SIEMENS
Ingenuity for life

通过先进材料的应用减轻汽车重量

用于满足汽车工程中降低环境排放、改善燃油效率的要求

Paul Mouland
SES Portfolio Development Executive APAC

SIEMENS

Agenda

- Automotive Lightweighting汽车轻量化
  Why Now?为什么是现在？
- Automotive Lightweighting汽车轻量化
  Why Composites?为什么是复合材料?
- Automotive Lightweighting汽车轻量化
  Why Siemens?为什么是西门子?
- Complexities of Mixed Material Assemblies
  异种材料连接装配的复杂性

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Fuel Economy & Emissions Reductions Are燃油经济性和排放降低 Driving Innovation To New Levels 推动创新推动到新的水平

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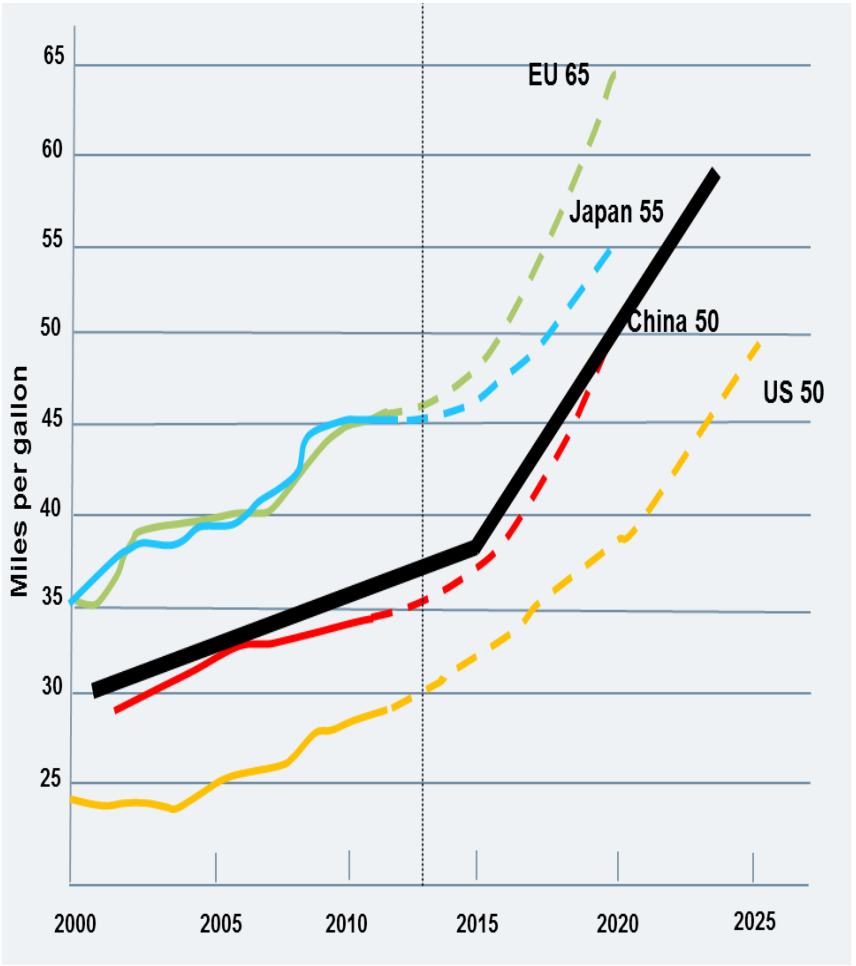
Huge improvements to fuel economy required by 2025!
2025年燃油经济性需要大幅提升

过去：每加仑约行驶0.5英里
Past: ~0.5 mpg per year

未来：每加仑约行驶2英里
Future: ~2.0 mpg per year

2015年后增长4倍
4X CURRENT RATE of increase after 2015

现在是时候采取行动
Time to act is now.



Source An, F., and A Sauer.

Regulations aimed at reducing emissions and improving fuel efficiency
旨在减少排放、提高燃料效率的法规

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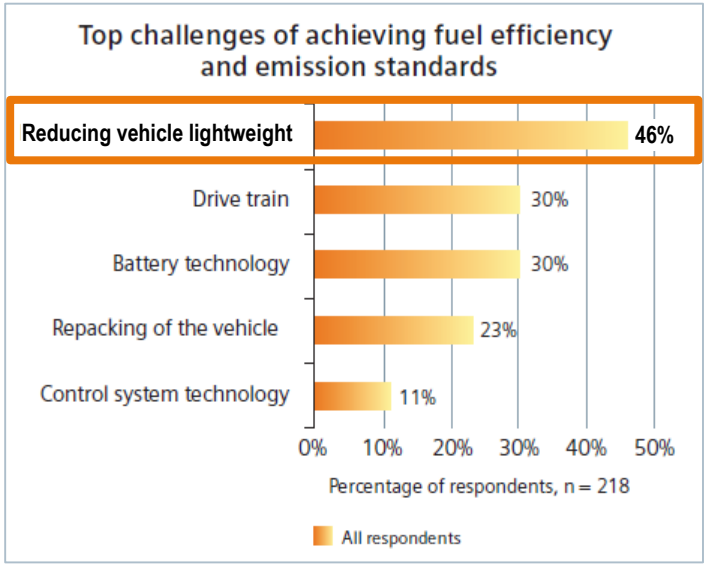
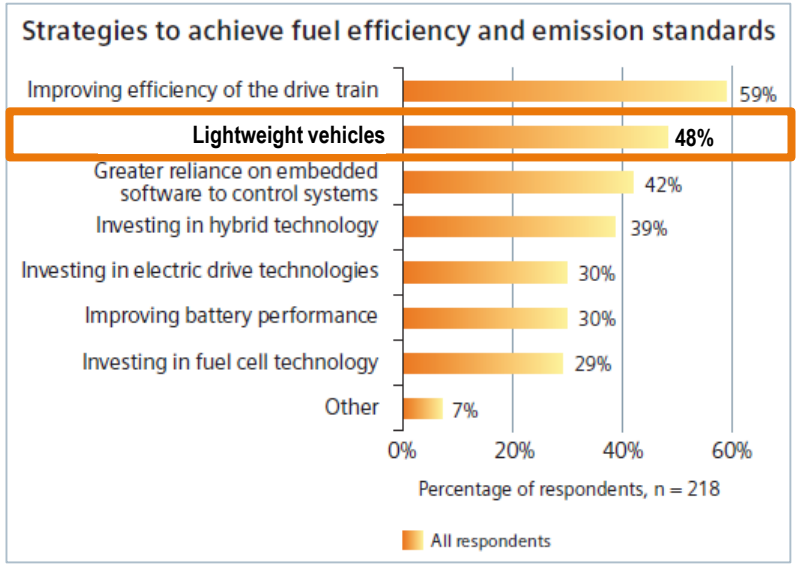
Automotive companies must drastically rethink the way vehicles are engineered and manufactured to comply with government regulations.
汽车公司必须重新思考车辆工程和制造方法，以满足政府法规要求。





Source: "How Prepared Is the Automotive Industry? Solutions for Meeting Fuel Efficiency and Emissions Standards" Aberdeen Group, Inc., 2014.

未来50几年内的最大变革Biggest Change in 50+ Years
轿车设计和制造方法的根本变革Fundamental changes to how cars are designed and built

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Fuel efficiency/emissions regulations燃料效率/排放法规	New materials/joining technology for light weight用于轻量化的新材料/结合技术	Build new application experience quickly快速积累新应用经验
Response响应	**Impact影响**	**Solution解决方案**
重新思考车辆的设计和制造方法 Rethinking how vehicles are engineered and manufactured	以往的钢焊接轿车经验不适合于异种材料车辆 Past steel welded car experience not suited to mixed material vehicles	工程软件可以加快所需专业知识的积累速度 Engineering software can accelerate creation of needed expertise

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Complexities of Mixed Material Assemblies
异种材料连接装配的复杂性

重量减轻的策略Weight savings strategies

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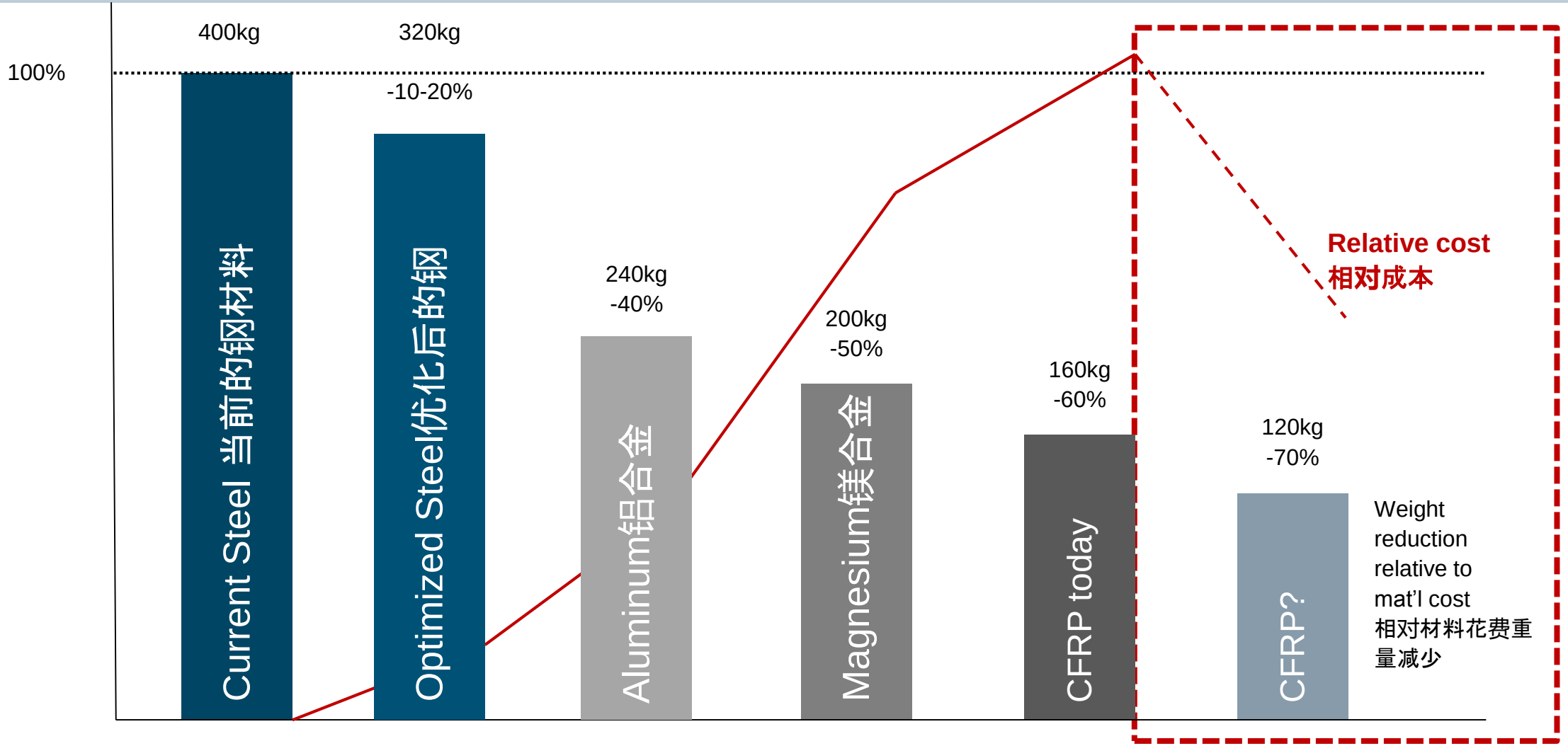
To increase speed, Chevrolet jettisoned most non-critical items adding weight – trunk carpeting, insulation and all but one speaker.
为了提高速度，雪佛兰抛弃了大多数导致增加重量的非关键项，包括后地毯、隔离件、只保留一个扬声器等。

Savings减重 = 140kg

Range Rover looked to a lightweight riveted all-aluminum frame.
路虎揽胜寻找全铝车身铆接方式进行轻量化

Savings减重 > 500kg

材料重量减轻潜力Material weight reduction potential



案例Example
使用碳纤维增强塑料的异种材料白车身 – 宝马 7系
Mixed Material Body in White with CFRP - BMW 7 Series

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支持量产轻量化汽车的设计
Supporting Design of High Volume Light Weight Vehicles

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Engineering innovative, durable and lightweight vehicles
设计创新的、耐用的和轻量化的汽车

AUDI
DAIMLER
MAGNA
PORSCHE
GM
Ford
LEAR CORPORATION
OPEL
roding
Continental Structural Plastics
HONDA
faurecia
CHRYSLER
EISSMANN | COTESA automotive carbon
PLASTIC OMNIUM
Johnson Controls

Mitsubishi Rayon Co., Ltd.三菱纤维公司
Prepreg Compression Molding on Decklid行李箱盖预浸料模压

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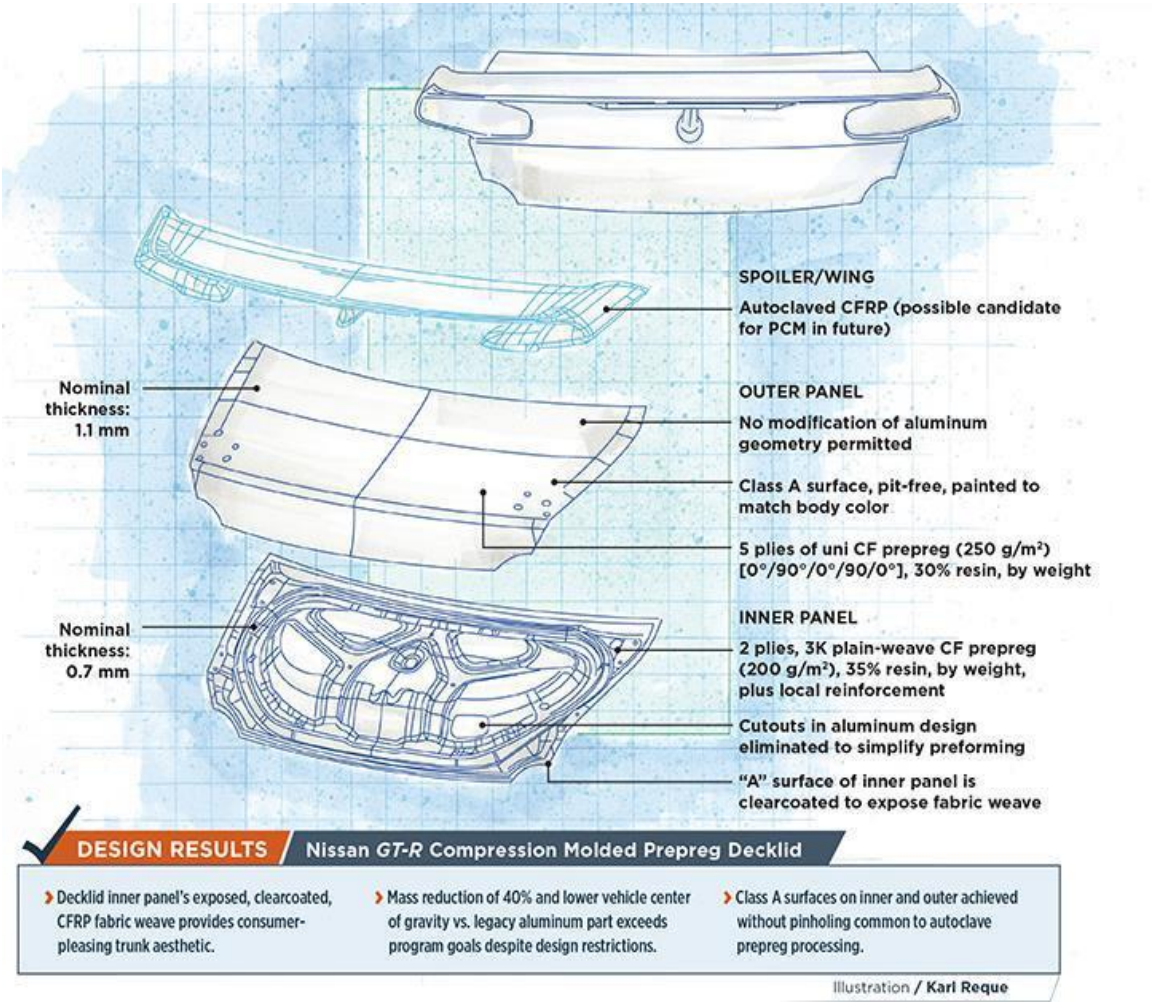
CHALLENGE挑战:
保证与铝合金装配一样或者更好性能，重量至少降低30%
Equal or better mechanical performance with at least 30% less mass than aluminum assembly

SOLUTION解决方案:

通过应用Fibersim进行成型分析，与传统铝合金零件相比，重量降低了40%且重心更低
Mass reduction of 40%
and lower center of gravity
vs. legacy aluminum part
exceeds program goals
utilizing Fibersim
for forming analysis.



Source: CompositesWorld, Case Study-Prepreg compression molding makes its commercial debut, Peggy Malnati, 6/1/2015.

Mitsubishi Rayon Co., Ltd.三菱纤维公司
Prepreg Compression Molding on Commercial Production Vehicle
在商业投产的汽车上运用预浸料模压

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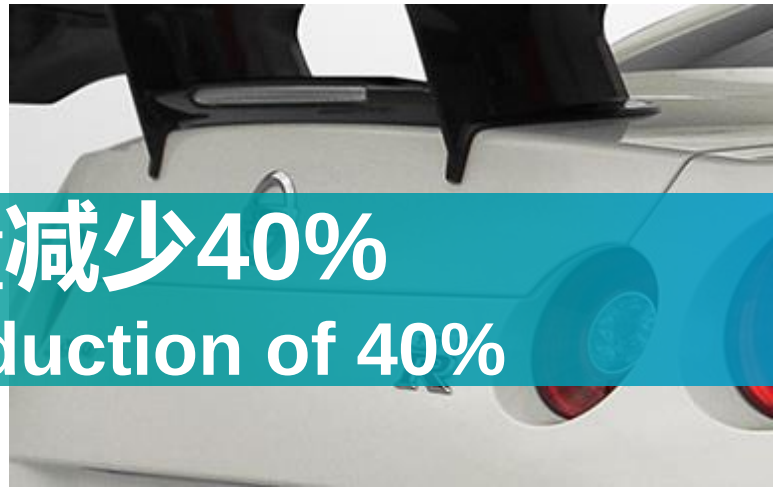

重量减少40%

Mass reduction of 40%

Source: SPEA 2014 Mitsubishi Rayon report.

Mitsubishi Rayon Co., Ltd.三菱纤维公司
Prepreg Compression Molding on Decklid行李箱盖预浸料模压

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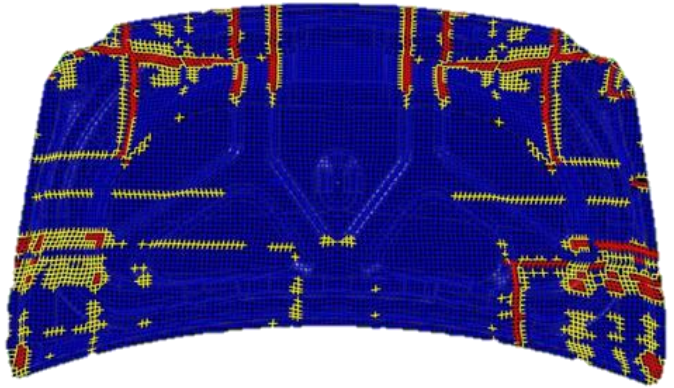
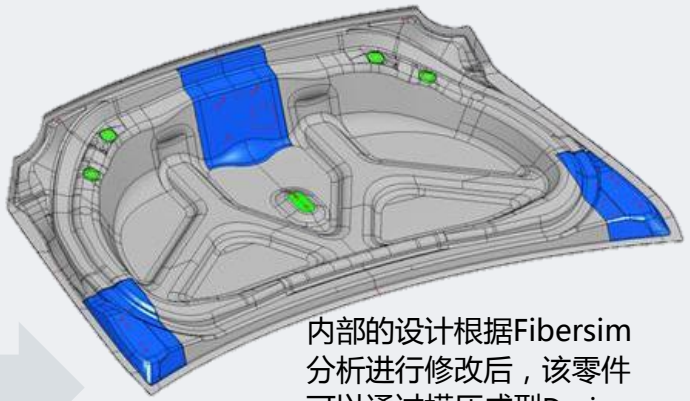
基于原始铝合金零件的初步设计
Preliminary design based on original Aluminum part

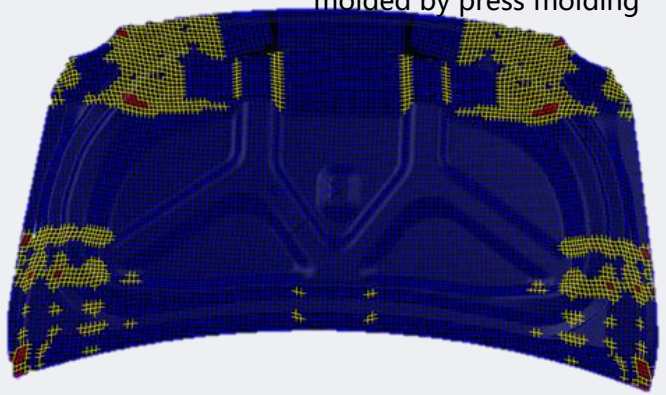
通过Fibersim进行铺覆性分析
Drapability analysis by Fibersim



修改后的形状Modified Shape



内部的设计根据Fibersim分析进行修改后，该零件可以通过模压成型Design of inner panel was modified by Fibersim analysis so it could be molded by press molding



质量比期望更轻
循环周期时间接近批量生产的速度
Lower-than-expected mass supporting cycle times approaching mass-production speed

Source: SPEA 2014 Mitsubishi Rayon report.

使用Fibersim进行成型加工/工艺设计Using Fibersim for Formed Part/Process Design
成型的复合材料内板Formed Composite Inner Hood

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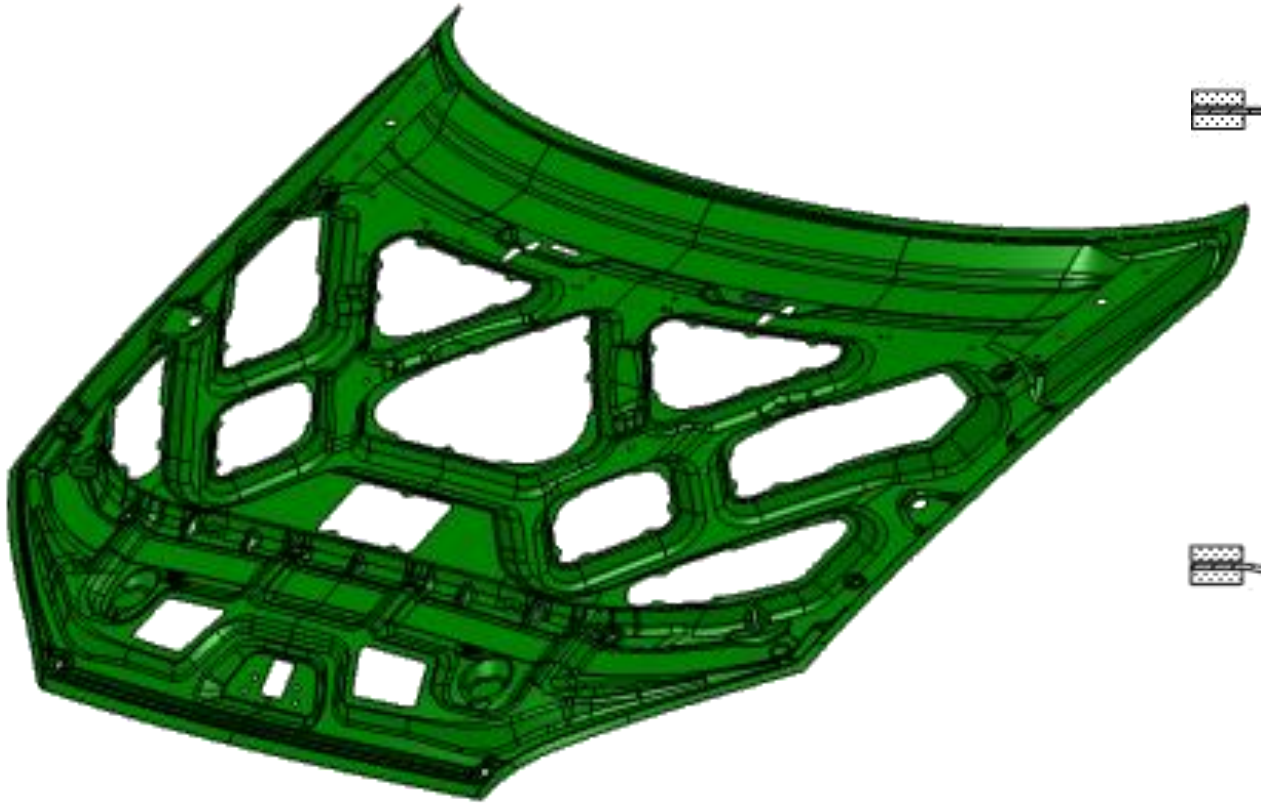

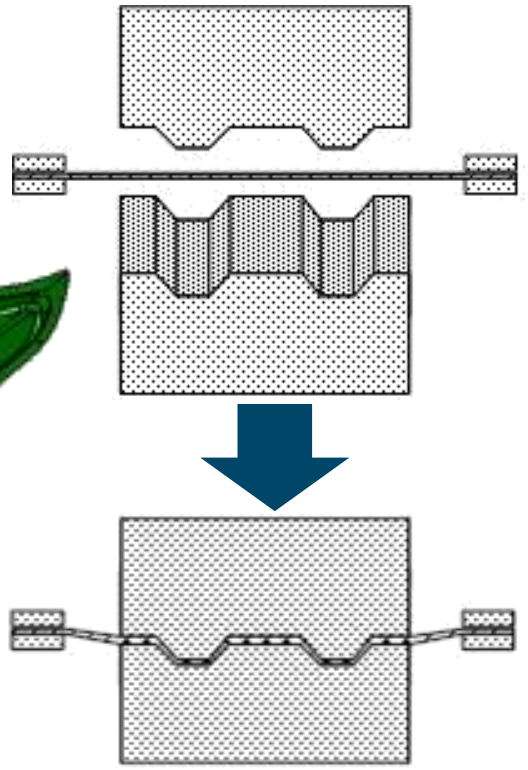

与金属成型相匹配
matched metal forming

使用Fibersim进行成型加工/工艺设计Using Fibersim for Formed Part/Process Design
在整个物体的铺层上评估可制造性Evaluation of Producibility on Full Body Ply

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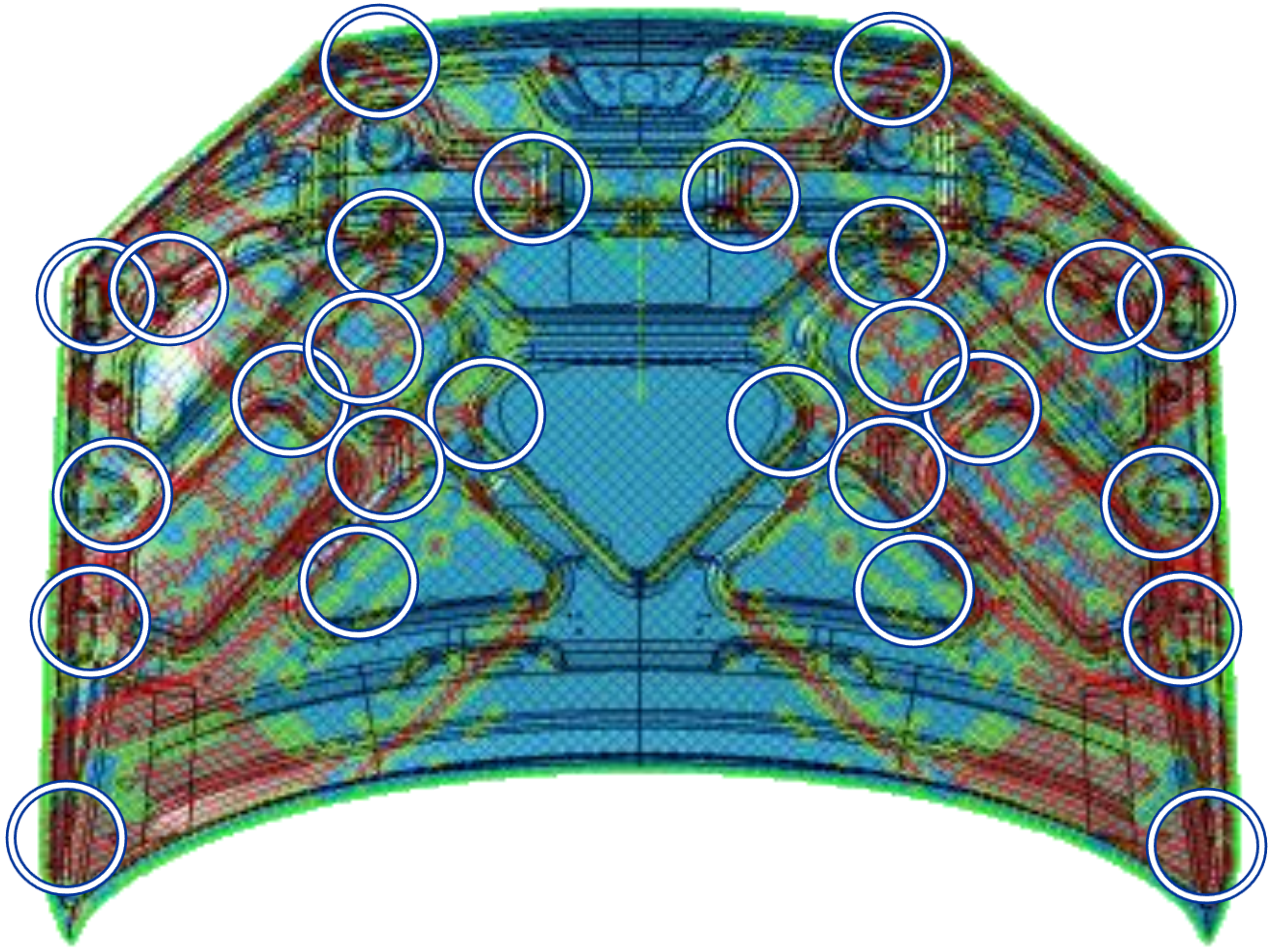

使用Fibersim进行成型加工/工艺设计Using Fibersim for Formed Part/Process 导致制造问题的设计特征Design Features Causing Manufacturing Issues

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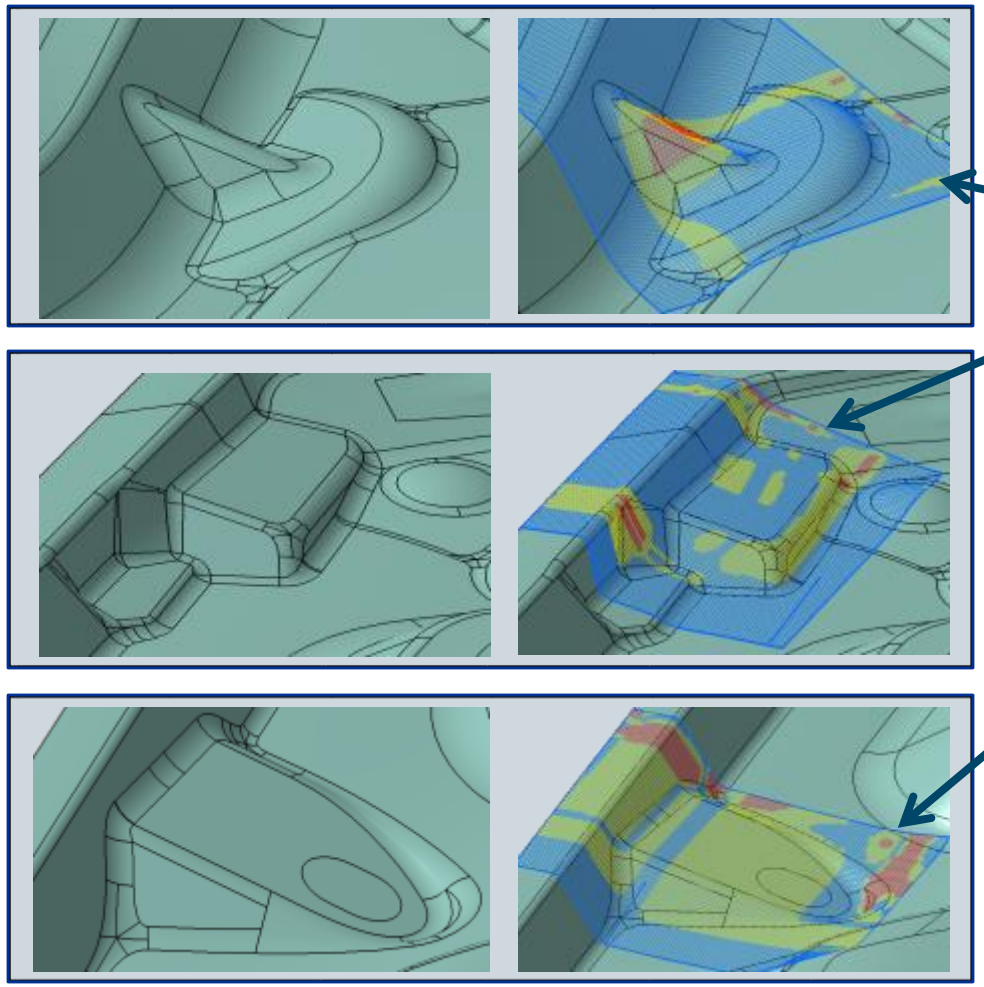

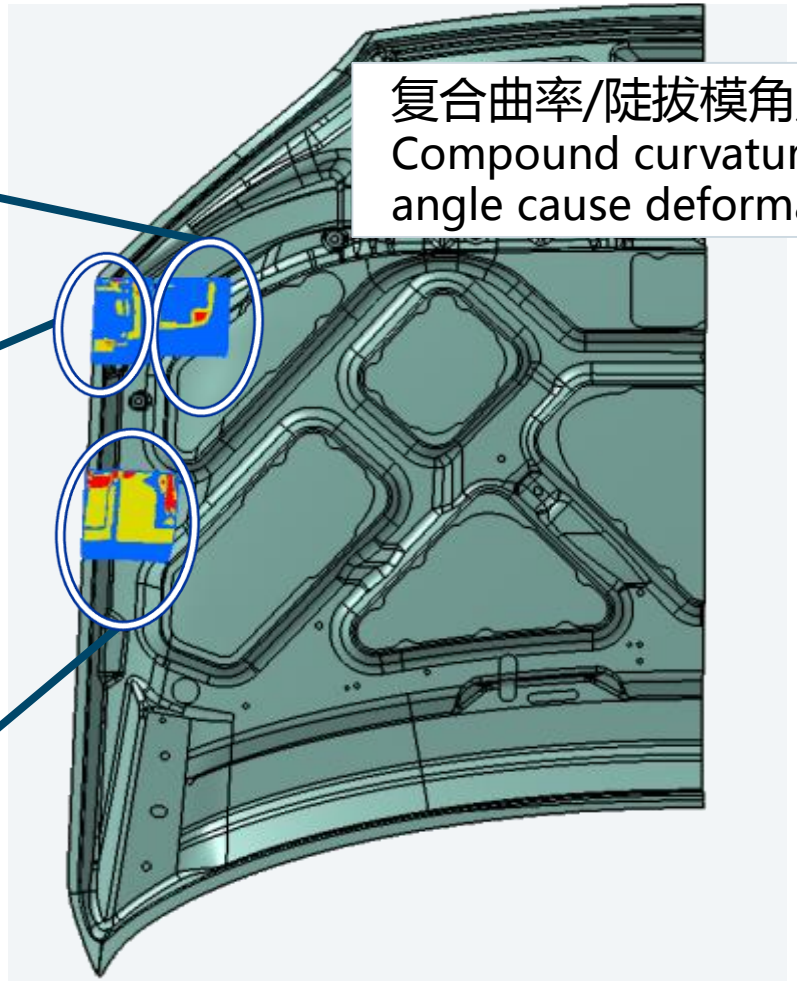

支持端到端的设计工艺流程Support End-to-End Engineering Process Workflow…并与制造无缝连接Plus a Seamless Link to Manufacturing

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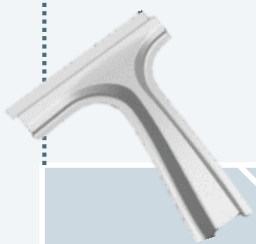
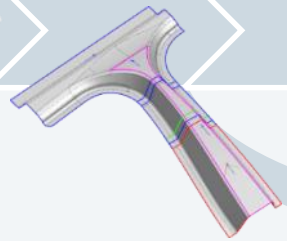
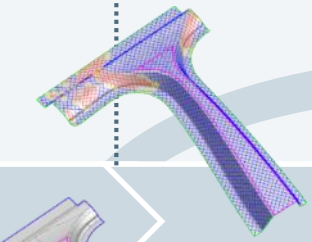
CAD曲面
CAD surface



定义层合板
Define
Laminate

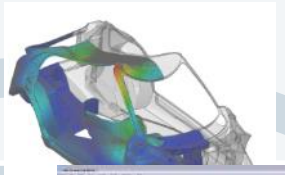


设计、可制造性、分析迭代
Design, Producibility,
Analysis Iterations



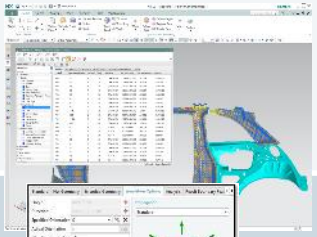
Iterative loop

双向分析接口
Bi-Directional Analysis
Interface

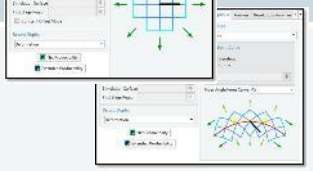


开放的CAE架构
Open CAE Architecture

设计验证
Design
Validation



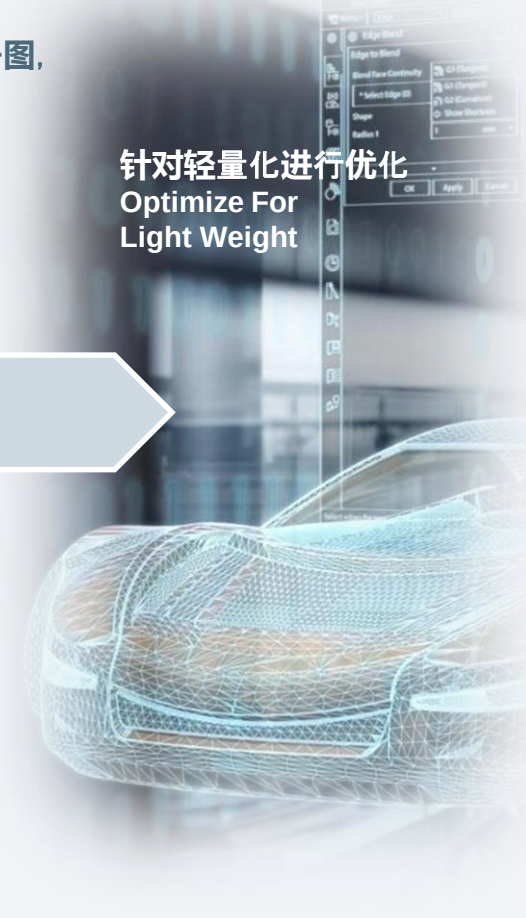
准确地计算刚度、强度、热、NVH、声学、耐久性、碰撞……
Accurately Solve for
Stiffness, Strength,
Thermal, NVH, Acoustics,
Durability, Crash…



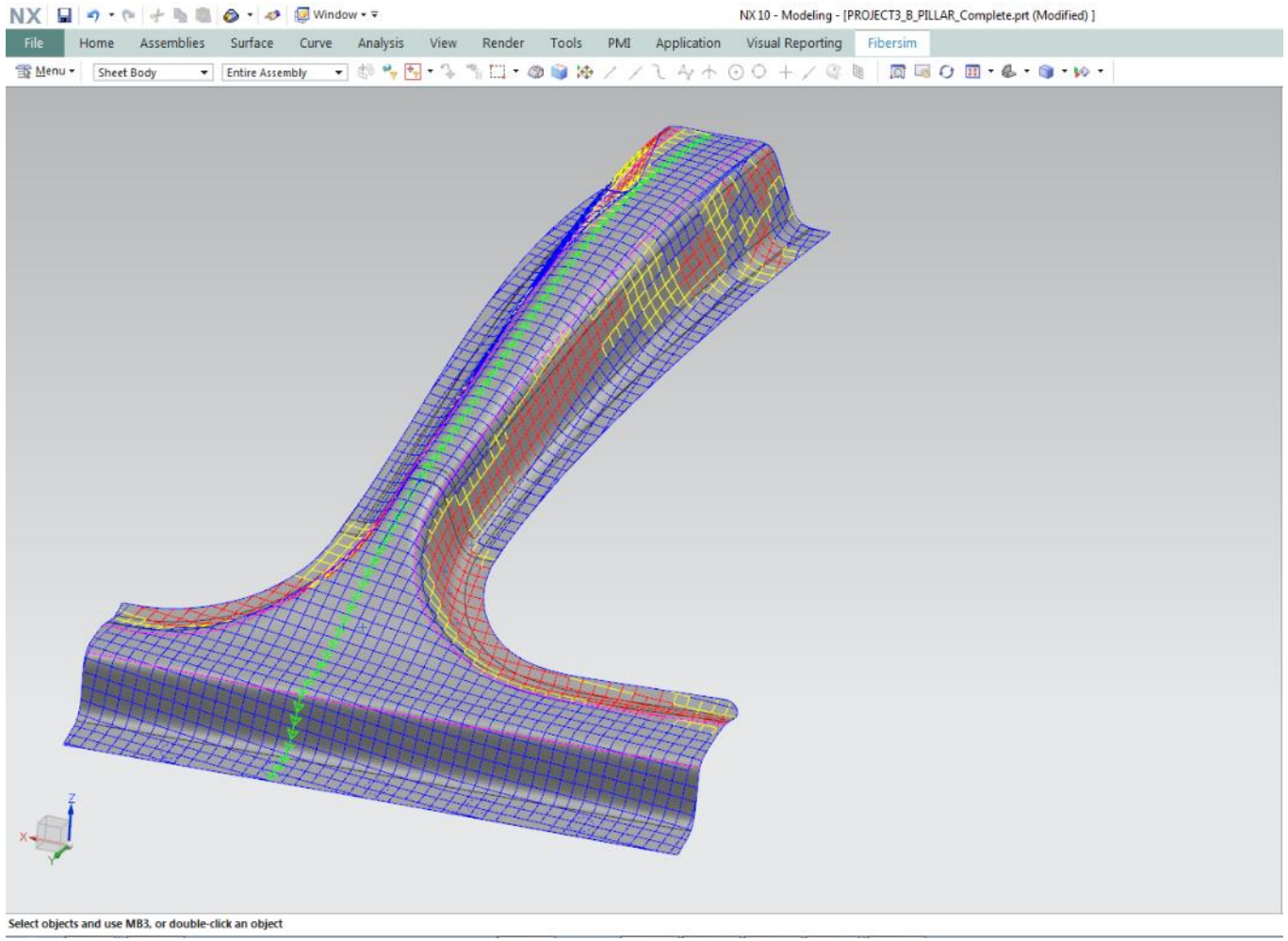
自动生成平面展开图，制造数据
Auto-generate Flat
Patterns,
Manufacture Data

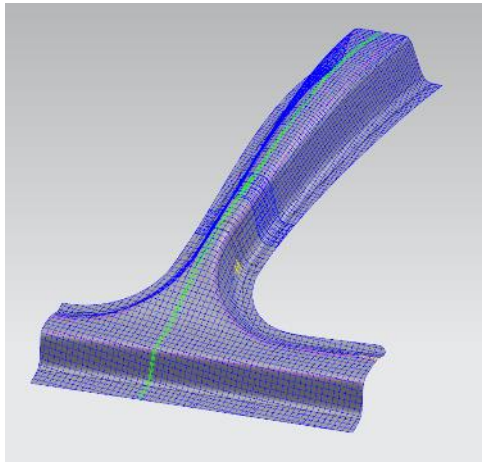
自动生成图纸和文档
Auto-generate
Drawings and
Documents

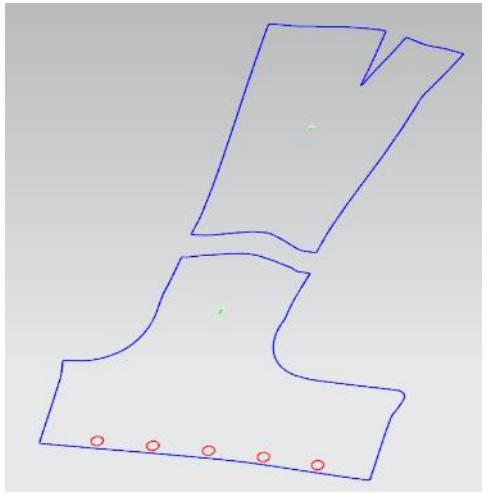
针对轻量化进行优化
Optimize For
Light Weight



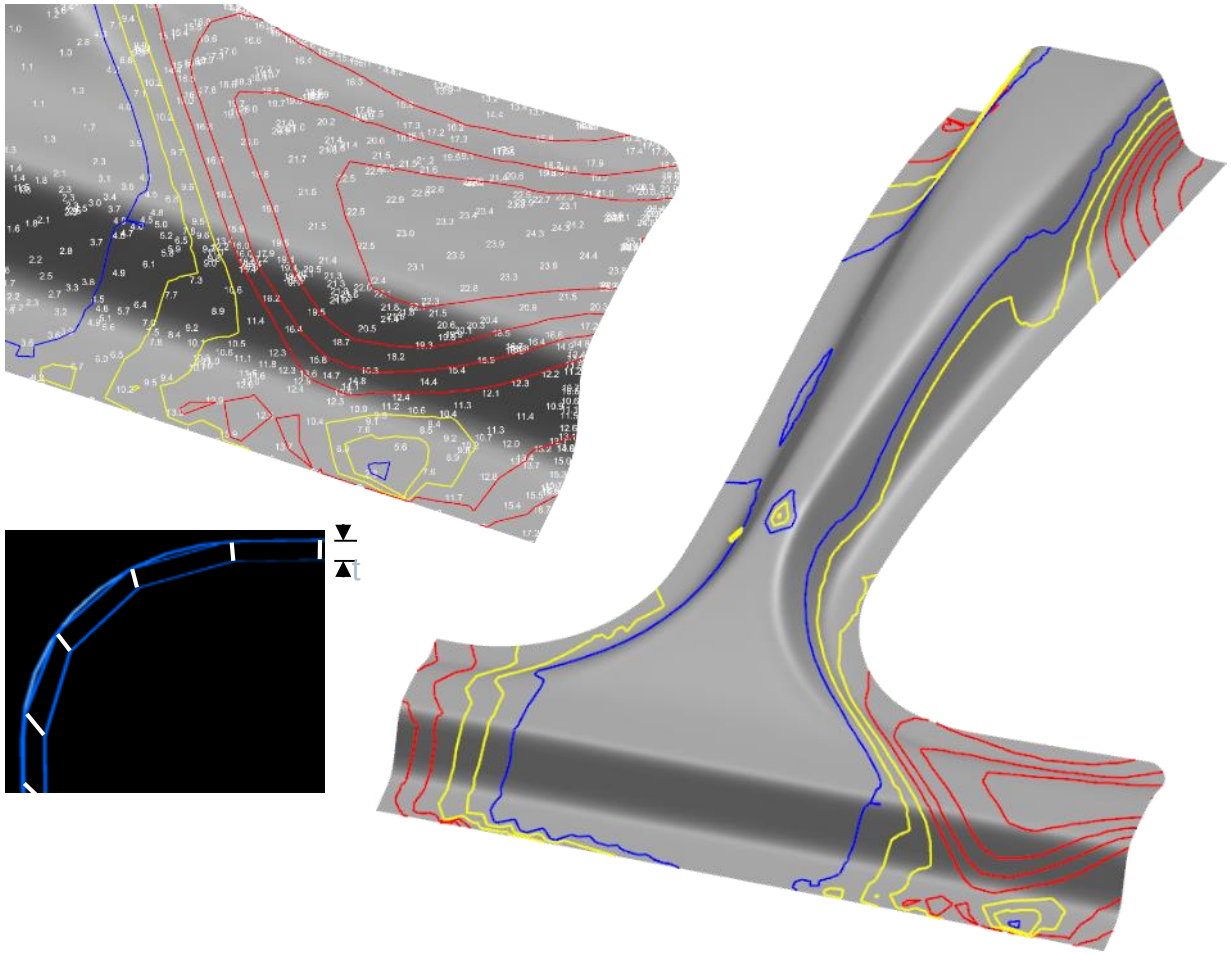
设计可生产的铺层Design Producible Plies







成型件开发工装Formed Part Development Tools

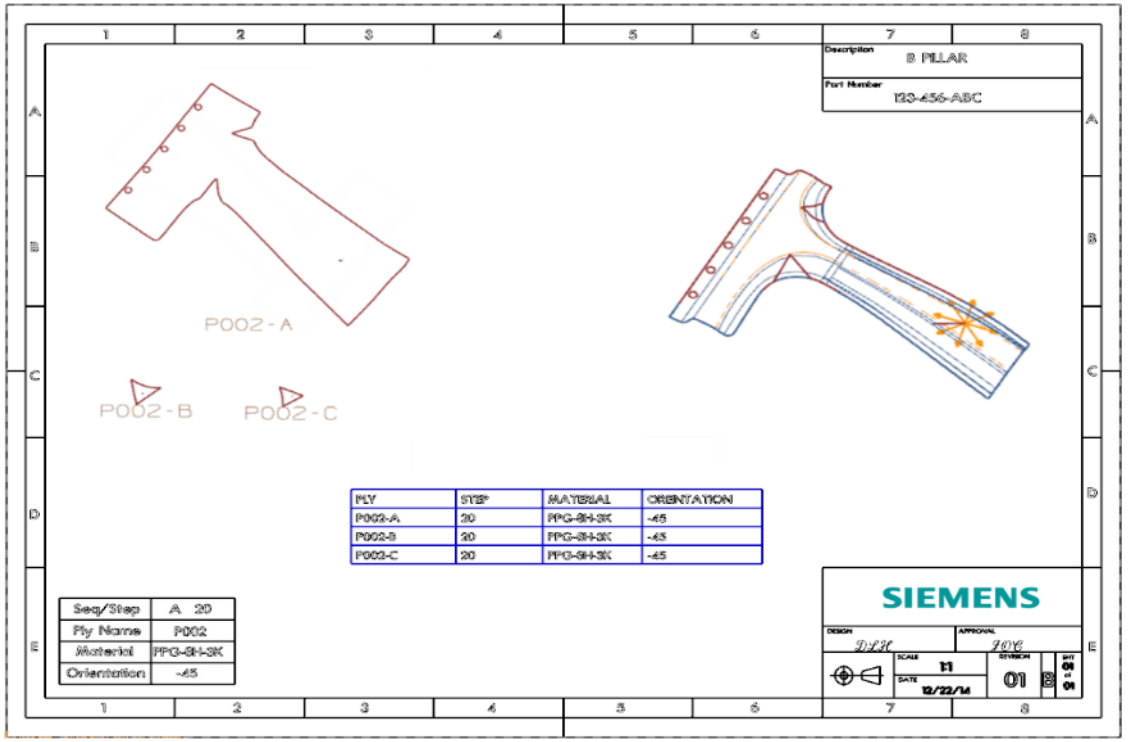


可视化的标识和颜色编码来指导成型策略
Visual indicators and color coding can be used to guide forming strategies

- 成型合板Formed laminate = 在铺层间相对运动relative motion between plies
- 蓝色Blue = 少量或没有相对运动little to no relative motion
- 红色Red = 铺层间有相对大的运动significant relative motion between plies

二维的层合板将铺层放置为空白地方，以便成型为三维
2D laminate positions plies in 2D blank for proper forming to 3D

自动化生成图纸、重量-成本数据、PLM系统的输入
Automated Generation of Drawings, Data for Weight-Cost, PLM Feeds



Composite Part Ply Table

Ply Name	Laminate	Sequence	Step	Material	Rosette	Orientation	Cured Thickness (mm)
P001	LAM001	A	10	PPG-8H-3K	ROS001	0	0.3429
P002-A	LAM001	A	10	PPG-8H-3K	ROS001	0	0.3429
P002-B	LAM001	A	10	PPG-8H-3K	ROS001	0	0.3429
P002-A	LAM001	A	20	PPG-8H-3K	ROS001	+/-45	0.3429
P002-B	LAM001	A	20	PPG-8H-3K	ROS001	+/-45	0.3429
P002-C	LAM001	A	20	PPG-8H-3K	ROS001	+/-45	0.3429
P003-A	LAM001	A	30	PPG-8H-3K	ROS001	0/90	0.3429
P003-B	LAM001	A	30	PPG-8H-3K	ROS001	0/90	0.3429
P003-C	LAM001	A	30	PPG-8H-3K	ROS001	0/90	0.3429
P004-A	LAM001	A	40	PPG-8H-3K	ROS001	45	0.3429
P004-B	LAM001	A	40	PPG-8H-3K	ROS001	45	0.3429
P004-C	LAM001	A	40	PPG-8H-3K	ROS001	45	0.3429
P005-A	LAM001	A	50	PPG-8H-3K	ROS001	-45	0.3429
P005-B	LAM001	A	50	PPG-8H-3K	ROS001	-45	0.3429
P005-C	LAM001	A	50	PPG-8H-3K	ROS001	-45	0.3429

Sequence	Laminate Name	Part Number	Laminate Net Weight (lb)	Laminate Net Weight Minus Cutouts (lb)	Laminate Net Center of Gravity (in)
A	Hood	VST-0012-001	5.63791002	5.33791002	-0.0186676056 -11.151936828 -4.6829180364
B	Pad-Up_1	VST-0012-001	1.51808179	1.31808179	-0.0000379372 -11.0349956097 -4.6656904588
C	Pad-Up_2	VST-0012-001	2.70705221	2.70705221	-0.0356618499 -11.0575588251 -4.7872750163
Total Part Net Weight				5.33791002 lb	

Component Name	Sequence Step	Material	Material Thickness (in)	Areal Weight (lb/in²)	Net Area (in²)	Net Weight (lb)	Center of Gravity (in)
P001	A10	PPG-8H-3K	0.01350000	0.00052630	1246.61032009	0.65609101	-0.0214 -0.44693338 -0.17875498
P002	A20	PPG-8H-3K	0.01350000	0.00052630	1247.73894375	0.65668501	0.00000747 -0.4474514 -0.17923878
P003	B30	PPG-8H-3K	0.01350000	0.00052630	1250.54421556	0.65816142	0.00001759 -0.44684674 -0.18463146
P004	B40	PPG-8H-3K	0.01350000	0.00052630	1253.58630995	0.65992036	-0.02128 -0.44656741 -0.18477908
P009	C25.5	PPG-8H-3K	0.01350000	0.00052630	10.23781983	0.00538816	-0.6838572 0.06323379 -0.18061418

三维直接连接到制造
Direct 3D Link to Manufacturing

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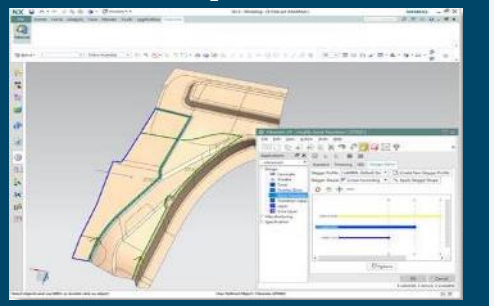
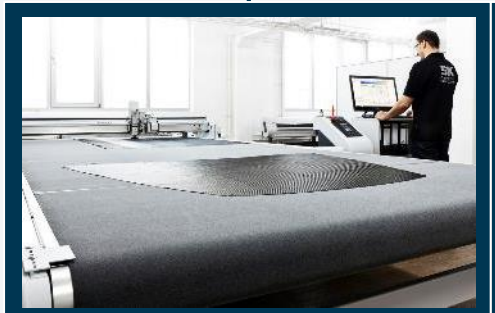
零件模型part model

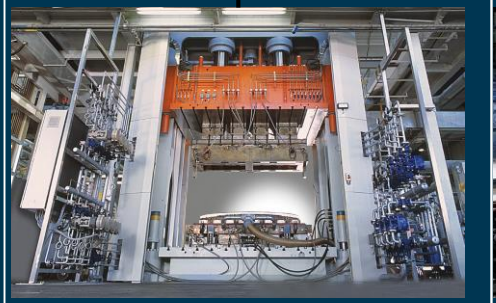




裁剪Cutting

Pick/Place

纤维铺放Fiber place



成型Forming

RTM

收益总结
Benefits Summary

SIEMENS

- 一致的基于模型的设计过程
- 提供了一个开放的平台，支持 NX，CATIA，Creo
- 基于制造材料属性来提高仿真精确度
- 支持更快和更频繁设计分析优化迭代
- 减少文档和数字化制造数据的创建时间
- 使设计更改透明并减少周期时间
- 详细设计整个供应链快速沟通

- **节约至少50%设计工作Saves over 50% in design efforts**
- **减少90%的制造废品Reduces manufacturing scrap by 90%**
- **提高质量、降低复合材料设计的风险Improves quality, reduces risk of composite design**

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Agenda

Automotive Lightweighting汽车轻量化
Why Now?为什么是现在？

Automotive Lightweighting汽车轻量化
Why Composites?为什么是复合材料?

Automotive Lightweighting汽车轻量化
Why Siemens?为什么是西门子?

Complexities of Mixed Material Assemblies
异种材料连接装配的复杂性

轻量化要求使用各种接合方法

粘合剂
保护电弧焊
电弧飞溅焊接
铆接，螺丝
冲压工具
激光焊接
压接
共固化
卷边
电阻焊接

车身技术	材料	接合方法	接头组合
钢	1	1	1
铝	1	3	3
异种材料	5+	10+	25+

异种材料装配工程软件的价值

- 确定零件复杂度和装配之间的折中方案
- 表示各种接缝类型
  黏合、铆接、焊接、螺栓连接、金属/复合材料混合接头
- 对性能、成本和可生产性进行折中评估

用Syncrofit 优化异种材料白车身开发过程

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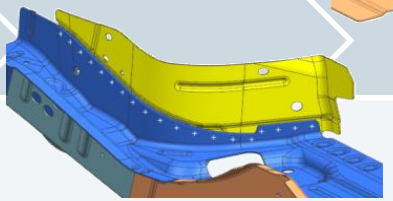
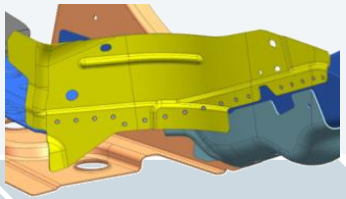
定义装配接缝

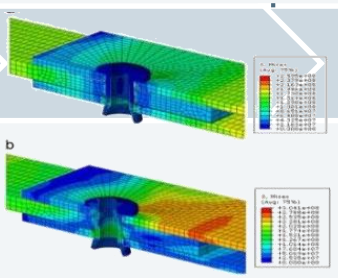
根据设计规则开发紧固模式



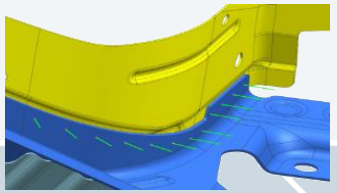
定义接缝细节（铆接、粘接、缝密封）



用CAE验证设计 规则和接口



可视化紧固位置和材料堆栈数据



将PLM用于“数字线到工厂车间”

优化异种材料车辆

Thank you

Paul Mouland

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