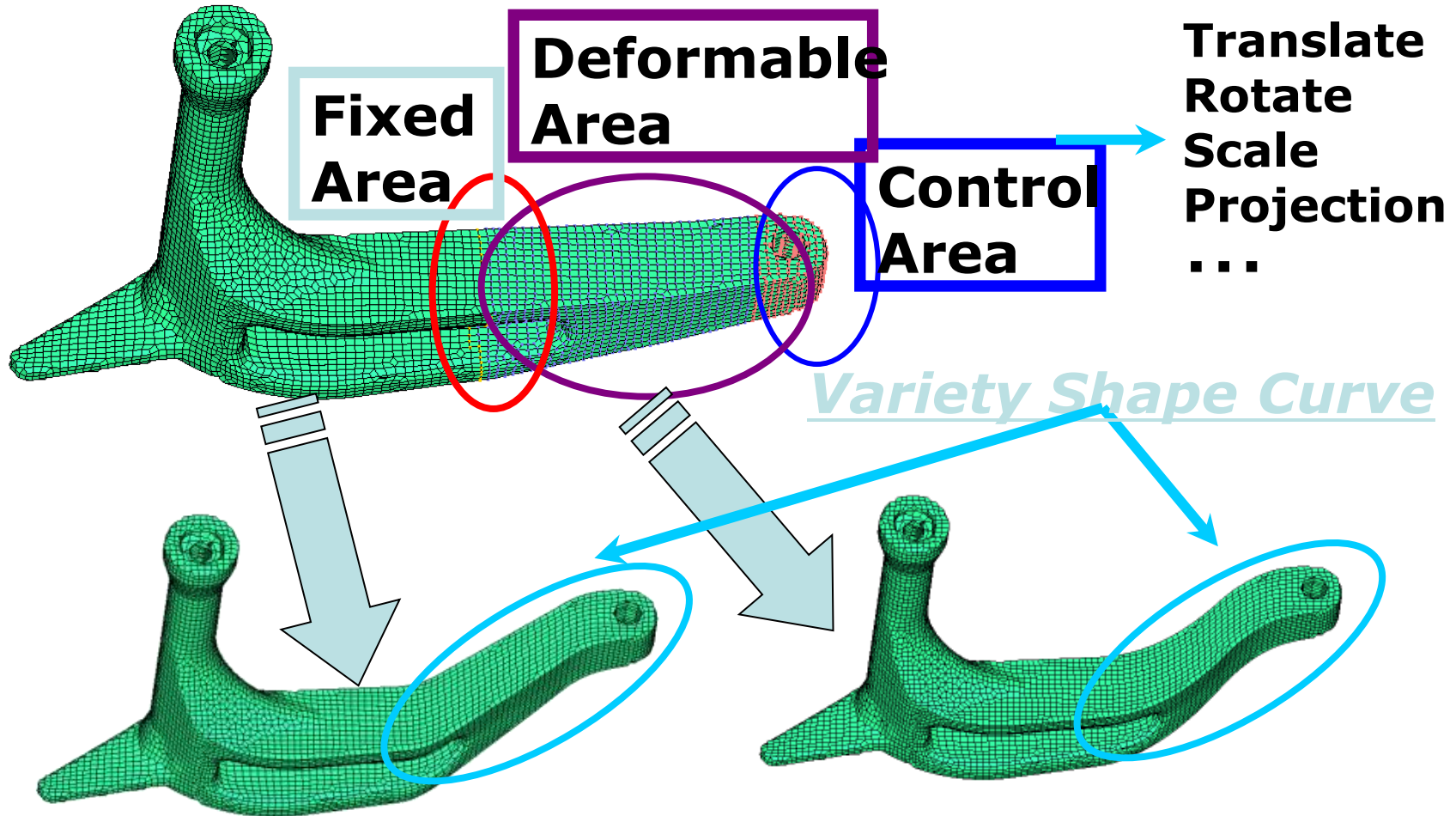


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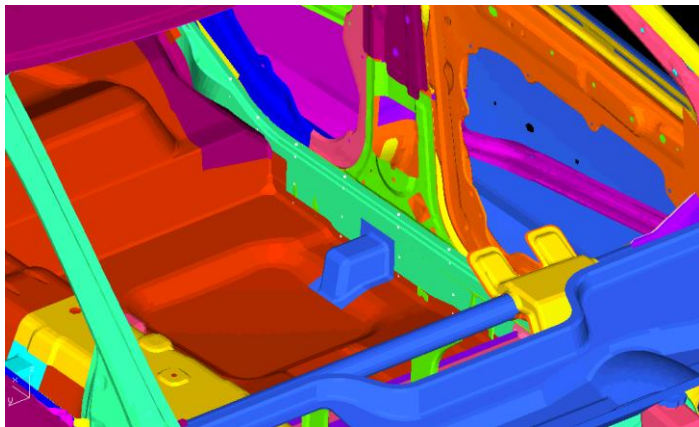
DEPMorpher主要功能



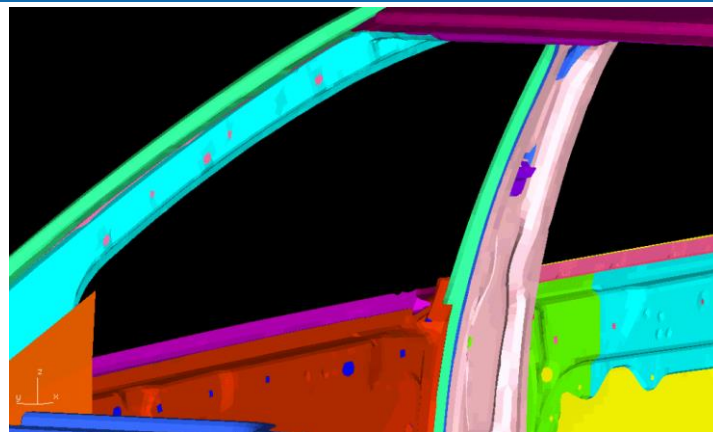
自由变形



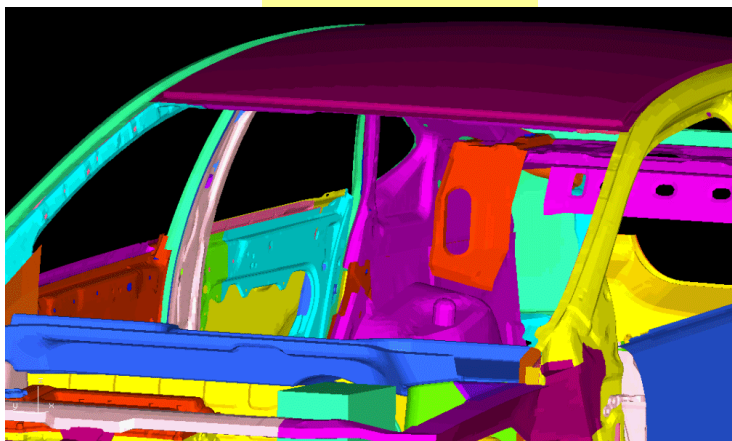
整车变形



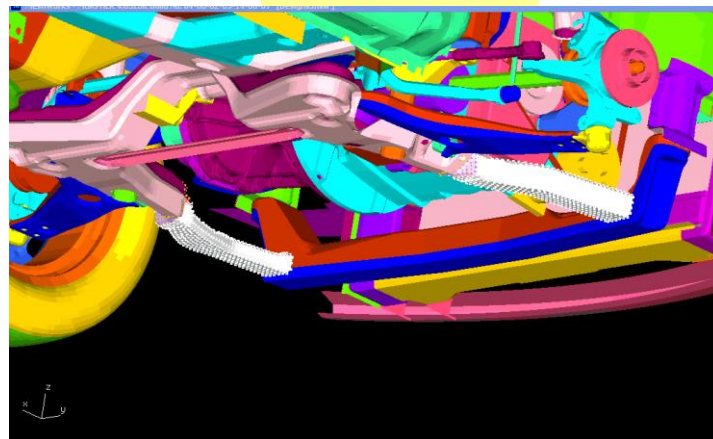
Rocker Width



B pillar shape



WindsShield Angle

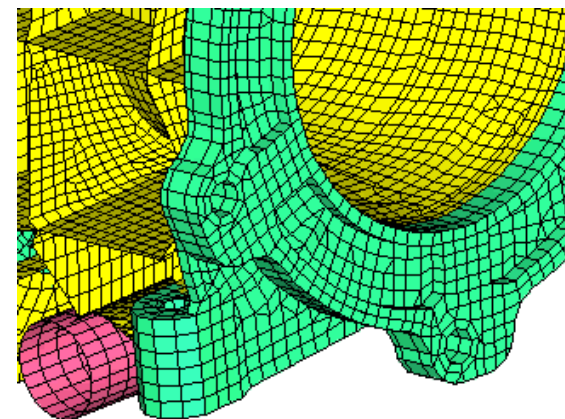
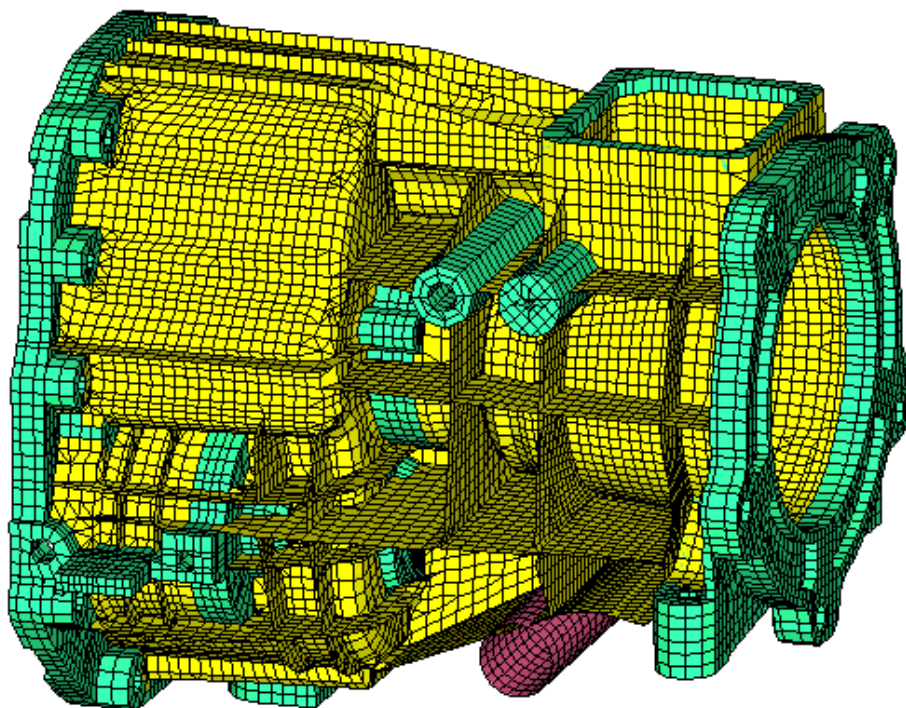


Sub frame shape

变速器壳体变形

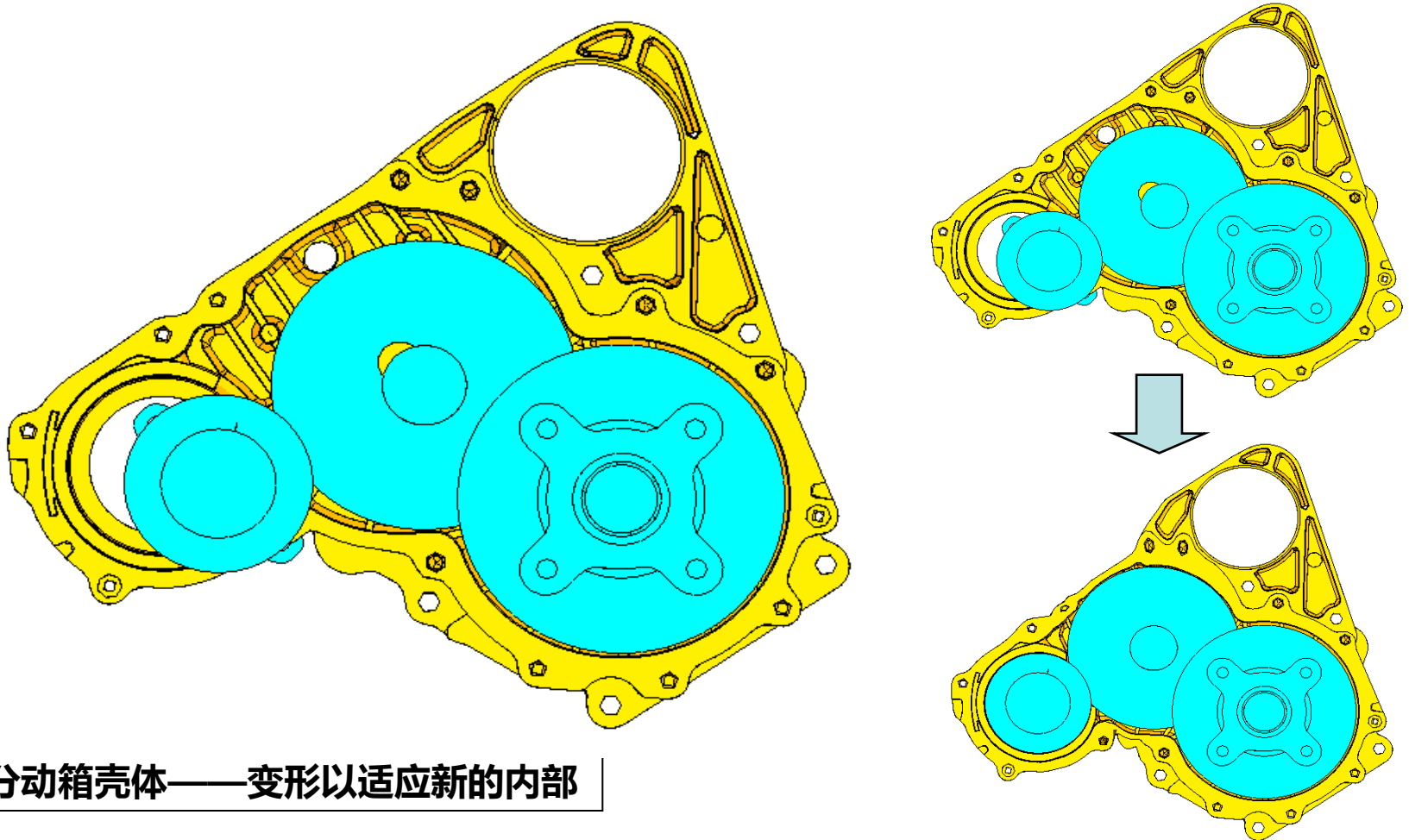
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目标：对变速器壳体网格进行变形，改变其长度



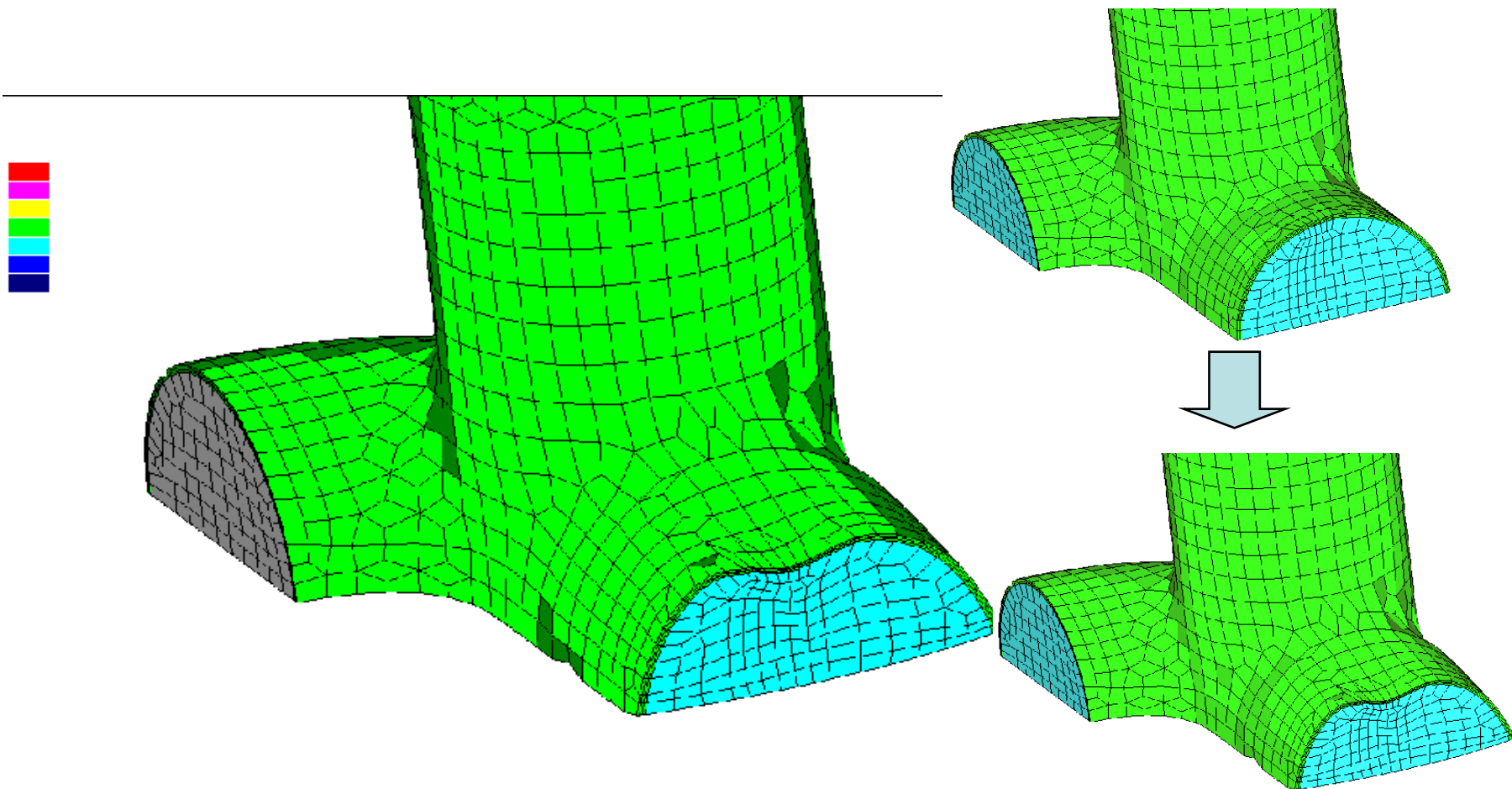
分动箱壳体变形

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分动箱壳体——变形以适应新的内部

管道流动CFD模型变形至新几何

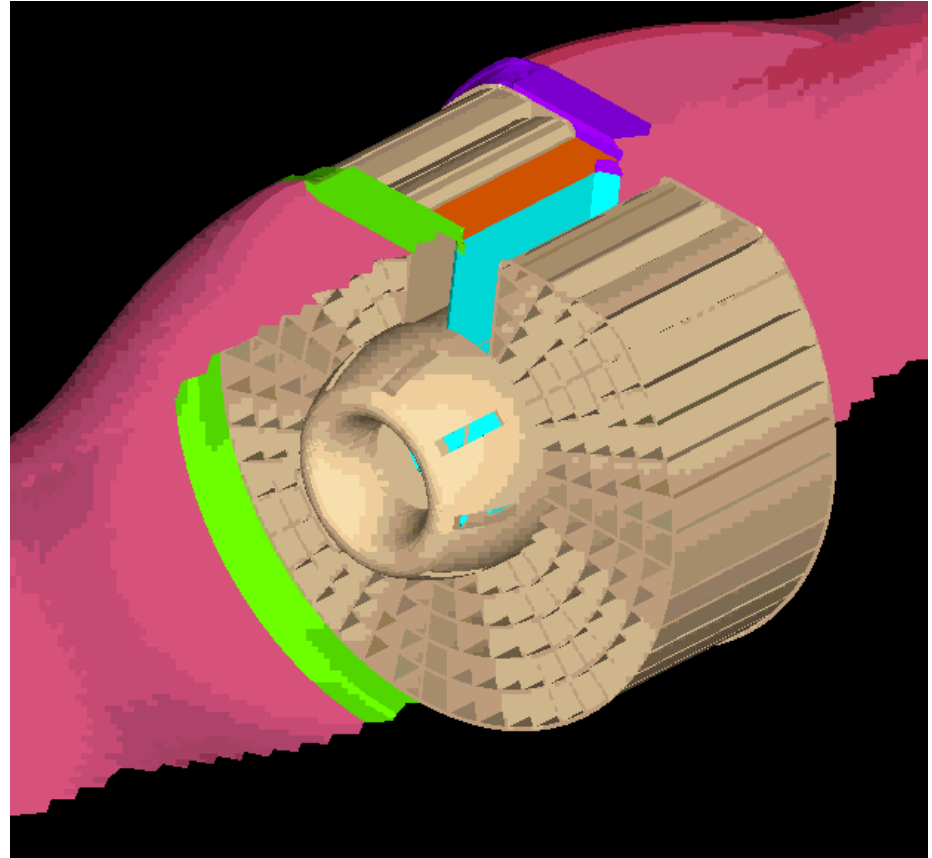


参数化CFD模型- 内流

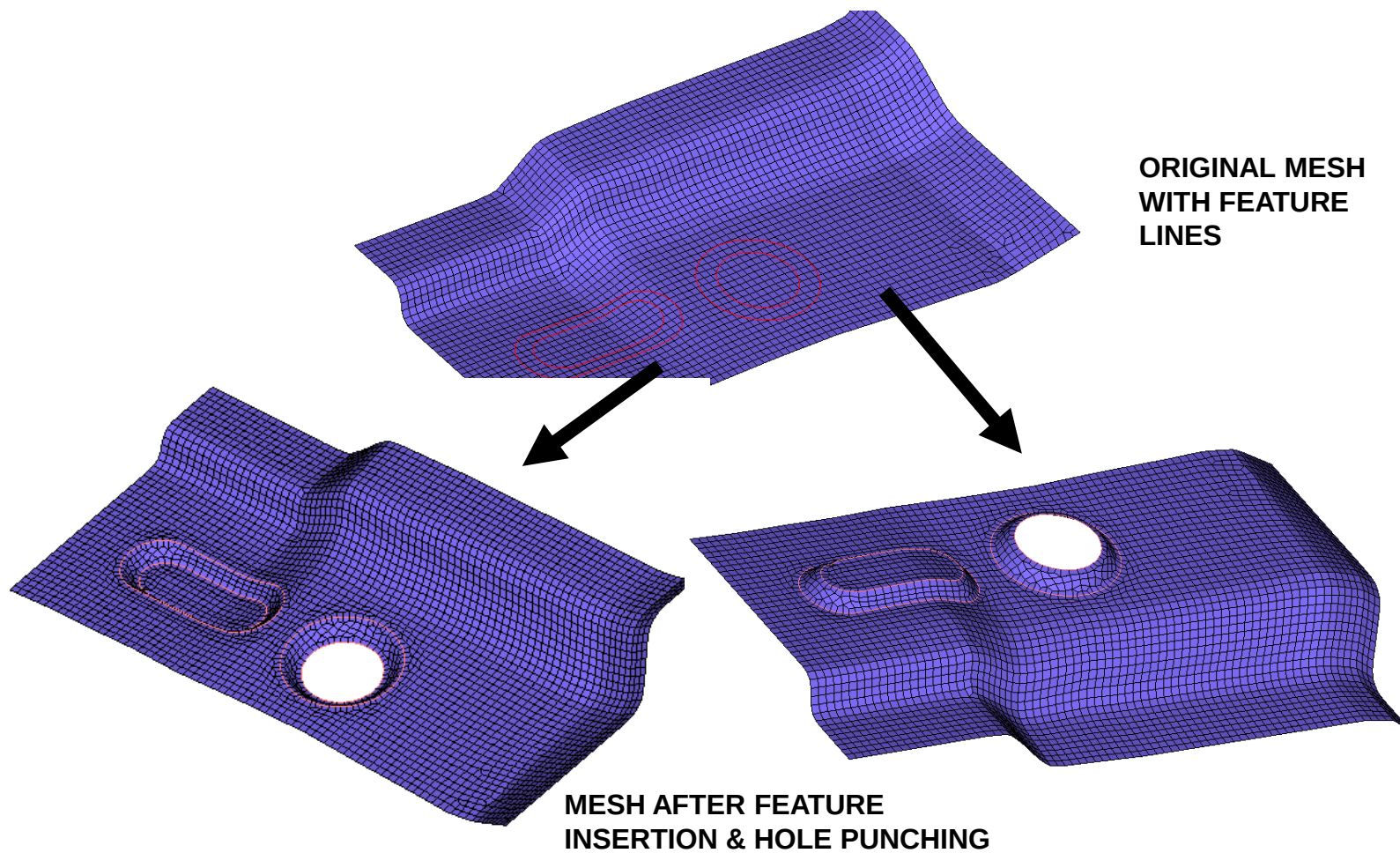
Parametric FLUENT CFD MODEL

Shown here are the following parameters:

- Length of inlet nozzle
- Diameter of inlet nozzle



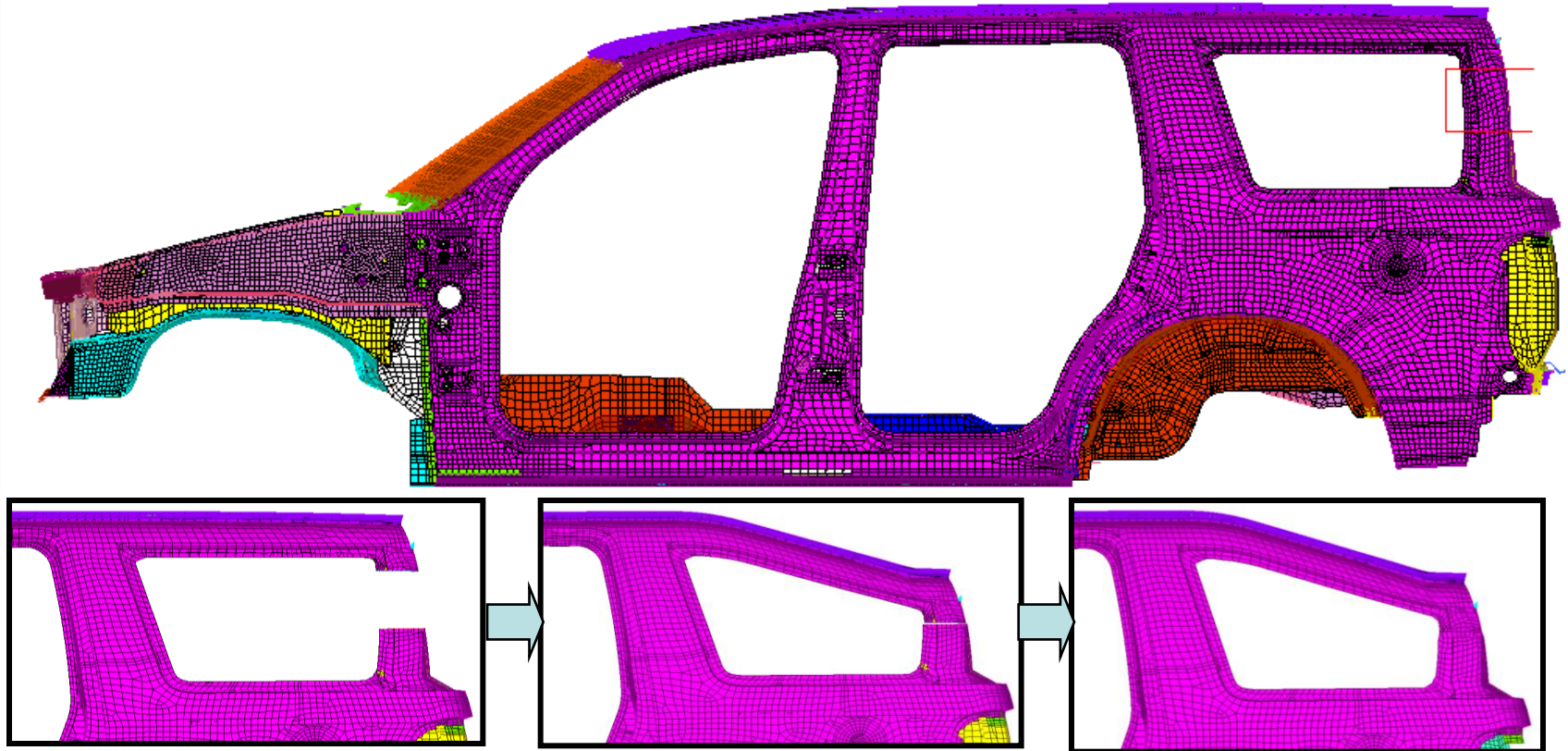
特征植入&打孔



快速模型加工

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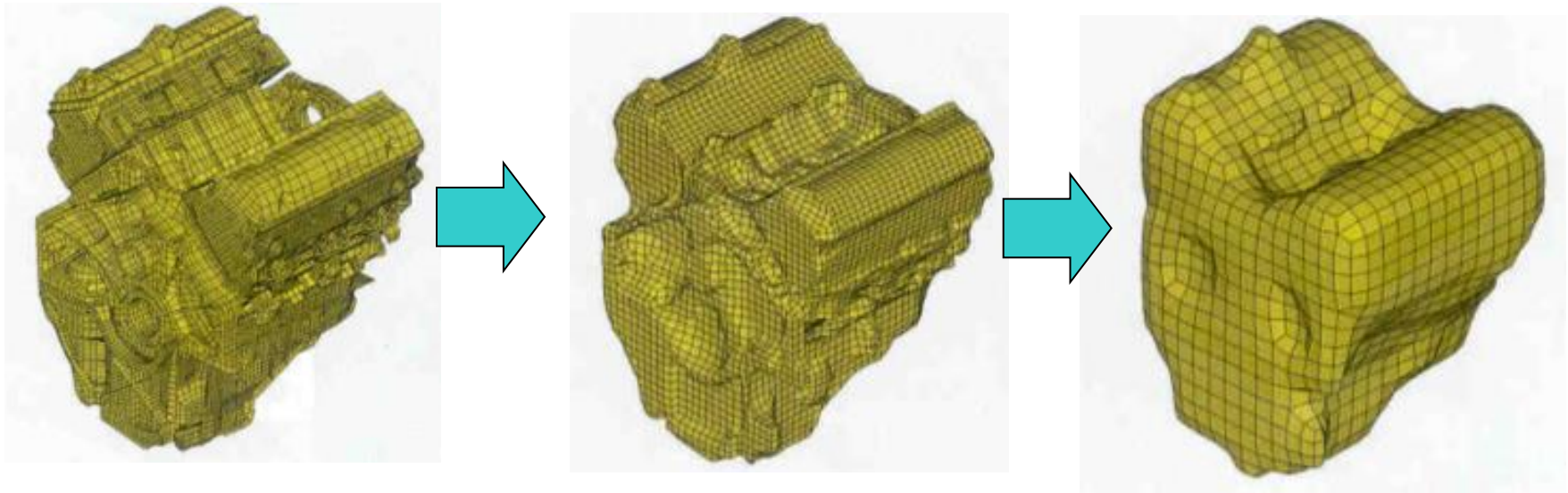
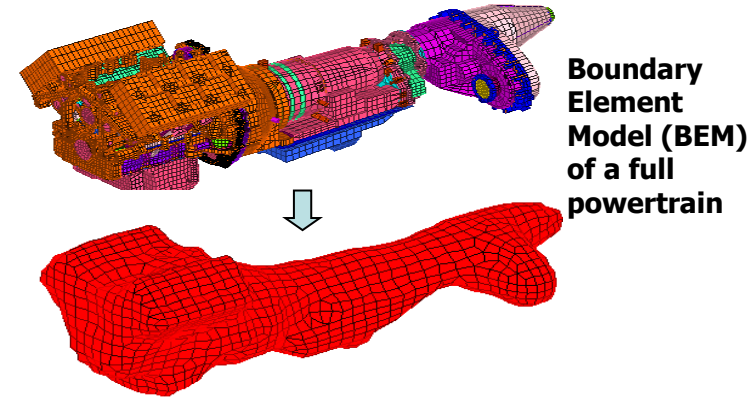
- 切割、变形及粘合



网格包面

Wrapper Mesh

- Sounds Simpler
- Shape simplification
 - Example : EngineBlock

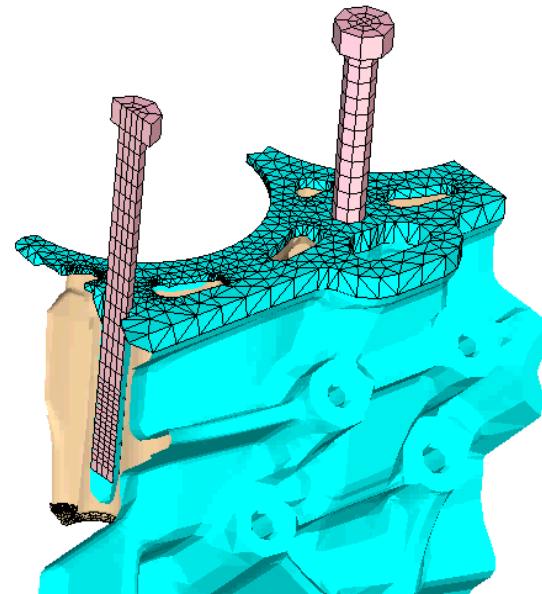


通过DOE参数表直接生成网格模型

- Direct Mesh model generation from DOE matrix

- DEP Parametric model(xxx.msw)
- DEP Batch Morpher file(xxx.bat)
- DOE Matrix file

Design	dv1	dv2	dv3
DES1	10	5	12
DES2	5	10	5
DES3	1	6	10
DES4	6	2	5
DES5	10	10	12
DES6	4	6	1
DES7	8	2	1
DES8	10	3	6
DES9	1	2	2



```
set DEPMORPHER30_HOME=C:\apps\dep
set PATH=%PATH%;%DEPMORPHER30_HOME%\Morpher3.1\LIB
%DEPMORPHER30_HOME%\Morpher3.1\utils\Parametric_batch\consolemorpher.exe inmani.msw inmani_b.bdf dep_input.txt "
nastran single sen.txt n
```

总结

- DepMorpher能与典型的CFD，FEA等软件联合起来进行网格变形与调控，从而不需要反复修改CAD模型，也不需要反复做网格
- DepMorpher的网格变形类型广泛而灵活，控制功能成熟有效，极大地改善了常规CAE设计研发流程，在CAE研发需要快速论证阶段发挥了显著作用
- DepMorpher特有的参数化建模和批处理功能，拓宽了DepMorpher的参数化寻优设计领域，与modeFRONTIER配合优化效果更佳
- 适用于需要对产品不同外形进行分析的场合，包括FEM、CFD等等



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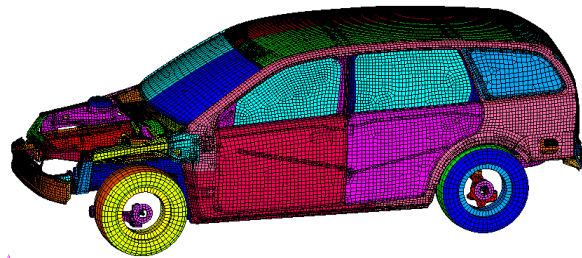
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案例介绍

- 通用公司汽车DepMorpher网格变形案例
- 汽车外气形优化案例
- 汽车前保险杠优化设计

通用公司汽车DepMorpher网格变形 案例

通用公司汽车案例（without DepMorph）



① Vehicle styling theme design
•CAD design of new vehicle styling
6 man months

① Computer Aided Design (CAD)
•Generation of initial design
80 man months

② Preprocessor
• Finite Element Model (FEM) creation
• CFD model creation
8 man months

**OVERALL TIME
TAKEN BEFORE THE
FIRST CAE RESULTS
CAN BE PROVIDED =
95 man months**

⑥ Design Improvement
•Update CAD model
10 man months

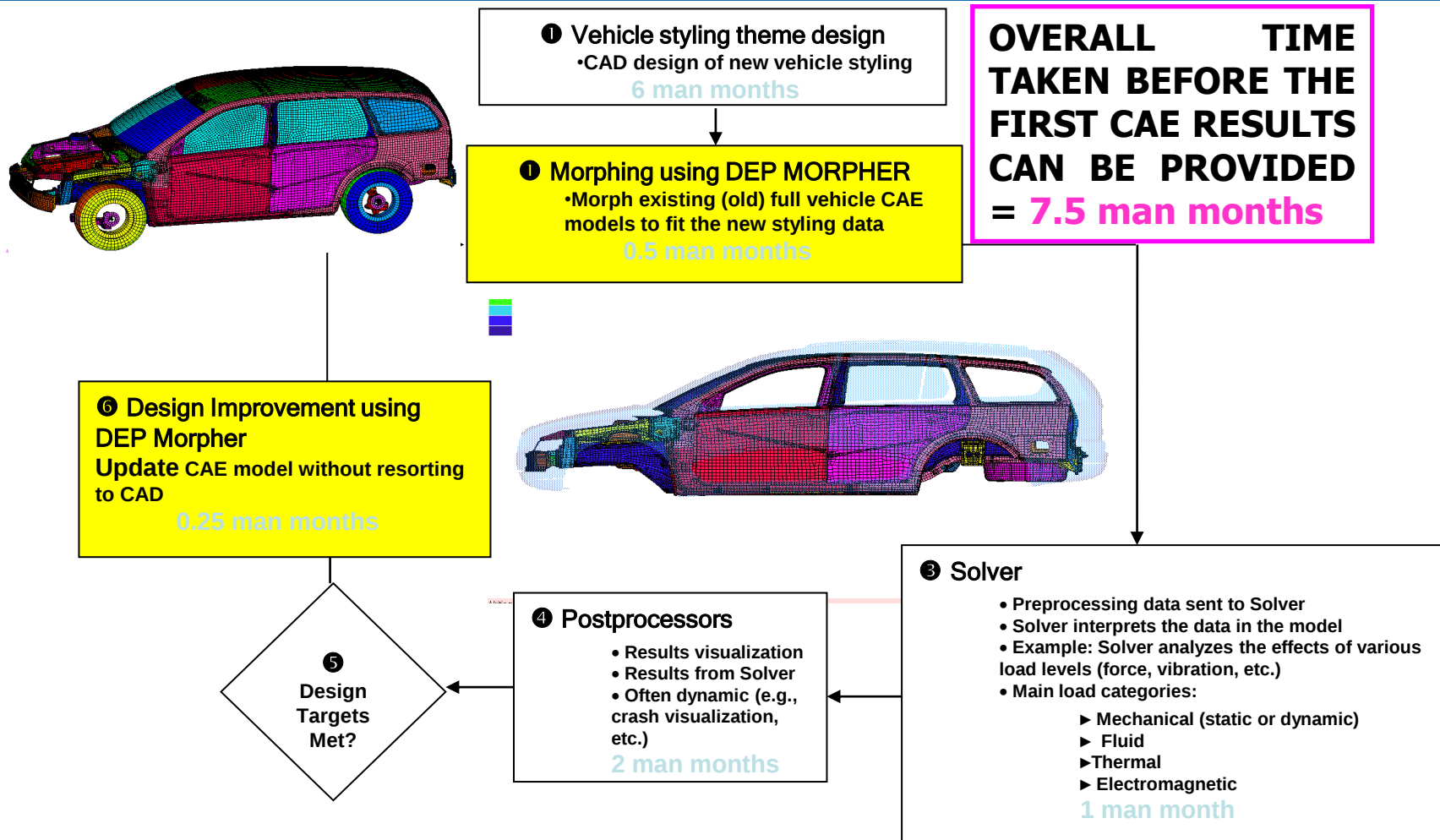
④ Postprocessors
• Results visualization
• Results from Solver
• Often dynamic (e.g.,
crash visualization,
etc.)
2 man months

③ Solver
• Preprocessing data sent to Solver
• Solver interprets the data in the model
• Example: Solver analyzes the effects of
various load levels (force, vibration, etc.)
• Main load categories:
 ▶ Mechanical (static or dynamic)
 ▶ Fluid
 ▶ Thermal
 ▶ Electromagnetic
1 man month

⑤
Design
Targets
Met?

Stop

通用公司汽车案例 (with DepMorph)



汽车外气形优化案例

(DepMorpher, STAR-CD, ModeFRONTIER,
IcemCFD)

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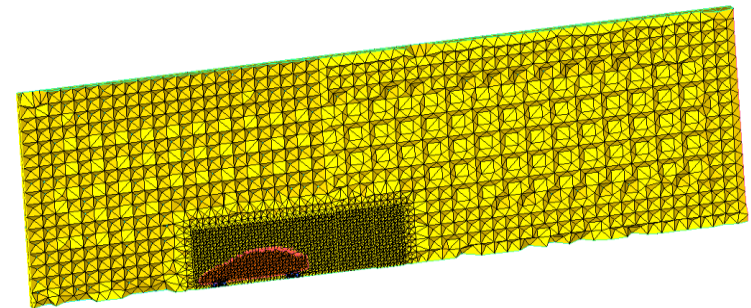
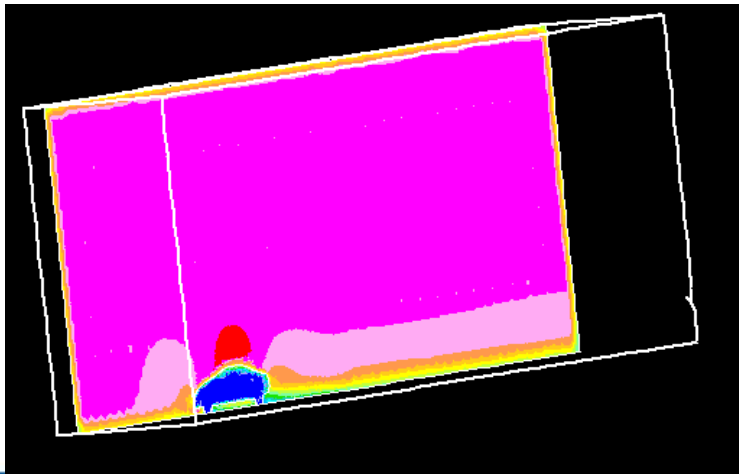
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问题概述

通过变化车模四个主要外形参数，使其风阻系数Cd值，升力Cl值均尽可能小

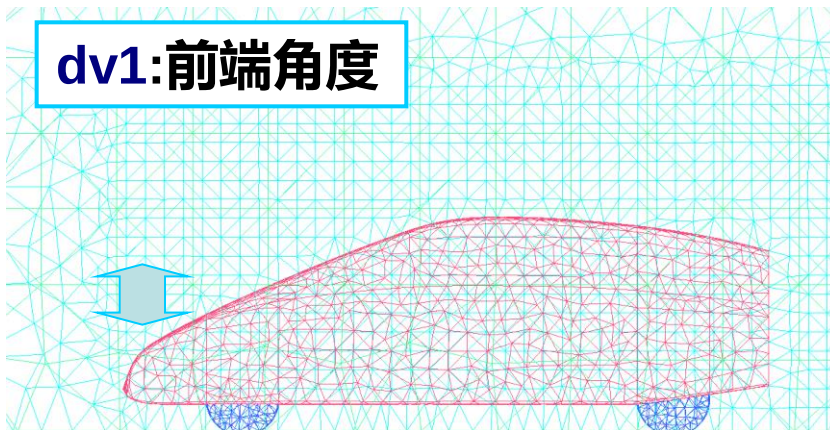
所用CAE软件

- ICEM CFD：初始网格生成
- Star CD：流场计算
- proSTAR：边界条件设定，数据后处理
- DEP MeshWorks/Morpher：外形参数变化之后网格变形与生成
- modeFRONTIER：集成，优化

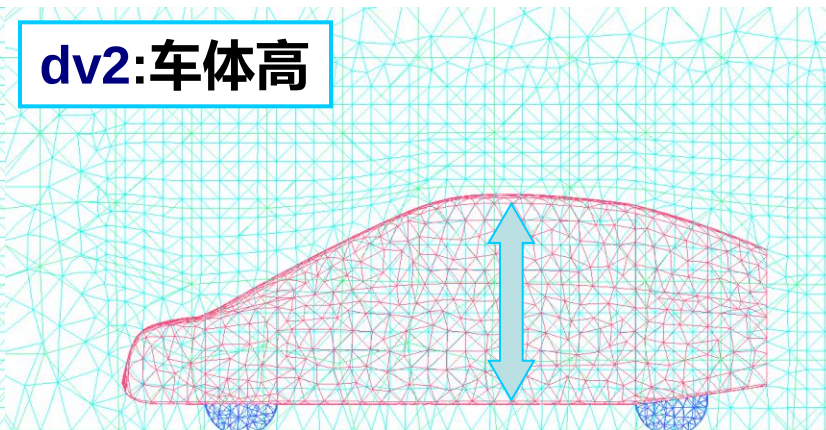


设计变量

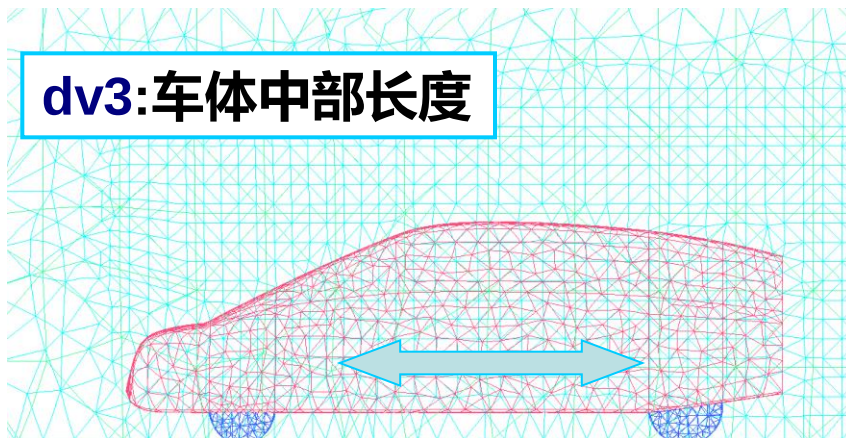
dv1:前端角度



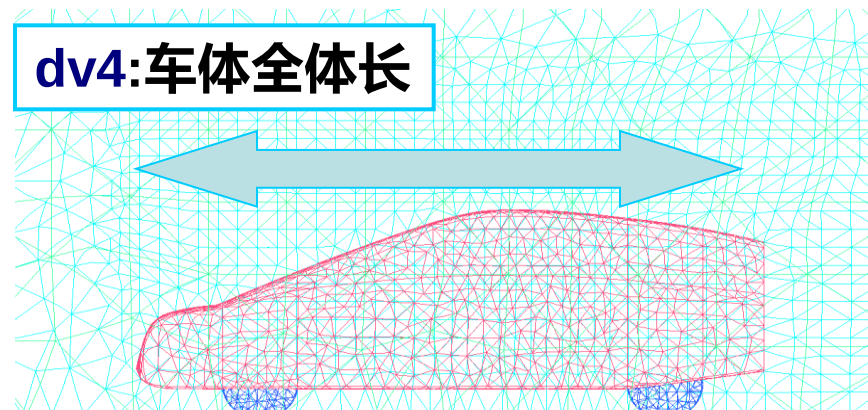
dv2:车体高



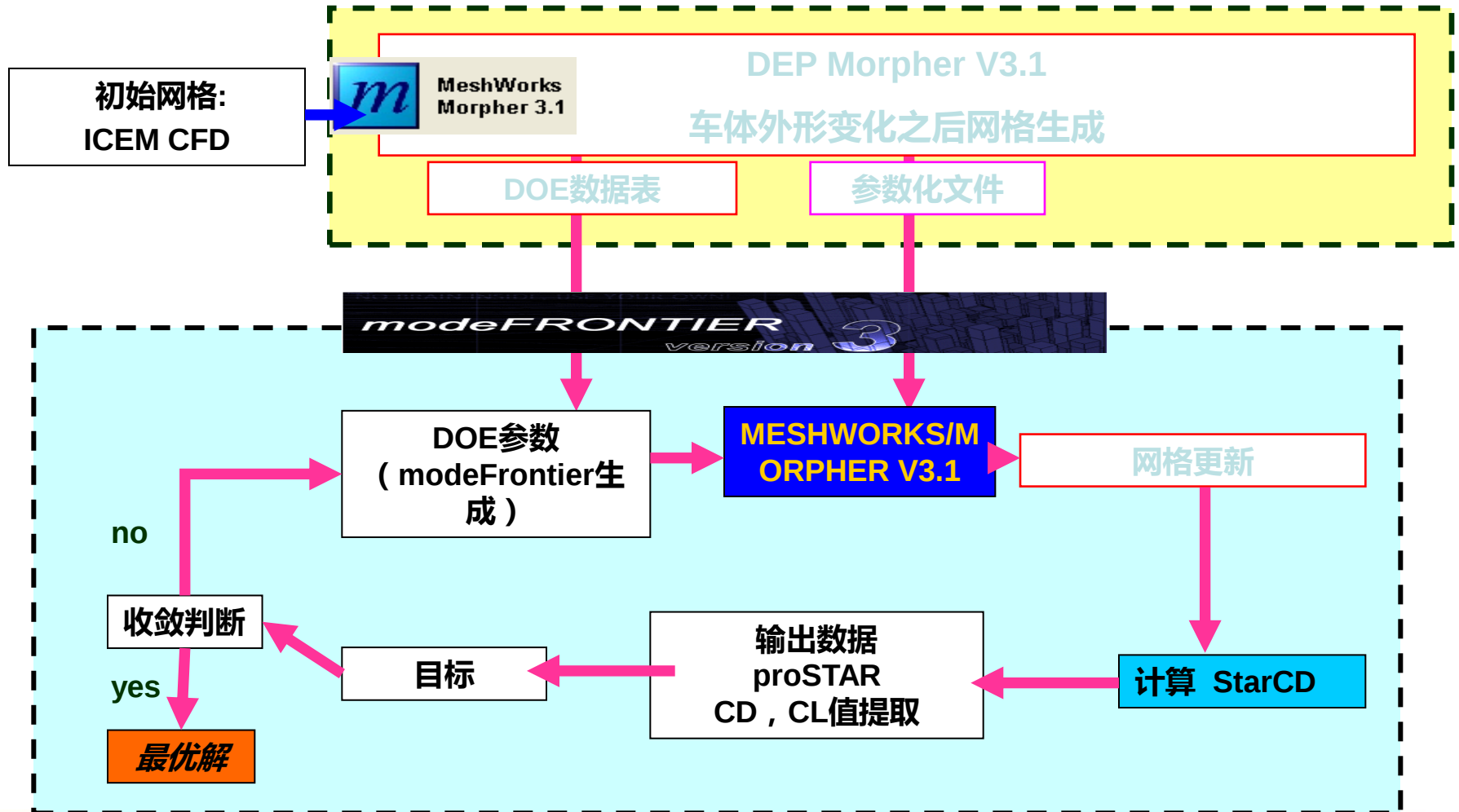
dv3:车体中部长度



dv4:车体全体长



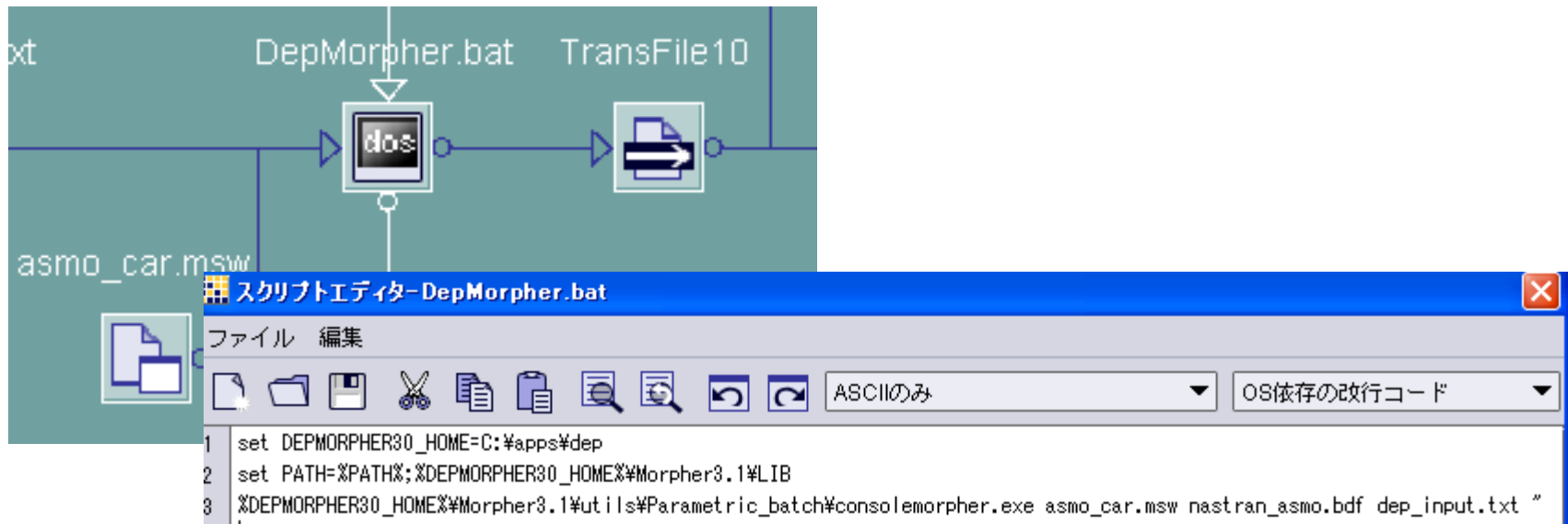
包含DepMorpher的优化集成流程



DEP Morpher集成

DEP Morpher执行

- DEP Morpher参数化网格变形模版文件(asm0_car.msw), 制定输入网格类型
- 输出网格(nastran_asm0.bdf)
- 参数DOE列表文件(dep_input.txt), 并与modeFRONTIER关联
- 将Nastran_asm0.bdf网格文件传递给StarCD



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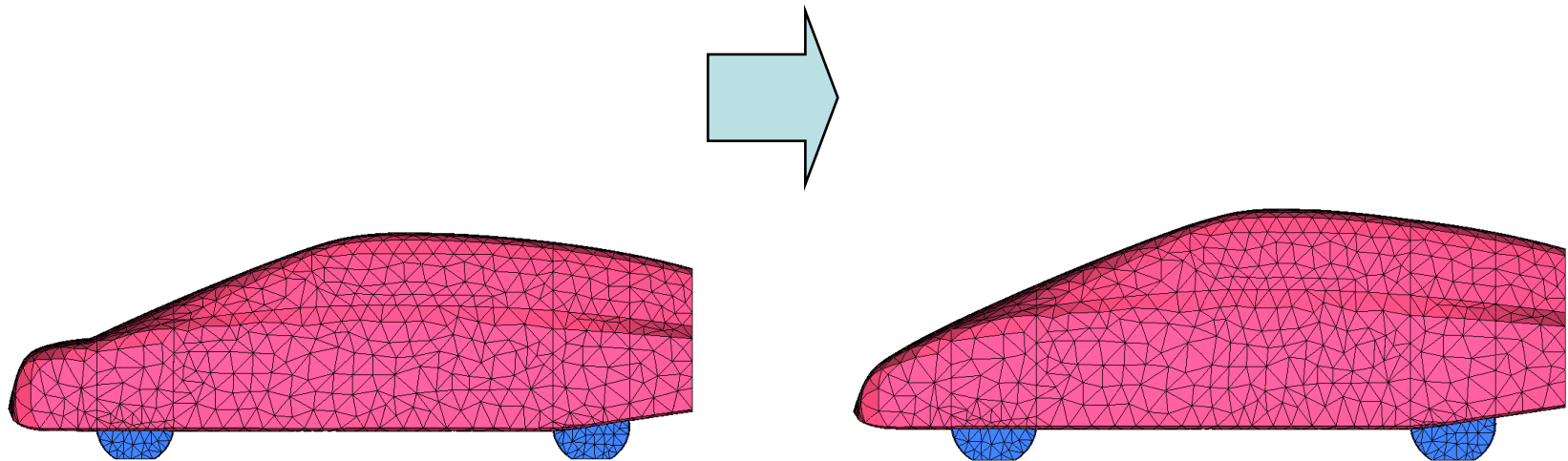
最优化结果

初始值

- CD值 : 0.287
- CL值 : 0.0425

● 最优化结果

- CD值: 0.257
- CL值: -0.035



汽车前保险杠优化设计

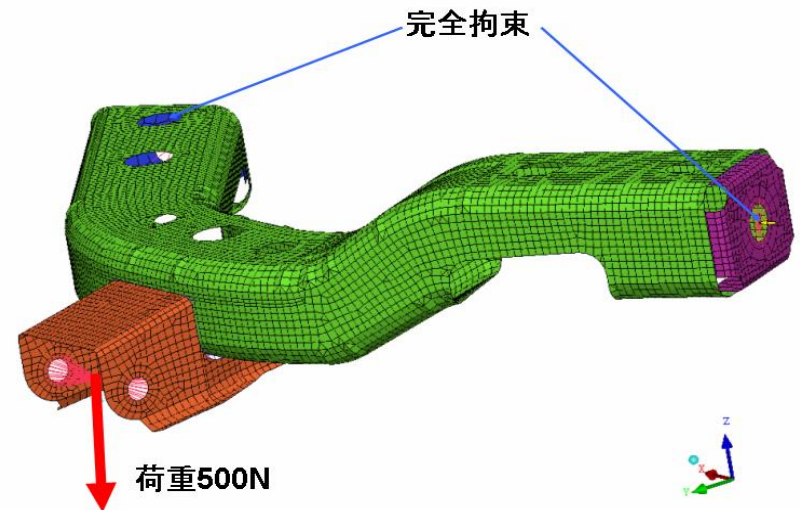
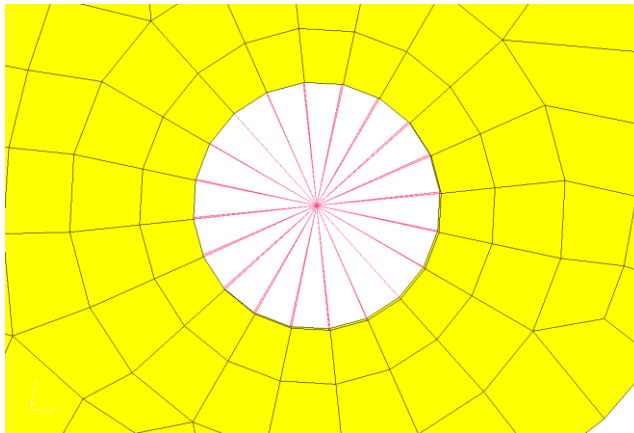
(DepMorpher, NASTRAN, Patran,
ModeFRONTIER)

问题概要

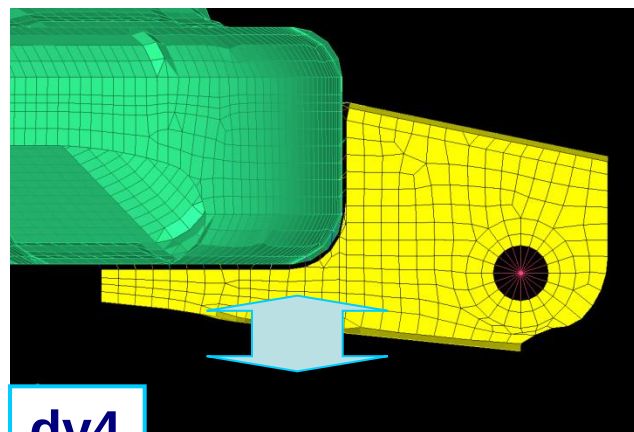
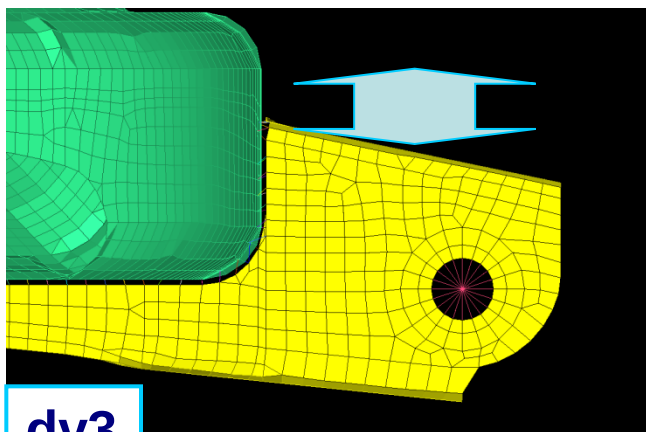
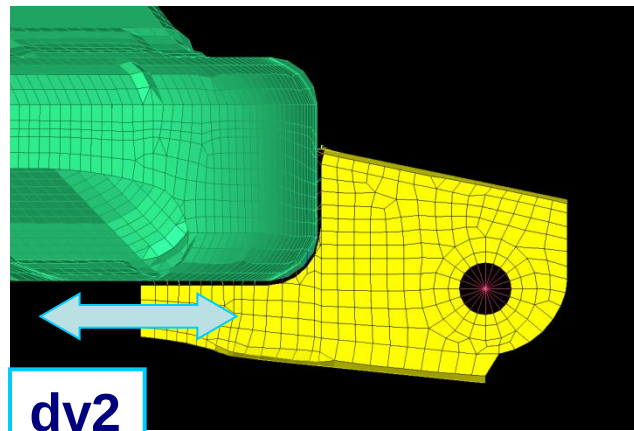
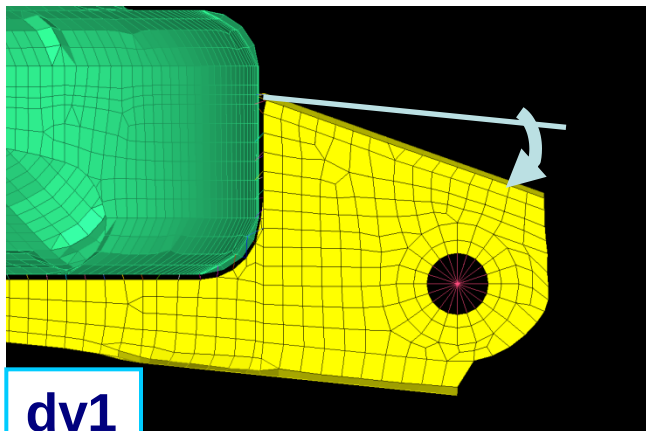
通过调整保险杠的外形参数，在满足应力约束条件下，使得质量尽可能轻，形变尽可能小

所用CAE软件

- IcemCFD：初始网格生成
- MSC.Nastran：FEM分析
- MSC.Patran：数据处理
- DEP MeshWorks/Morpher：网格变形与控制
- modeFRONTIER：集成，优化

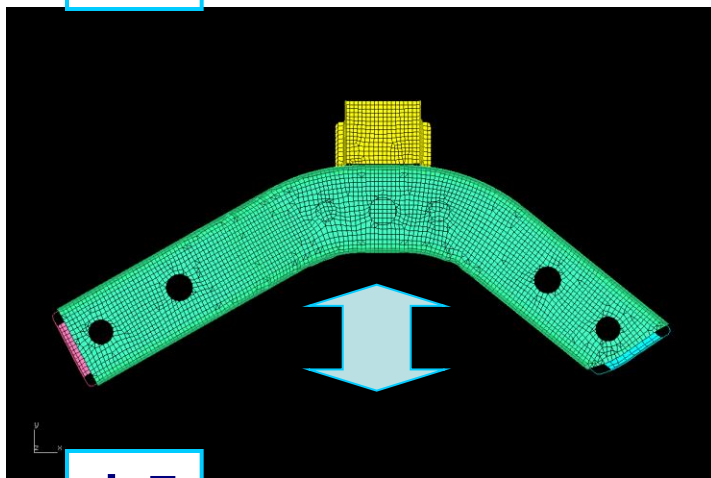
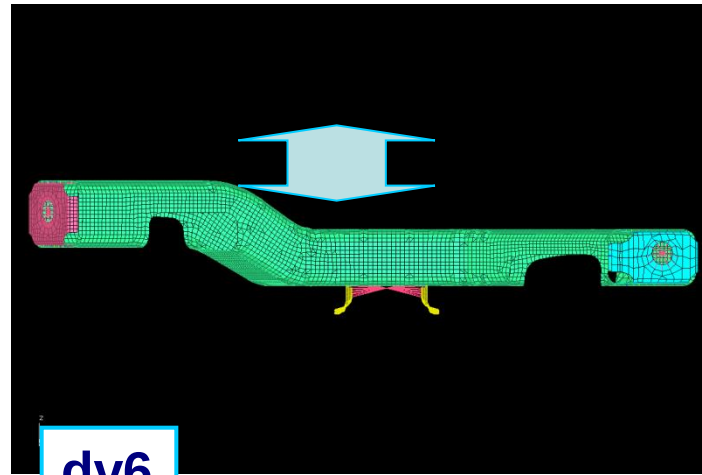
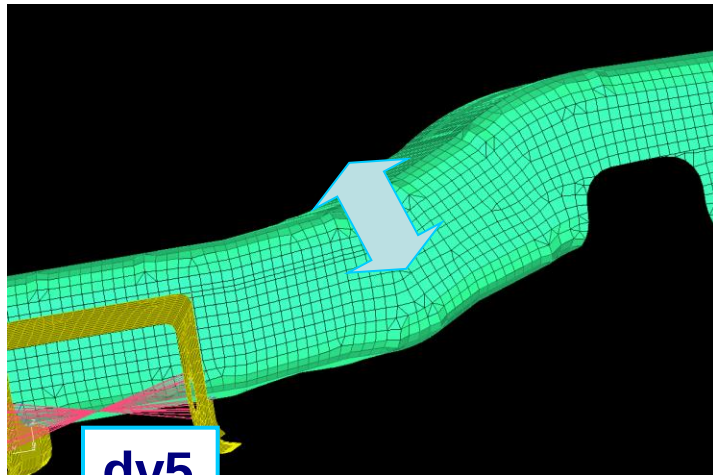


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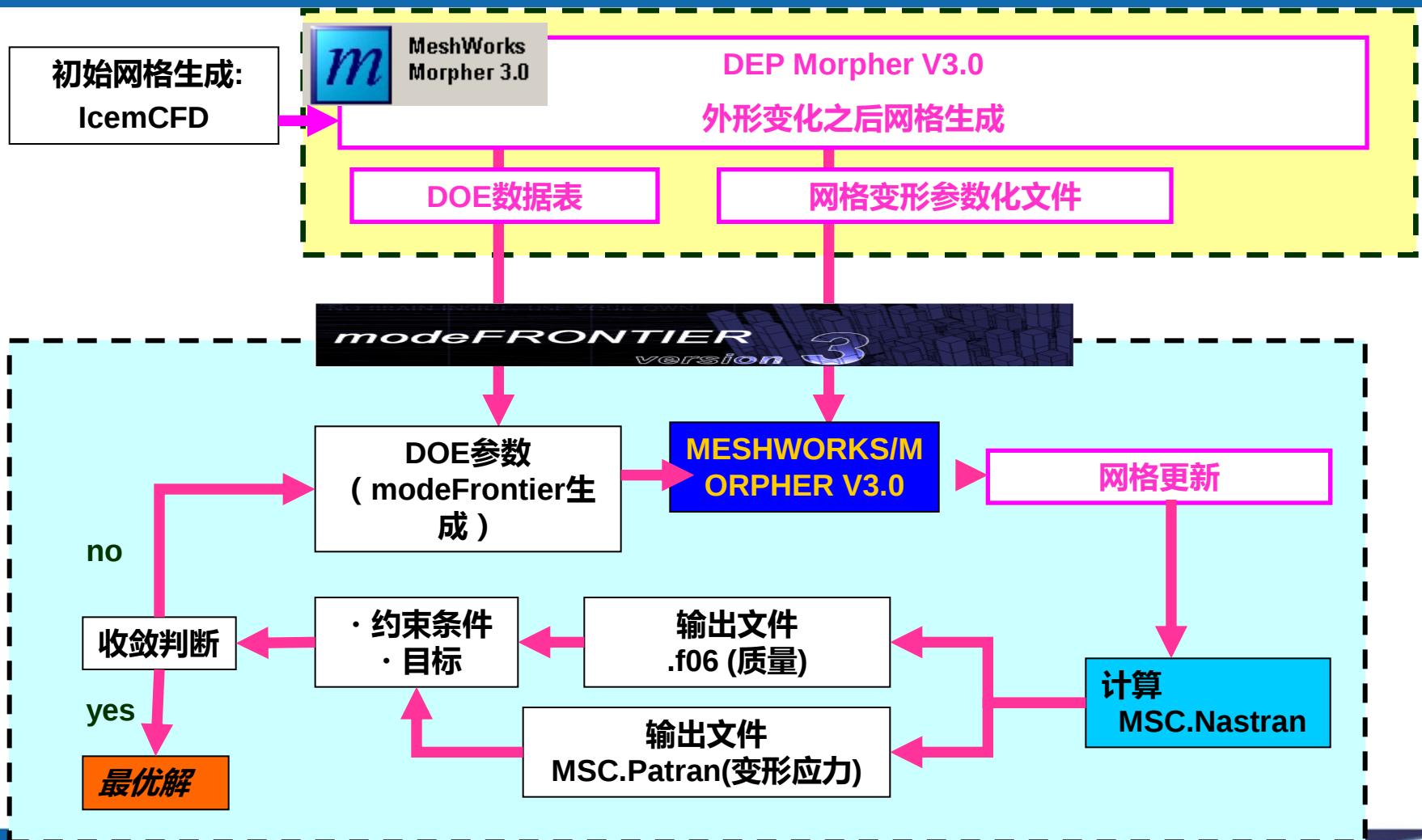


设计变量

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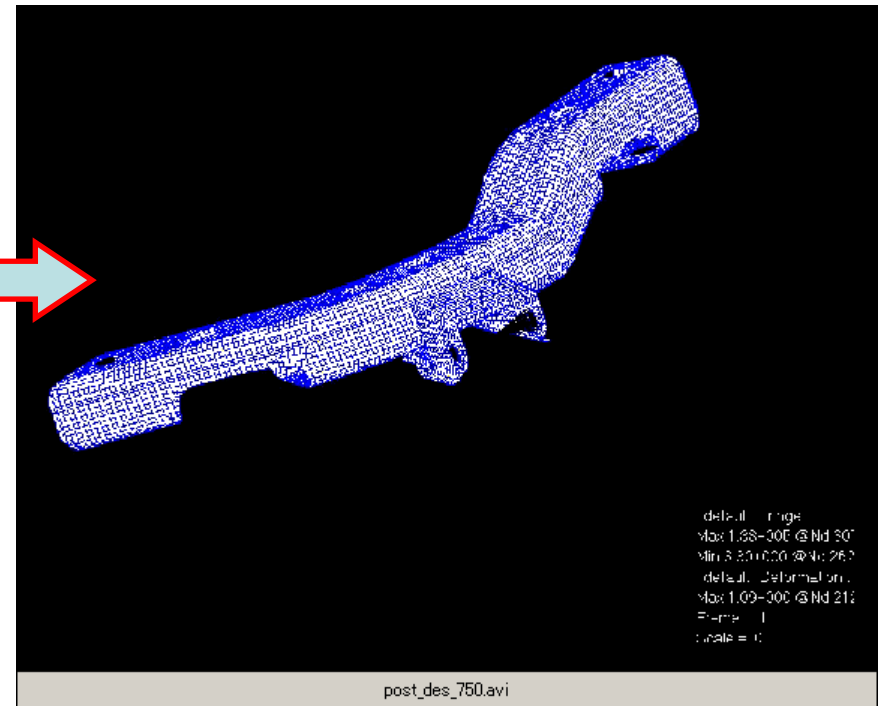
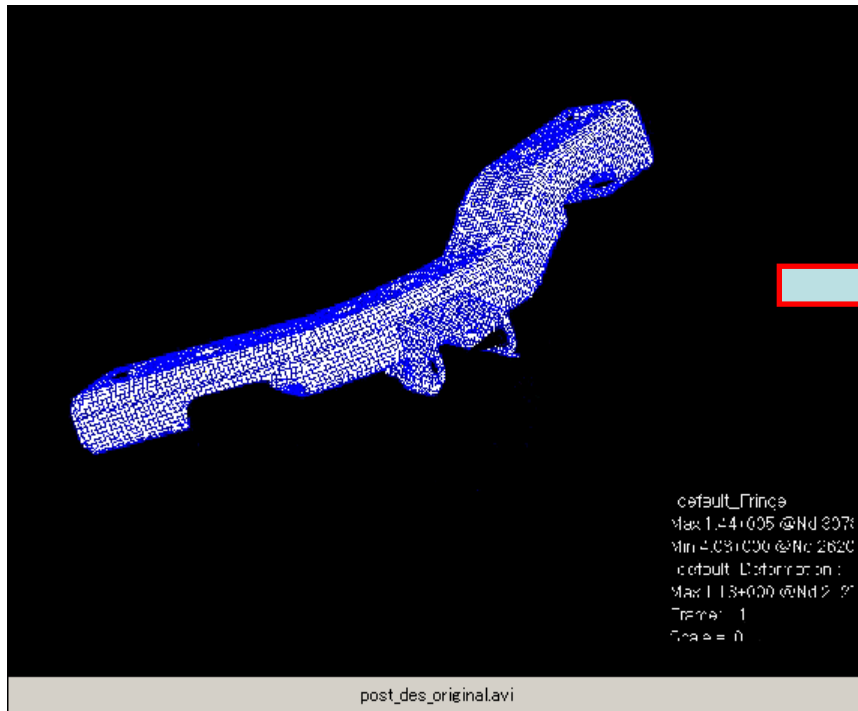
优化结果(des750)

初始解

- 质量 : 16.65kg
- 最大位移 : 1.13mm
- 最大应力 : 152MPa

● 优化解

- 质量: 16.60kg
- 最大位移: 1.09mm
- 最大应力: 142MPa





感谢您的关注！