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Ingenuity for life

Increasing the Value of Simulation for Aircraft Design/ 提升航空产品模拟的价值

Deryl Snyder, PhD
CD-adapco VP, Global Business Development

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Agenda

Background: Simulation Strategies
背景:模拟对策

Validate & Troubleshoot: Thrust Reverser
验证与除错:反推力系统

Predict: Electric Aircraft
预测:电控飞行器

Automate & Explore: ECS Components
自动化与空间探索: ECS (环控)零部件

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- Automate & Explore: ECS Components

Trends Driving Civil Aviation
推动民航发展的趋势

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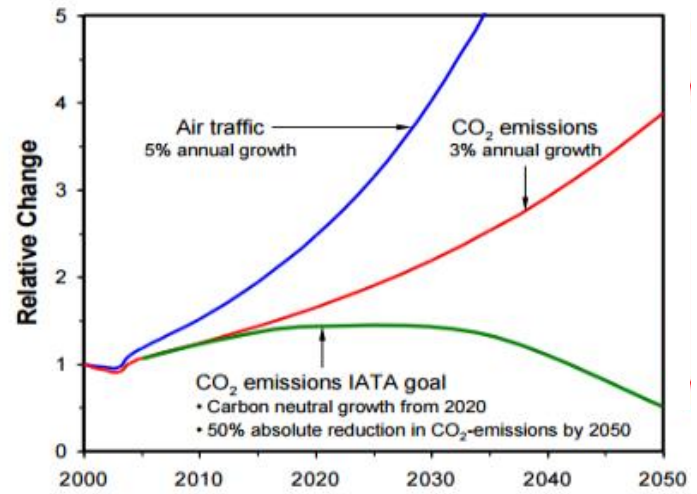
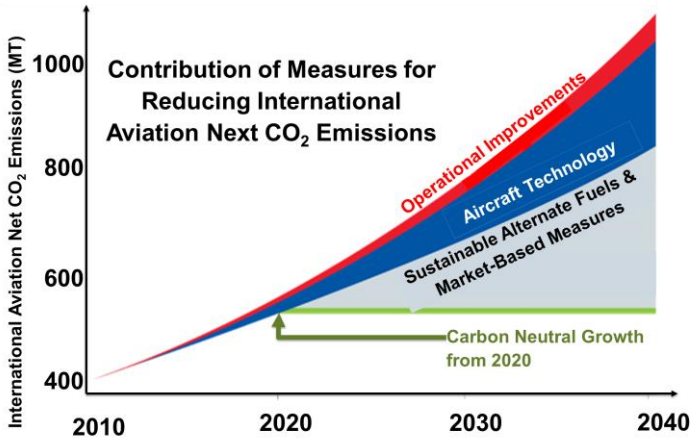
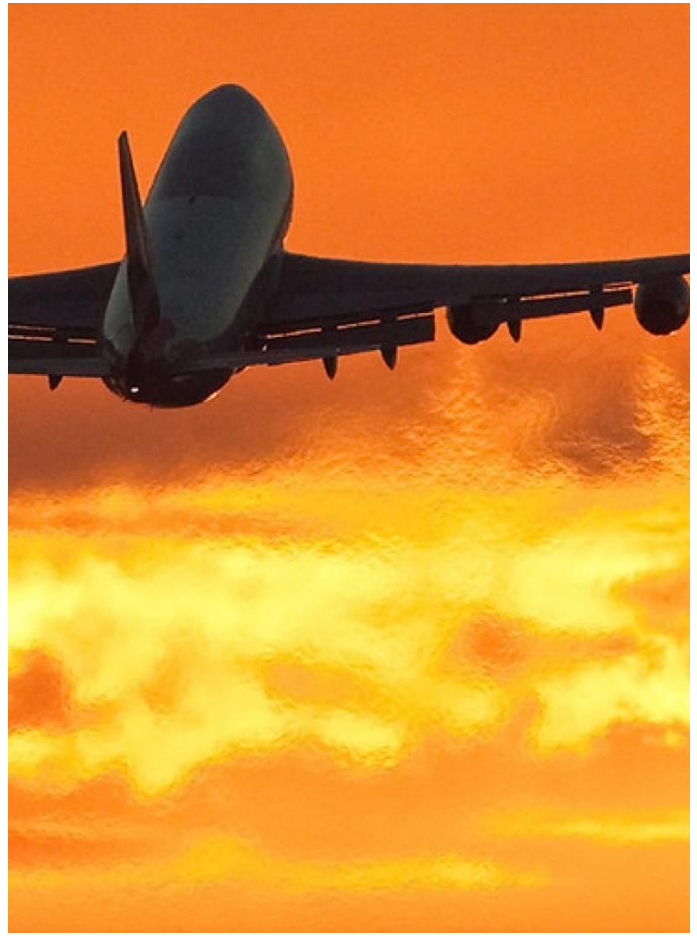
Increased Regulations/较严格的法规
Minimize environmental footprint/ 减少环境污染

Air Traffic & CO_2 Emissions/ 空中交通与CO_2排放







Trends Driving Civil Aviation
推动民航发展的趋势

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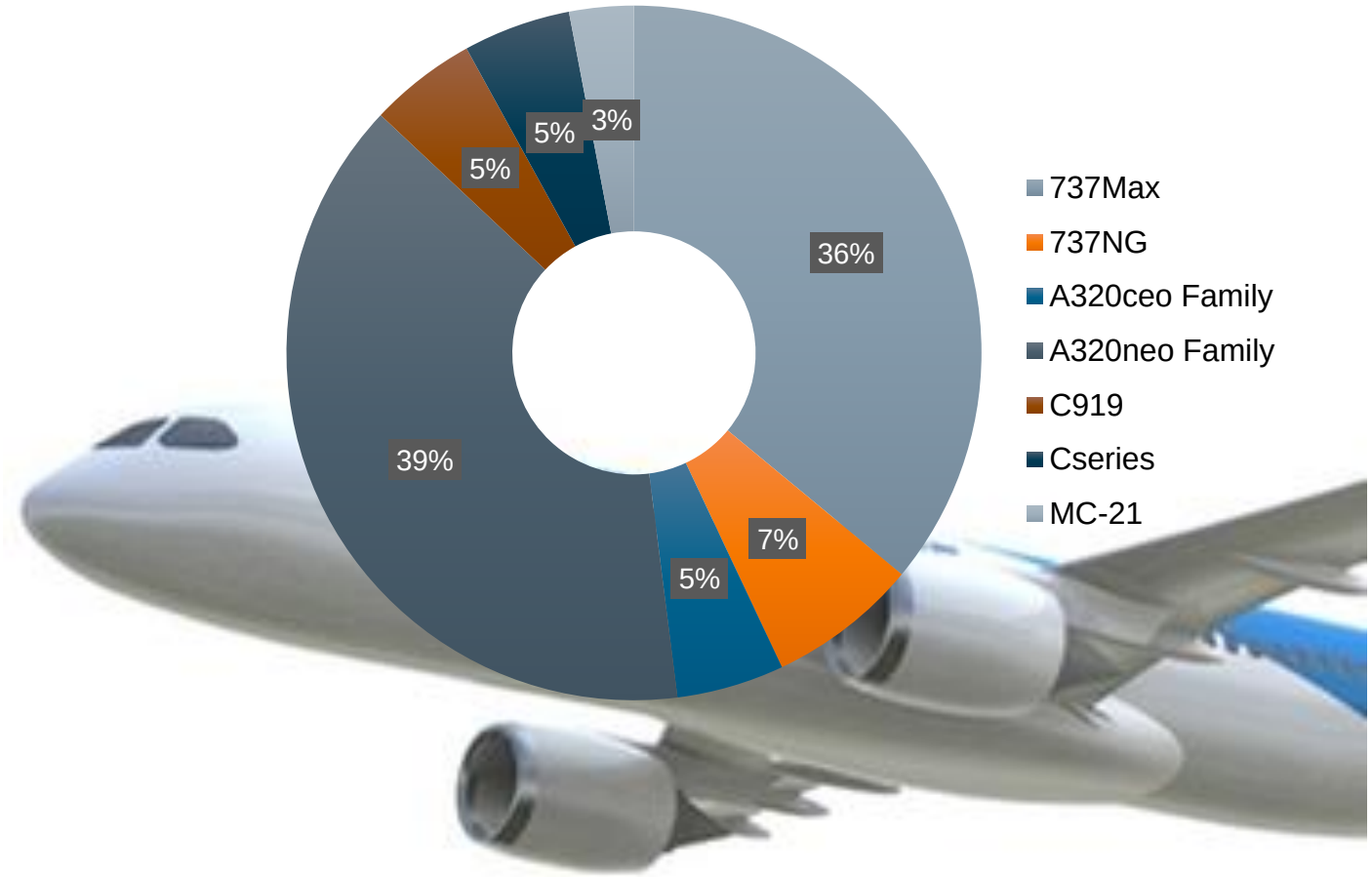
Increased Regulations
Minimize environmental footprint

Growing Competition/ 竞争者增加
Differentiate & capture market share/ 分享市场

Single-Aisle Deliveries 2015-2034 /单通道客机供应商



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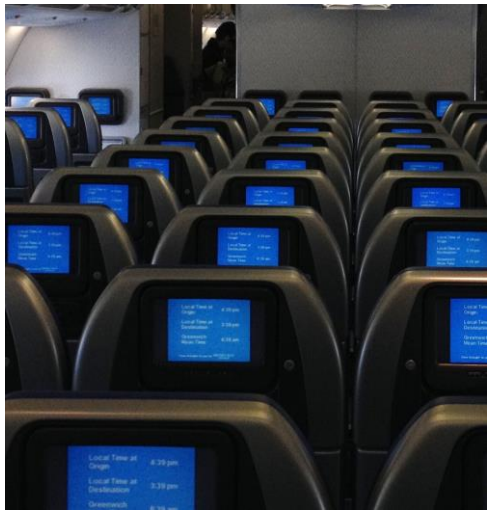
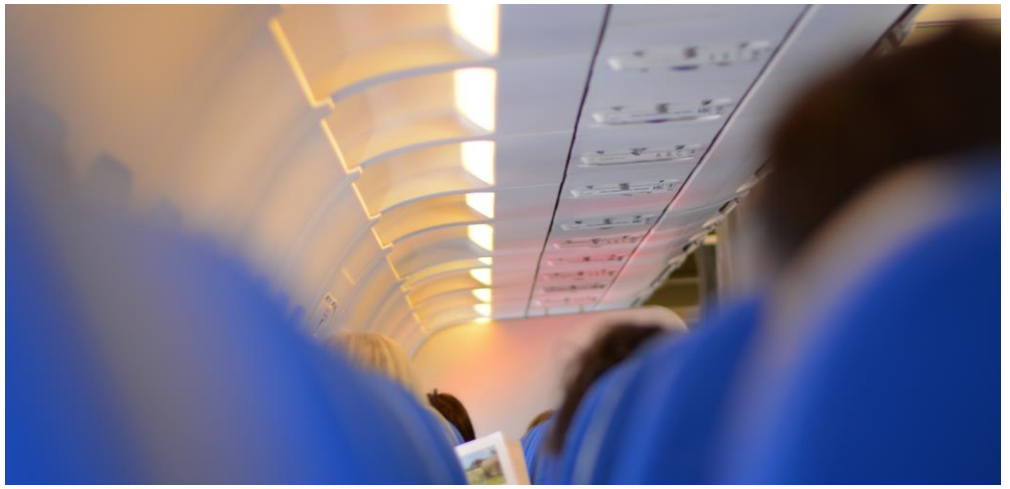
Growing Competition
Differentiate & capture market share

Better Customer Experience/
更好的客户体验
Demand for Comfort and Convenience/ 舒适度与便利性的需求





Customer Experience is the New Battleground for Winning Customer Loyalty /客户体验是赢取客户忠诚度的新战场

Trends Driving Civil Aviation
推动民航发展的趋势

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Reduced Operational and Maintenance Costs/
降低营运与维修费用

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推动民航发展的趋势

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Alternative Business Opportunities/ 其他商机
Leverage Emerging Capabilities/ 借用新开发的技术

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推动民航发展的趋势

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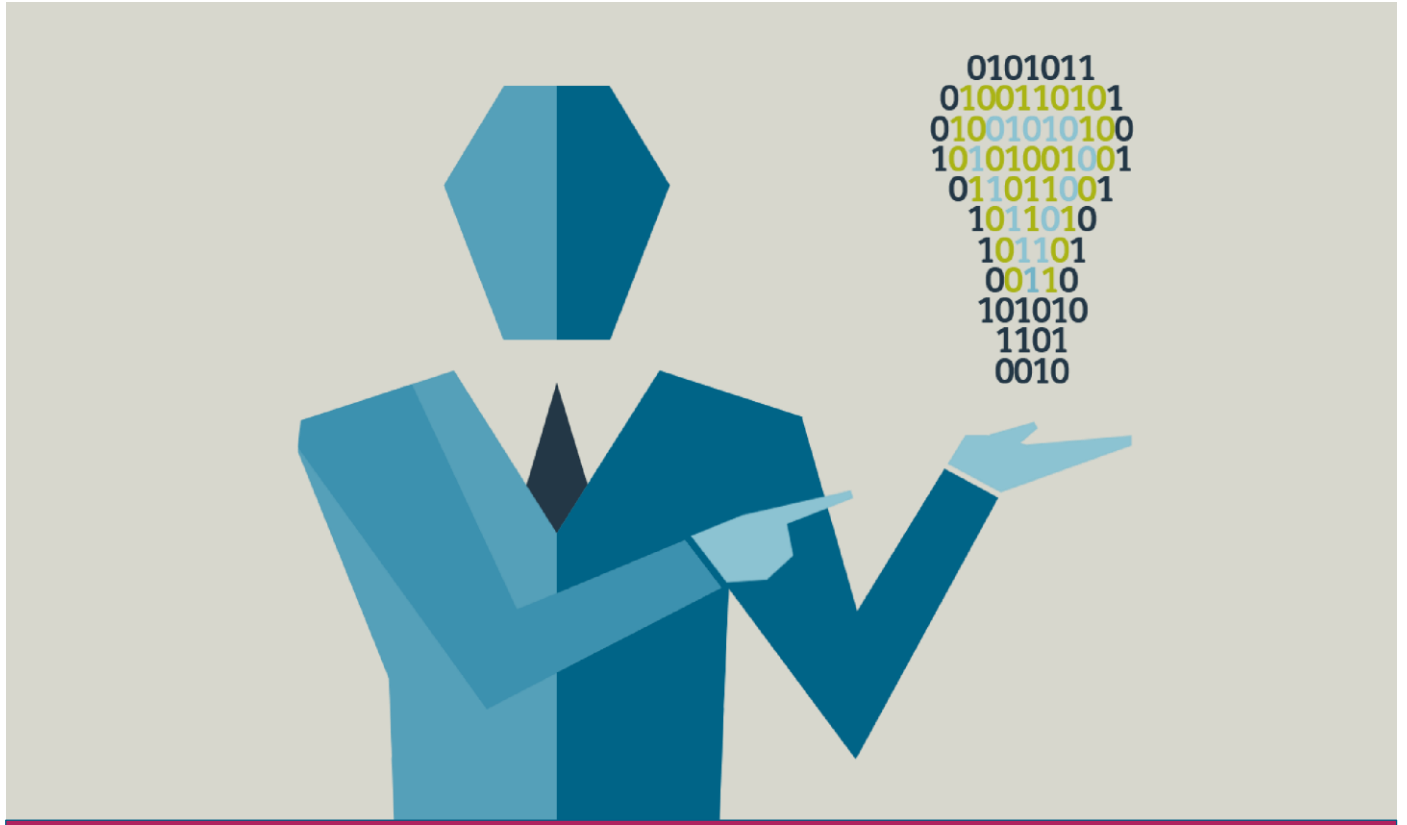

Driving Product Innovation Through Simulation /

通过模拟驱动产品创新

Simcenter™ Portfolio for Predictive Engineering Analytics: STAR-CCM+
Simcenter™旗下工程设计分析软件：STAR-CCM+

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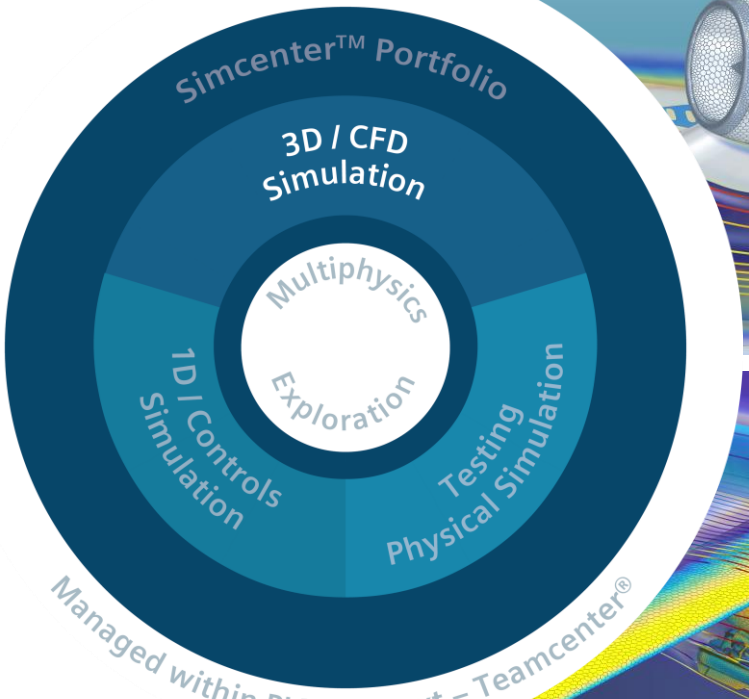
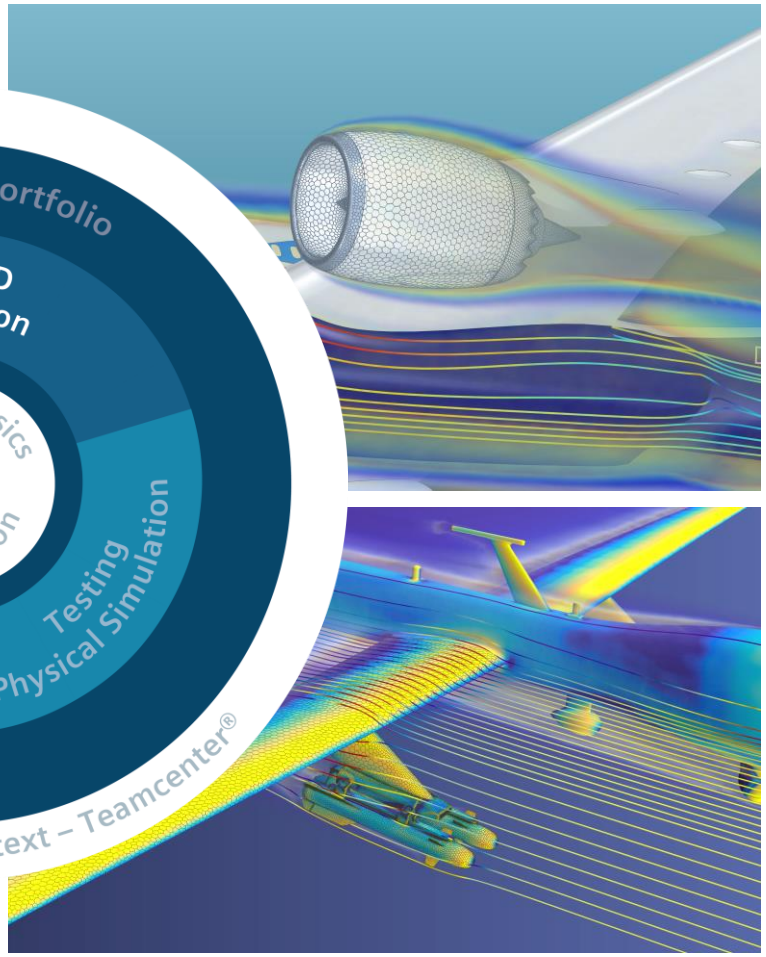
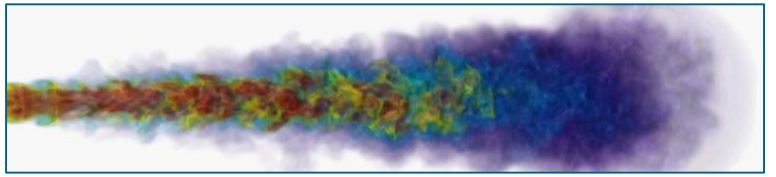
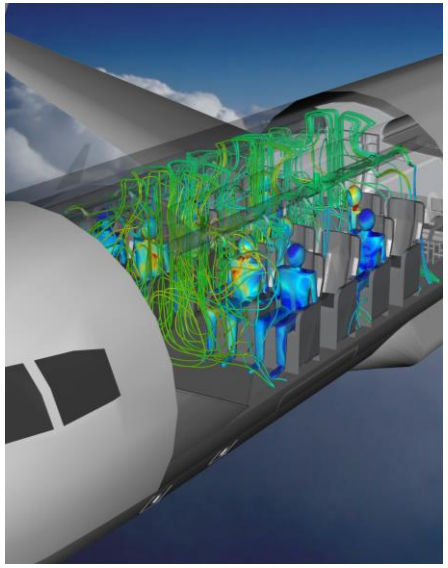
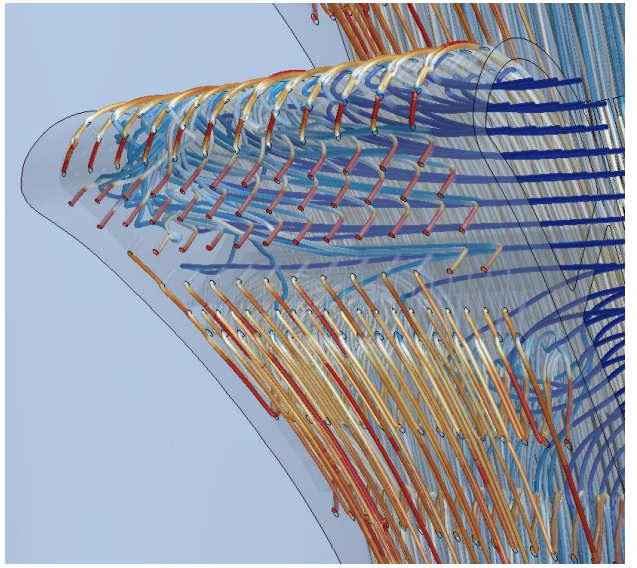






STAR-CCM+





Simcenter™ Portfolio for Predictive Engineering Analytics
STAR-CCM+/ Simcenter™旗下工程设计分析软件STAR-CCM+

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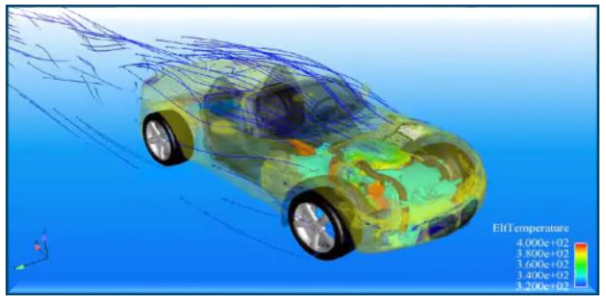
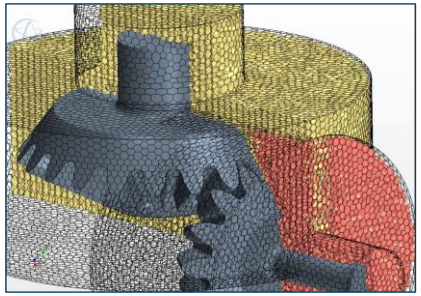
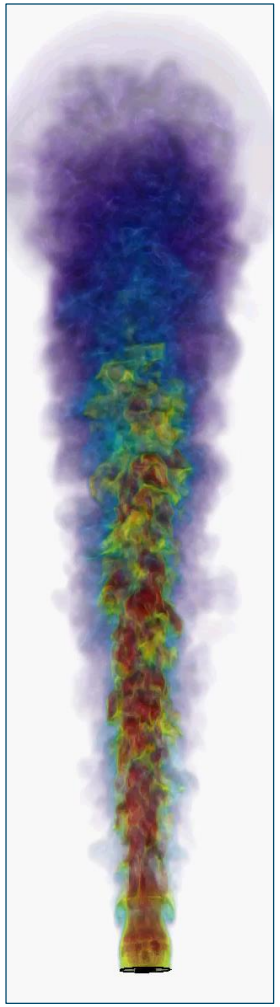
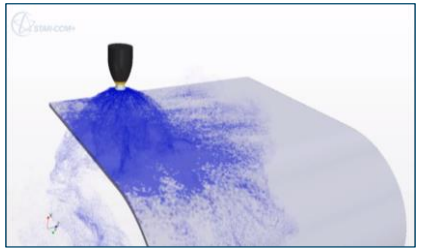
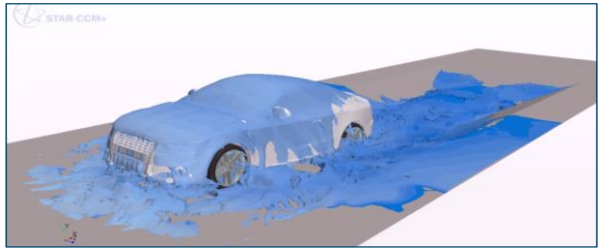
- Fluid Dynamics
- Solid Mechanics
- Fluid-structure Interaction
- Heat Transfer
- Particle Flows
- Reacting Flows
- Multiphase
- Electrochemistry
- Electromagnetics
- Acoustics
- Rheology

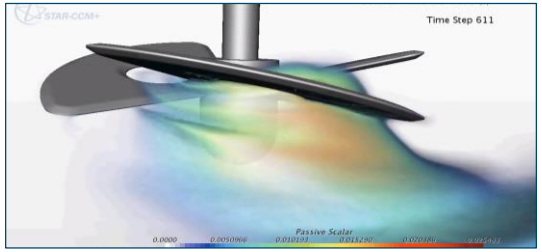


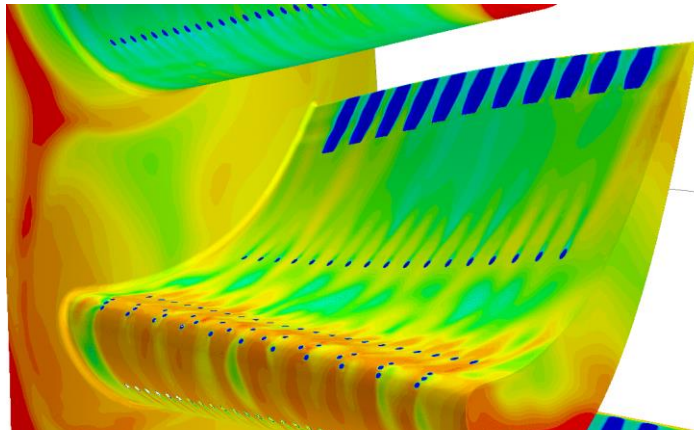




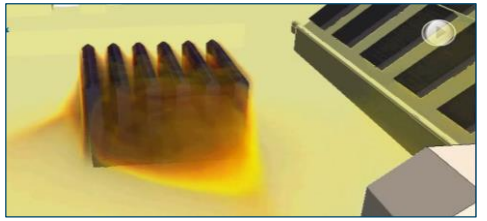


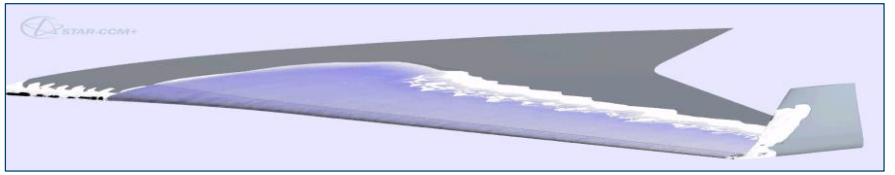




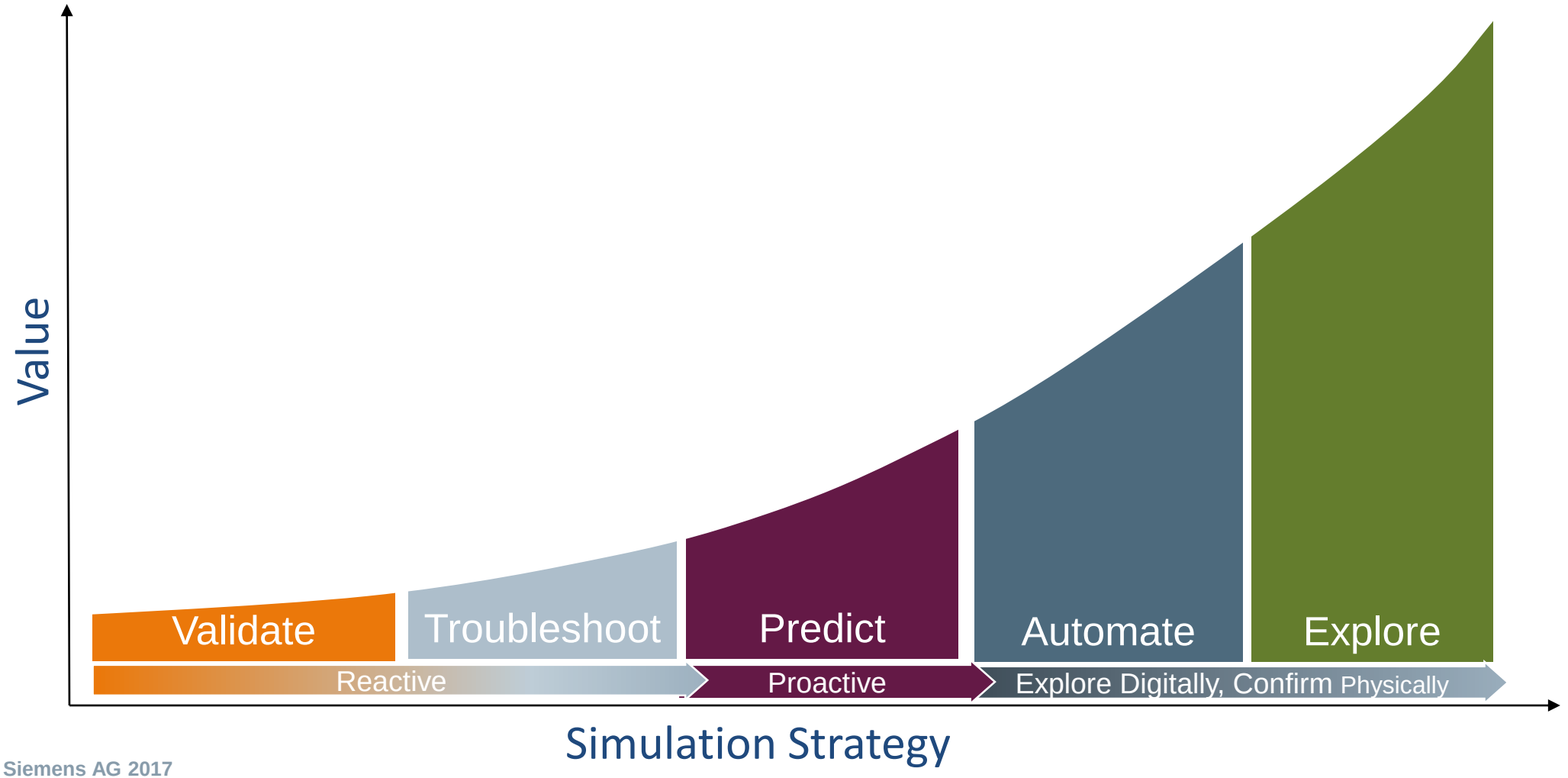


Multiphysics





Redefining Simulation Strategy for Innovation
重新定义创新的模拟策略



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  验证与除错:反推力系统
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Redefining Simulation Strategy for Innovation
重新定义创新的模拟策略

UTAS: Thrust Reverser Performance Estimation/ UTAS
反推力系统性能预测

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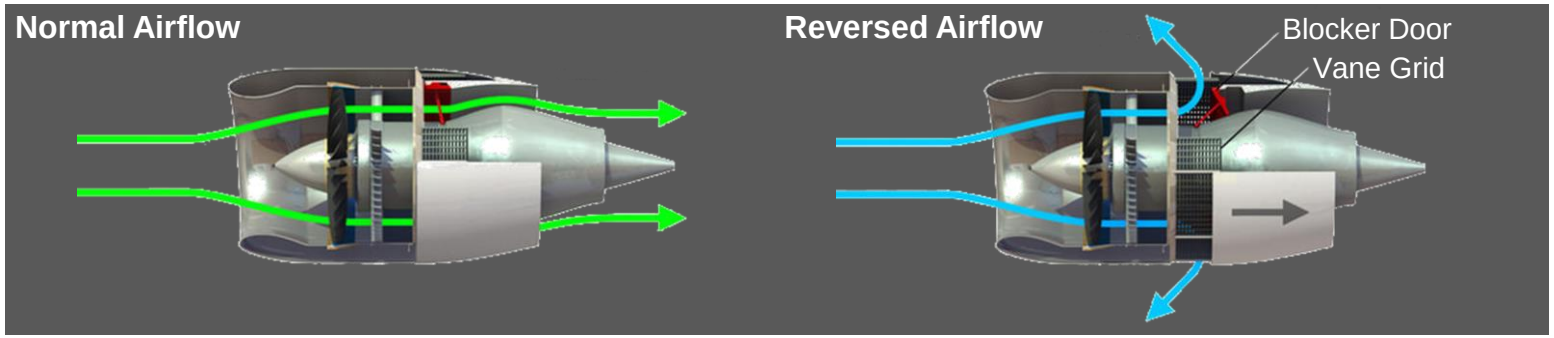
Background

- Most modern turbofan engines
- Play important role in safety
- Important in certification

Basic Requirements

- Gross reverser effectiveness
- Area match through deployment
- No re-ingestion of the plume
- No adverse performance at cruise conditions



UTAS: Thrust Reverser Performance Estimation/ UTAS
反推力系统性能预测

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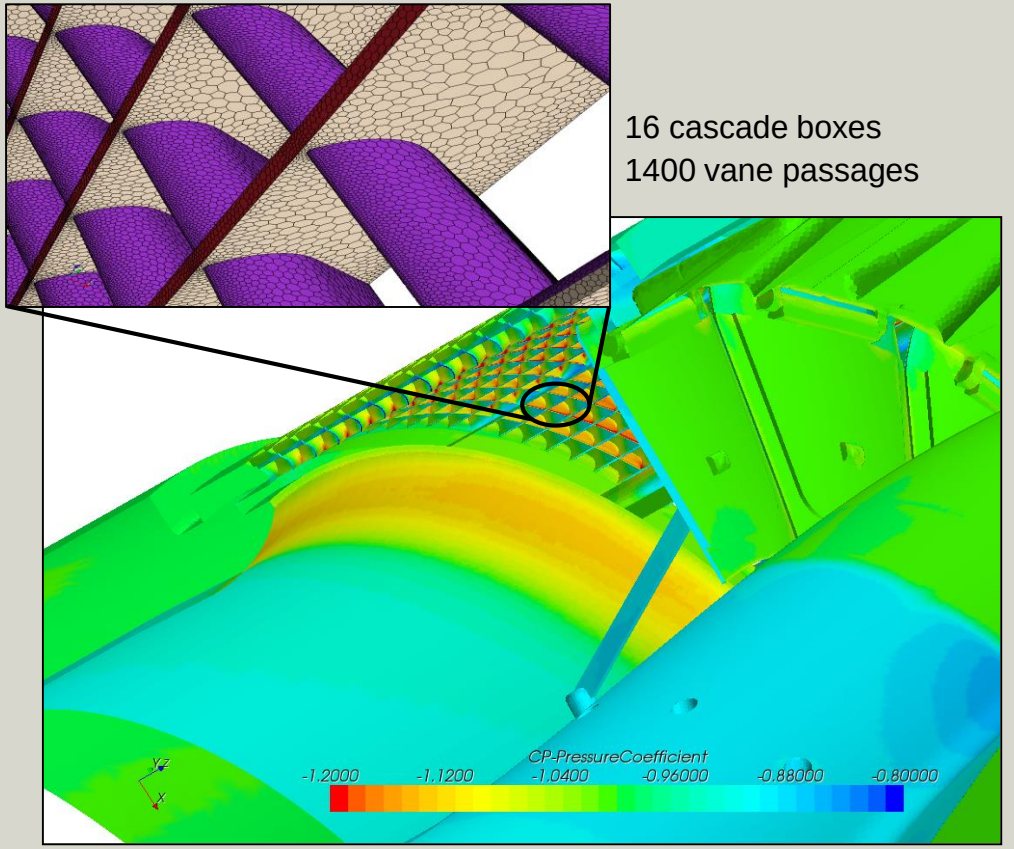
State-of-the-Art Validate / Troubleshoot Strategy（使用最新技术的验证/ 除错策略）

3D CFD Simulation of Full 360° Cascade

- Able to capture all relevant geometric details
- Fast, reliable, pipelined process



Simulation results in

- Time and cost savings via less physical testing
- Reduced risk

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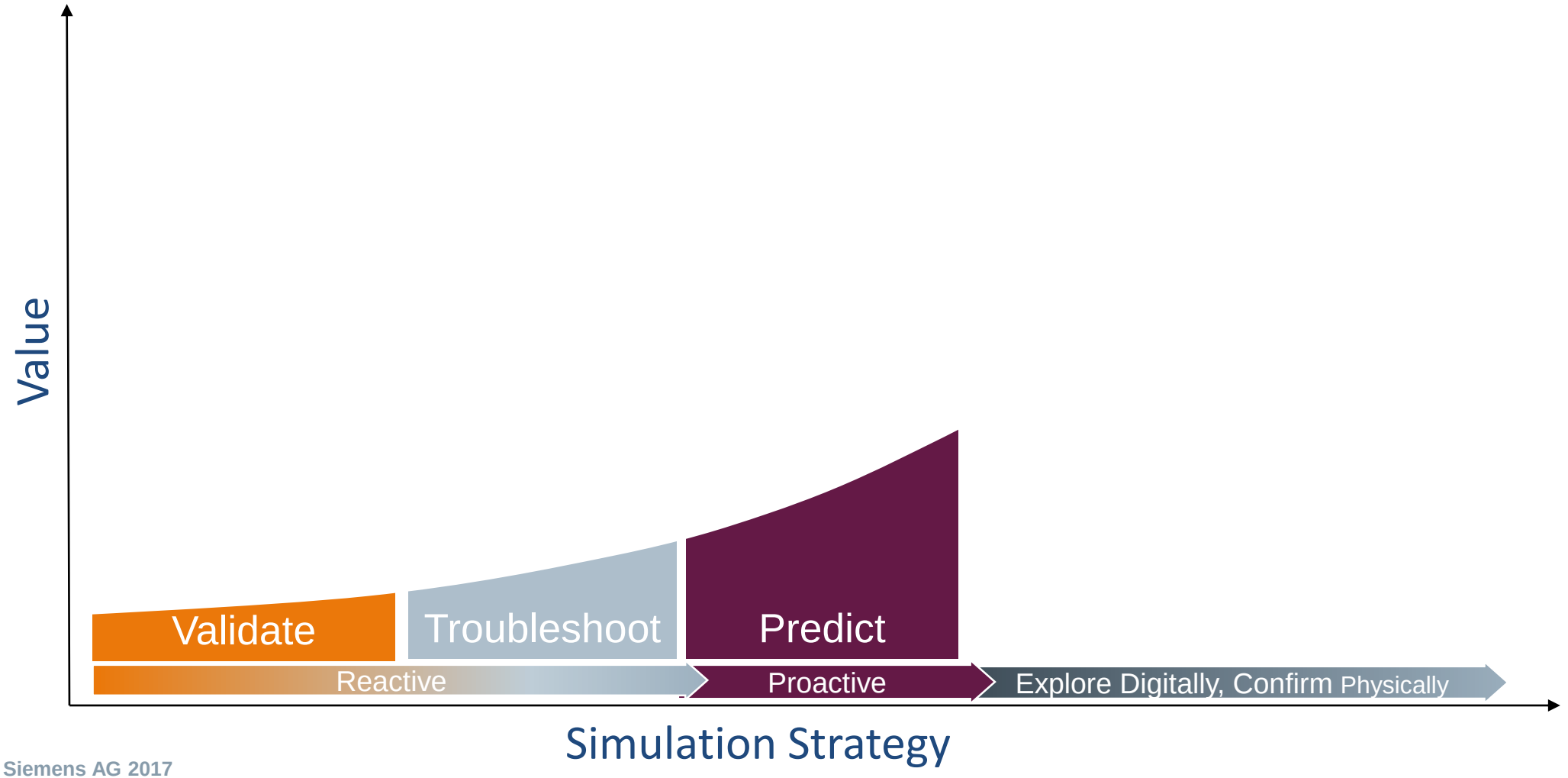

Joby Aviation: Electric Aircraft Design
宙比飞行器公司:电控飞行器设计

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Background

Opens the design space

- Wealth of aircraft design knowledge: over 100 years
- Much of this knowledge is irrelevant for electric propulsion

Multiple Motors/Propellers

Electric propulsion scales

- Redundancy for VTOL safety
- Increased efficiency
- Reduced noise

Introduces Design Questions

What to do at cruise?

- Fold into streamlined nacelles?
- Use as lifting surfaces?
- Remain in active propulsion?

Simulation is critical for good electric aircraft design/ 对于高质量的电控飞行器设计模拟是极为重要方法

Joby Aviation: Electric Aircraft Design
宙比飞行器公司:电控飞行器设计

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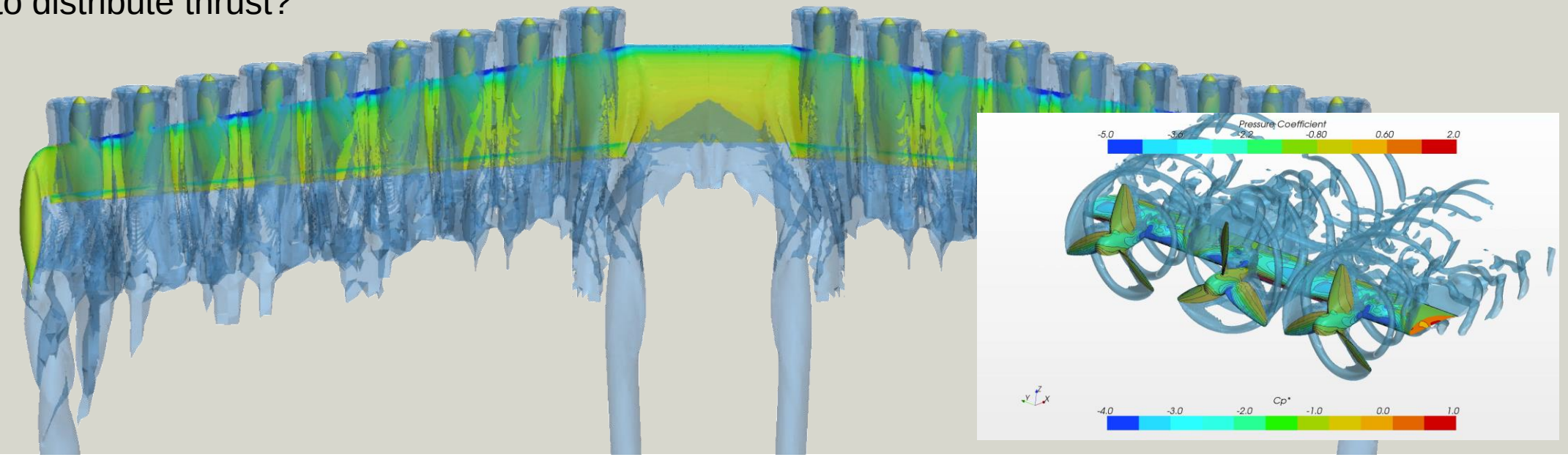
Distributed Propulsion at Cruise/在巡航使用分布式推进器

Increased dynamic pressure across wingspan

- Increases maximum lift; allows better wing sizing for cruise efficiency

Introduces many new design questions

- Propeller/propeller interactions
- How to distribute thrust?



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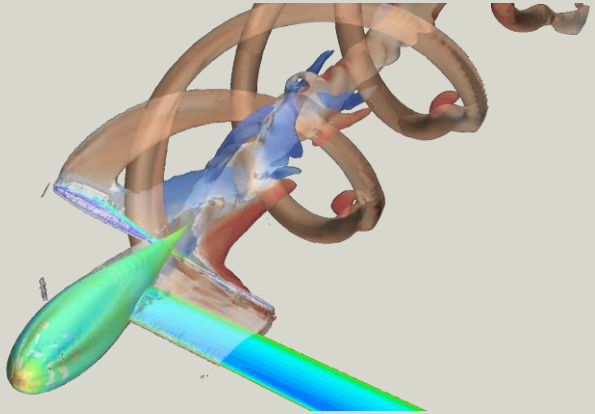
Wingtip Cruise Propellers/ 带有翼尖巡航螺旋桨

Propeller interacts positively with wingtip vortex

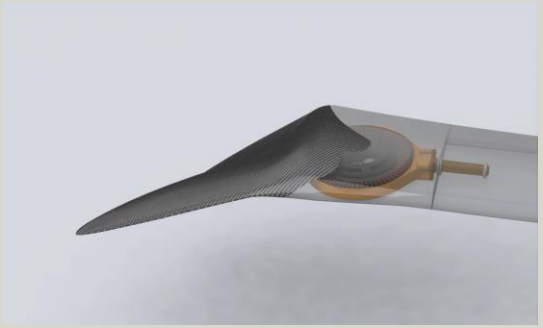
- Increase in propulsive efficiency
- Reduction in cruise power
- Reduction in induced drag of the wing

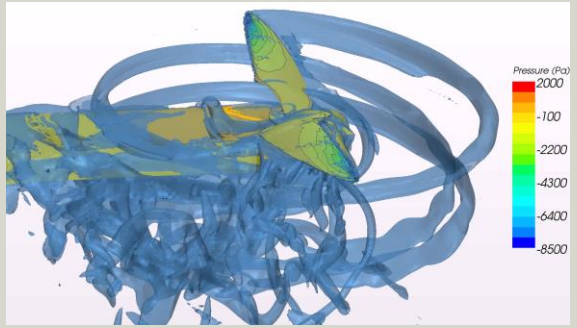


Extend Effective Wingspan/可调整的翼展设计

Propeller creates additional winspan at cruise

- Increase aerodynamic performance
- Introduces design compromise at VTOL
- Propeller/wing interactions are not well-known





Reliable predictions enable simulation-based design decisions/可靠的预测能实现模拟驱动设计

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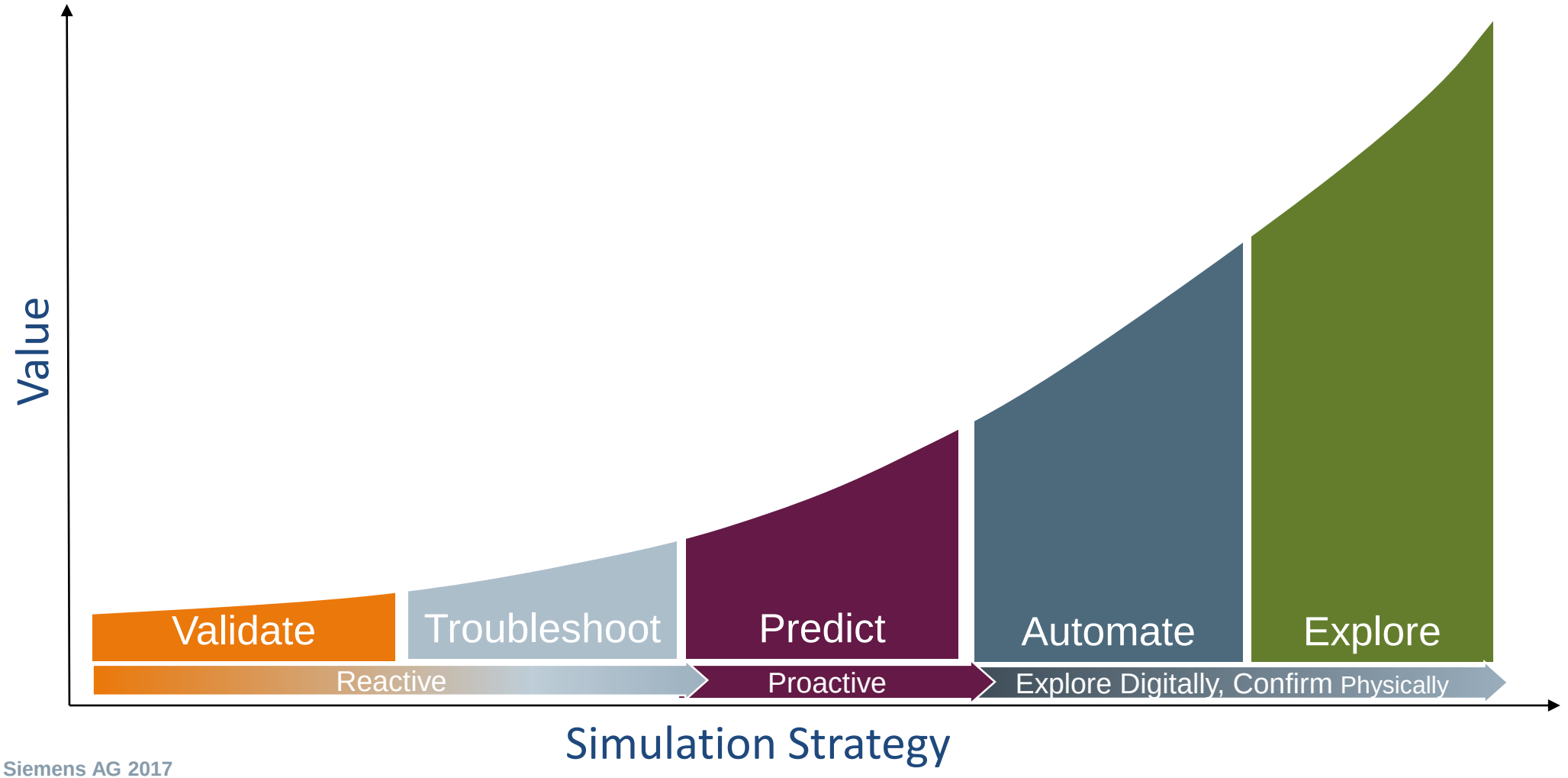

What is Design Exploration Through Simulation?
通过模拟进行设计空间探索

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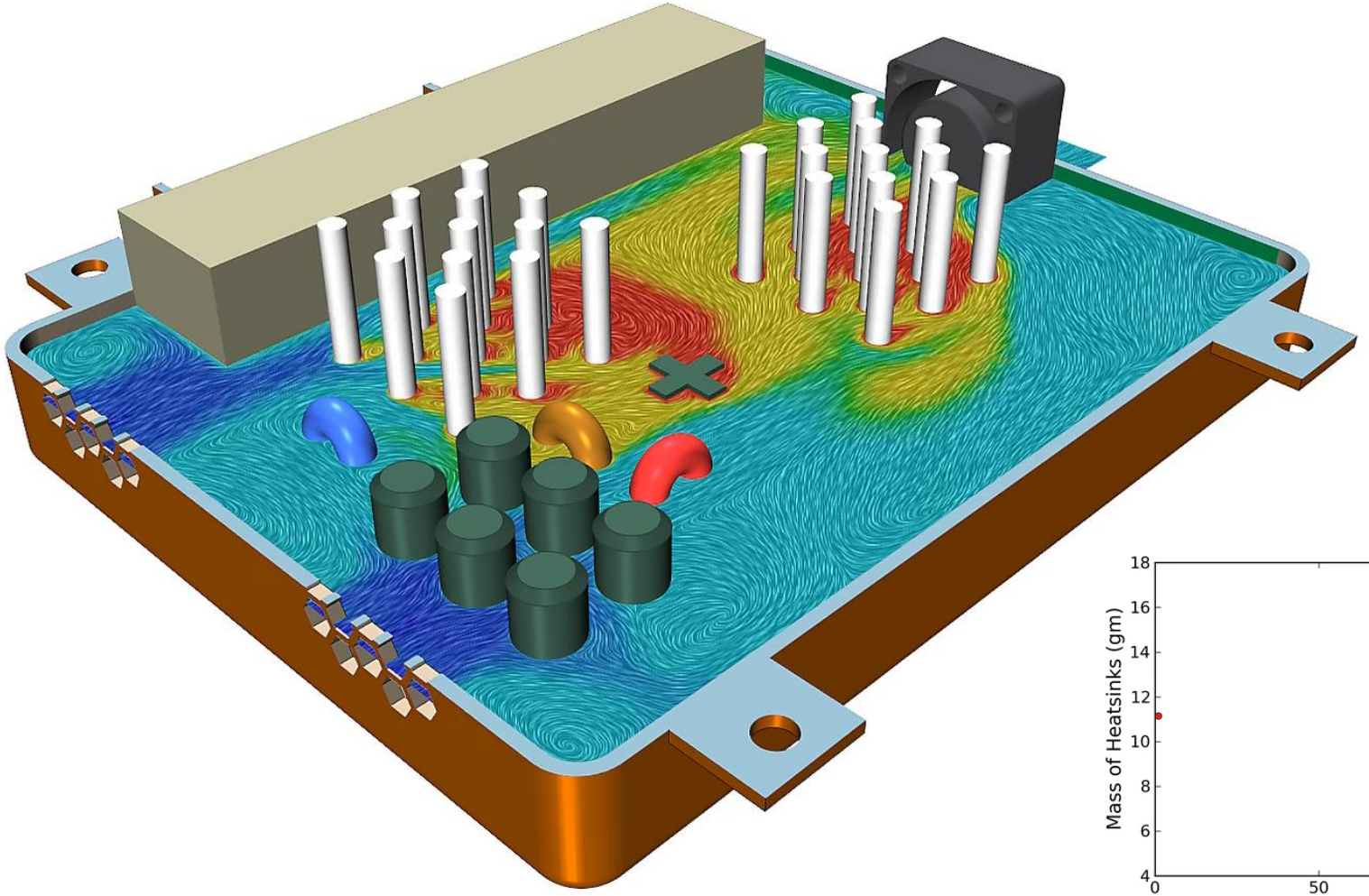

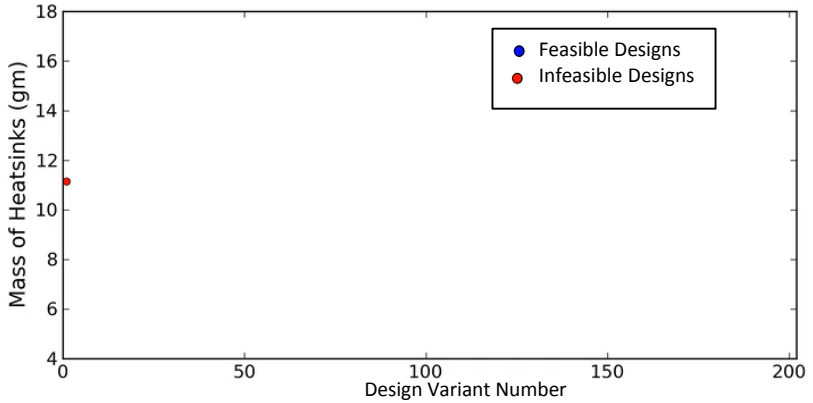

What is Design Exploration Through Simulation?
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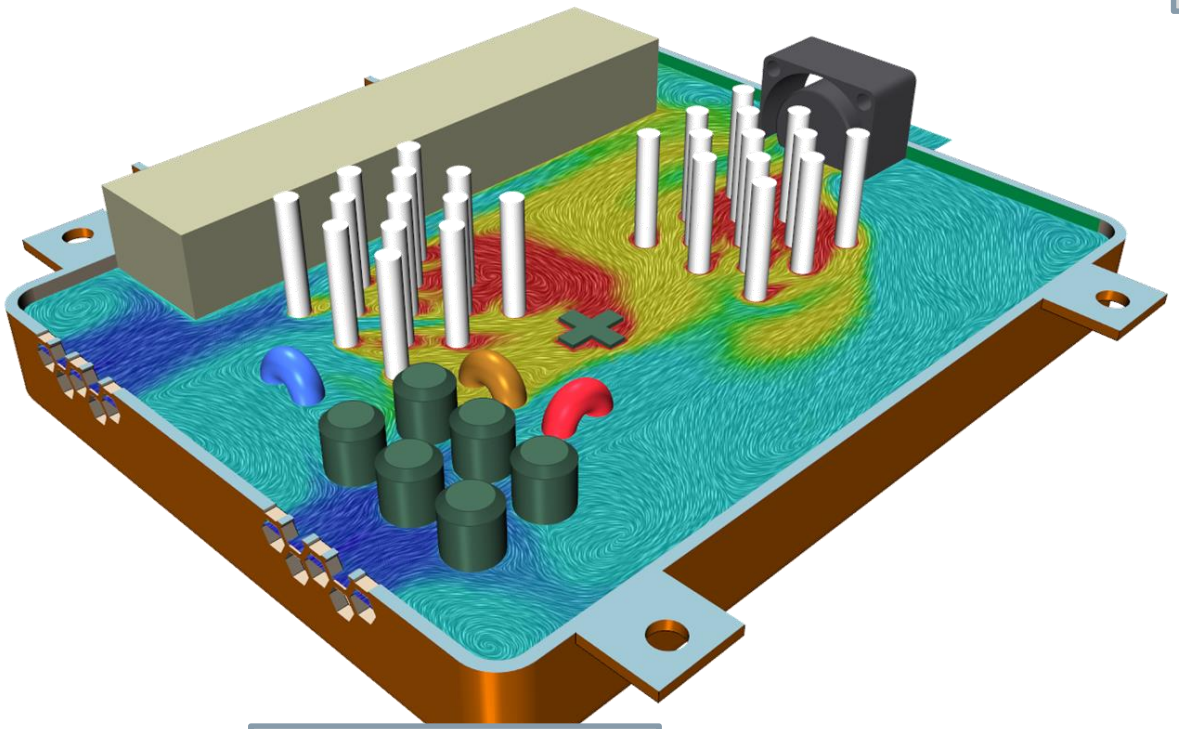
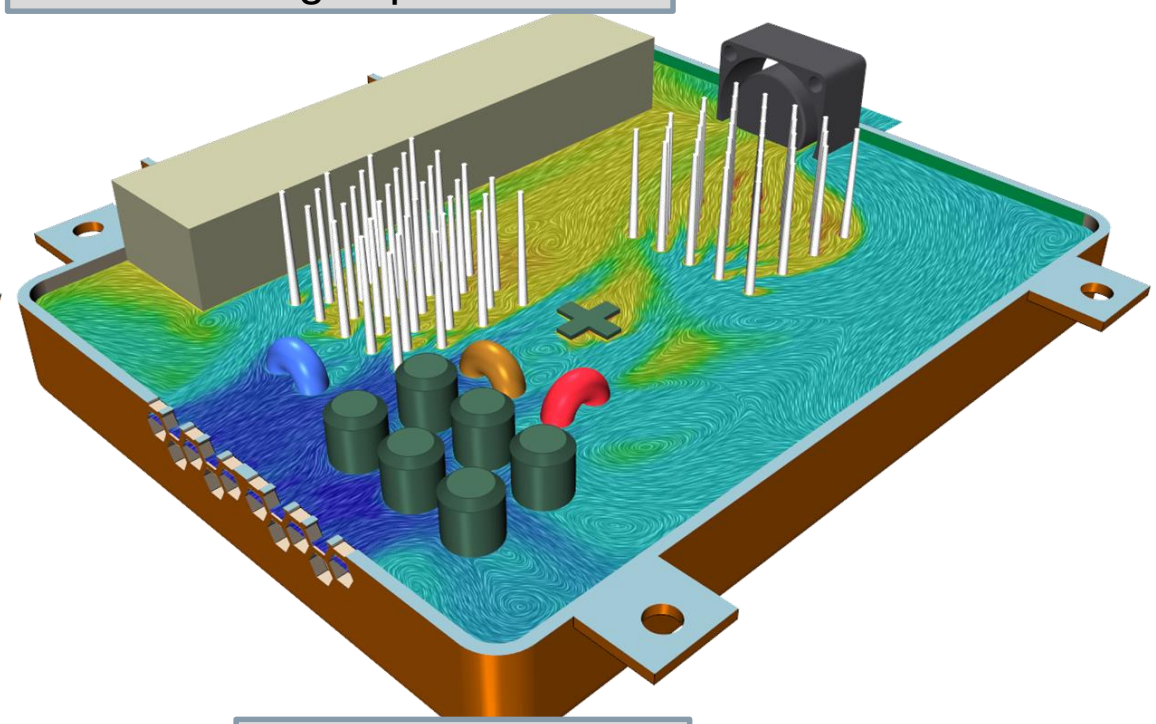
51% reduction in mass
25% cooling improvement



Baseline Design



Improved Design

Airbus: Static Air Mixer in ECS Design
空客：空气混合器设计探索

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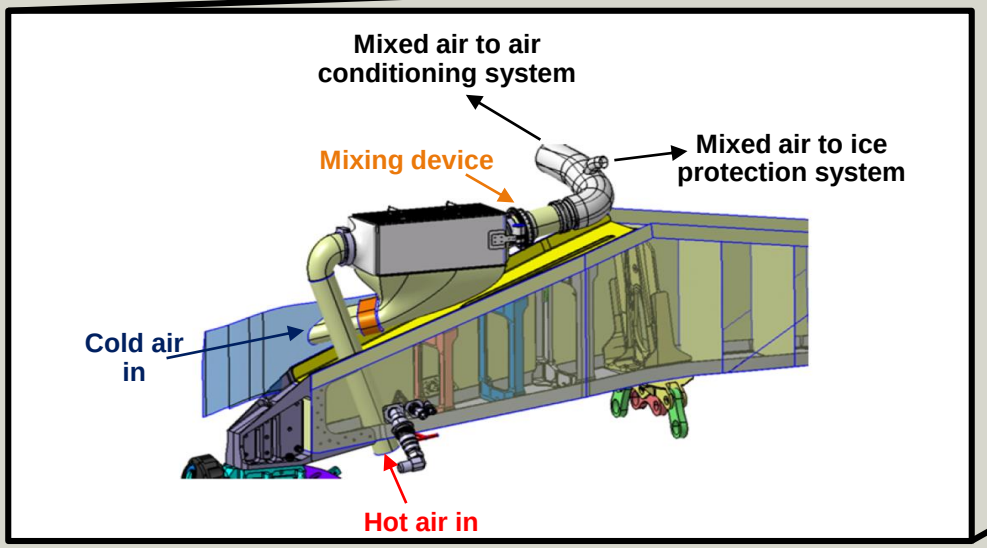
Aircraft Bleed-Air System Design
飞行器抽气系统设计

Goal: Redesign a mixing device to improve performance of air conditioning and wing ice protection systems



Airbus: Static Air Mixer in ECS Design
空客：空气混合器设计探索

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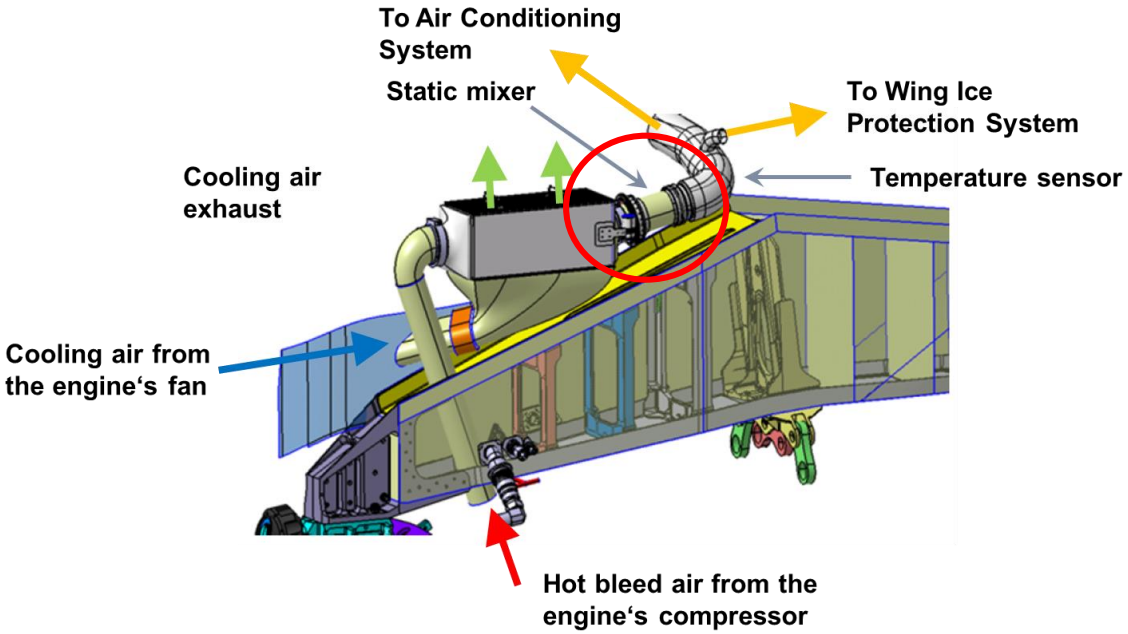
Purpose of Bleed-Air System/ 抽气系统目的

Supply air at a given temperature and pressure (actively controlled) to the Air Conditioning and Wing Ice Protection systems.

Static Mixer Design Goal/ 空气混合器设计目标

Total pressure loss < 5kPa
Temperature difference at sensor < 12K



Airbus: Static Air Mixer in ECS Design
空客:空气混合器设计探索

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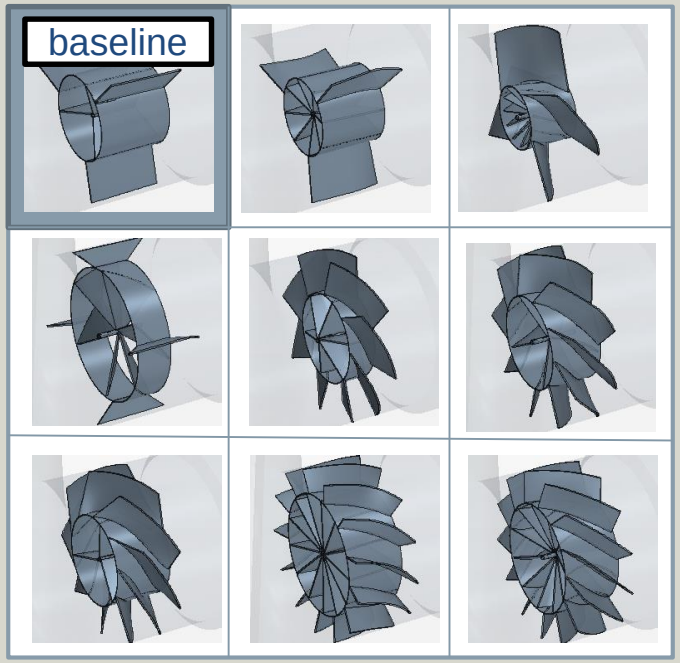
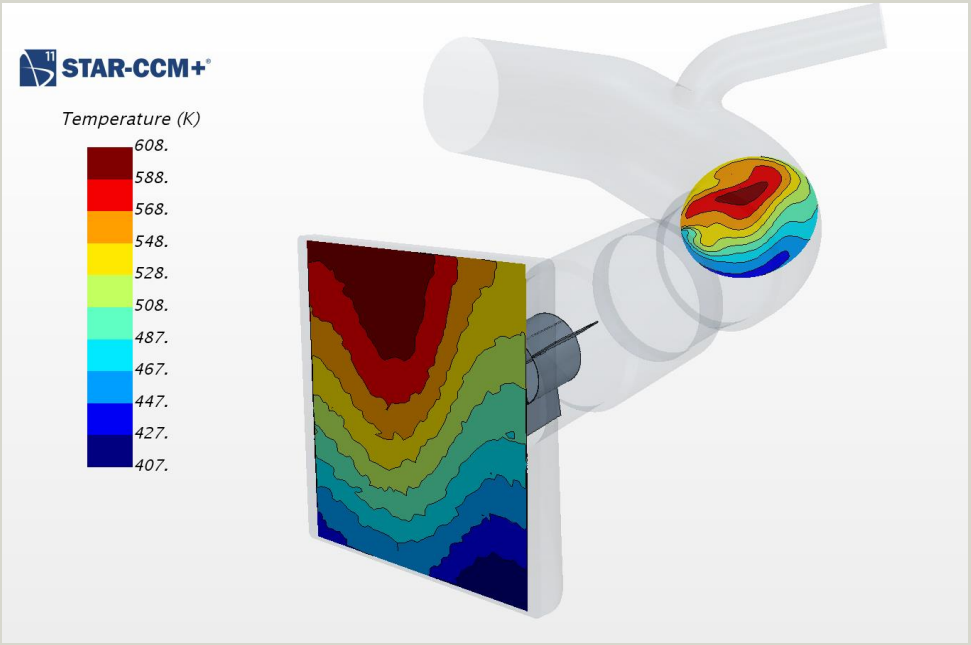
Concentric Mixer Concept/ 轴向混合器概念

- Chosen to give maximum design space flexibility
- Direct optimization does not require simplification of design space



Baseline Design/ 原始设计

- High variance in inlet temperature
- Limited mixing with baseline design:
  - ΔP = 1kPa , ΔT = 153K



Airbus: Static Air Mixer in ECS Design
空客:空气混合器设计探索

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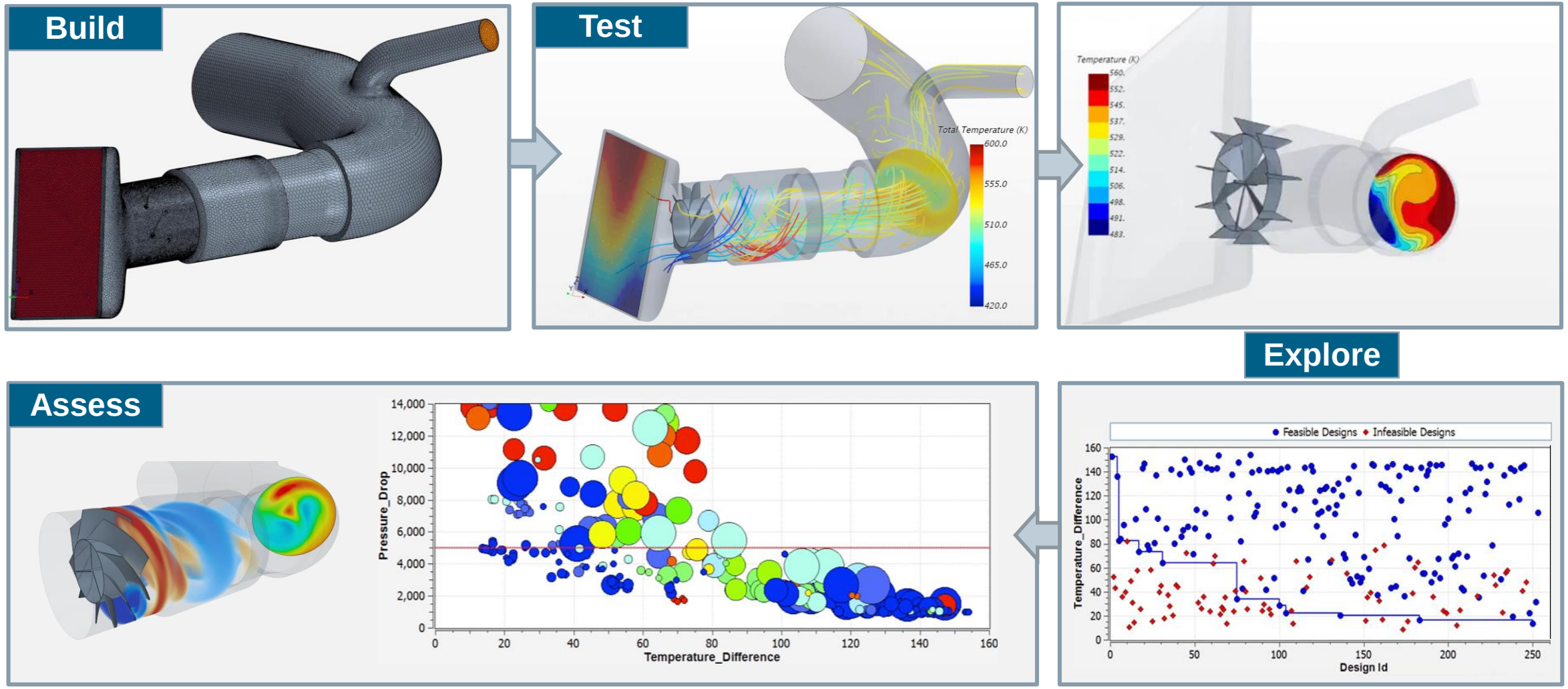

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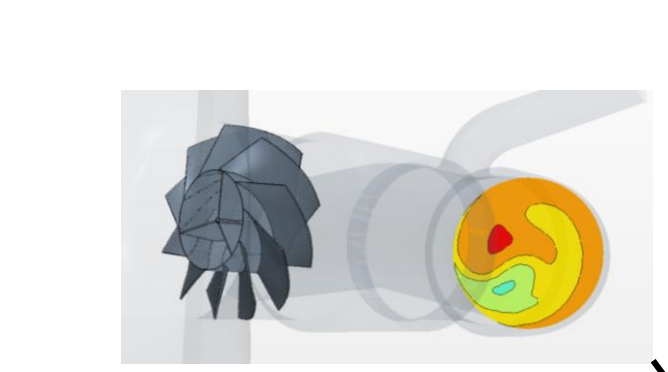
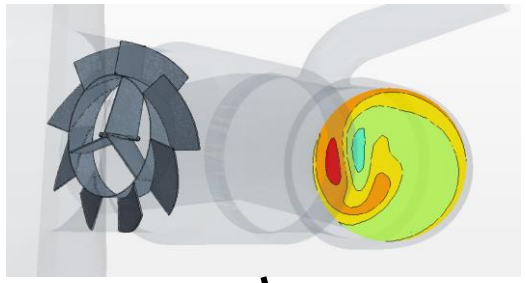
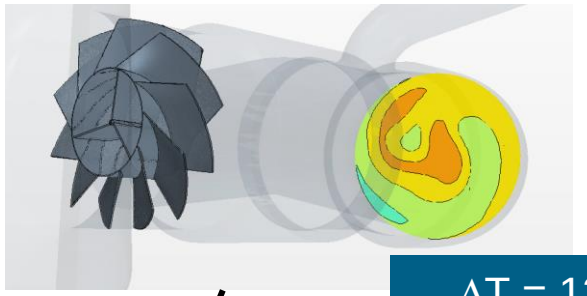
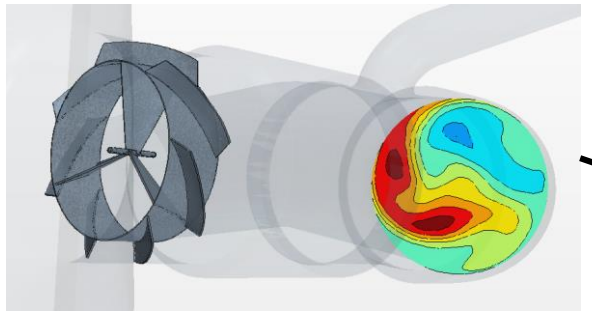
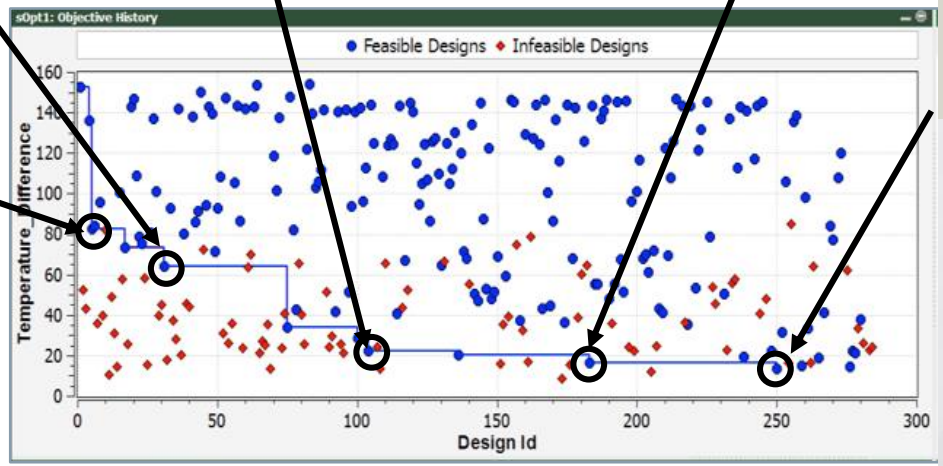
空客:空气混合器设计







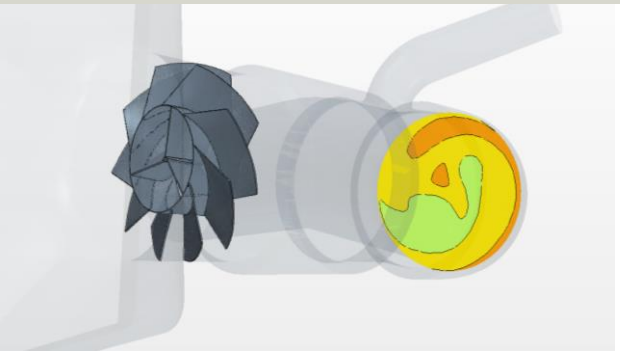




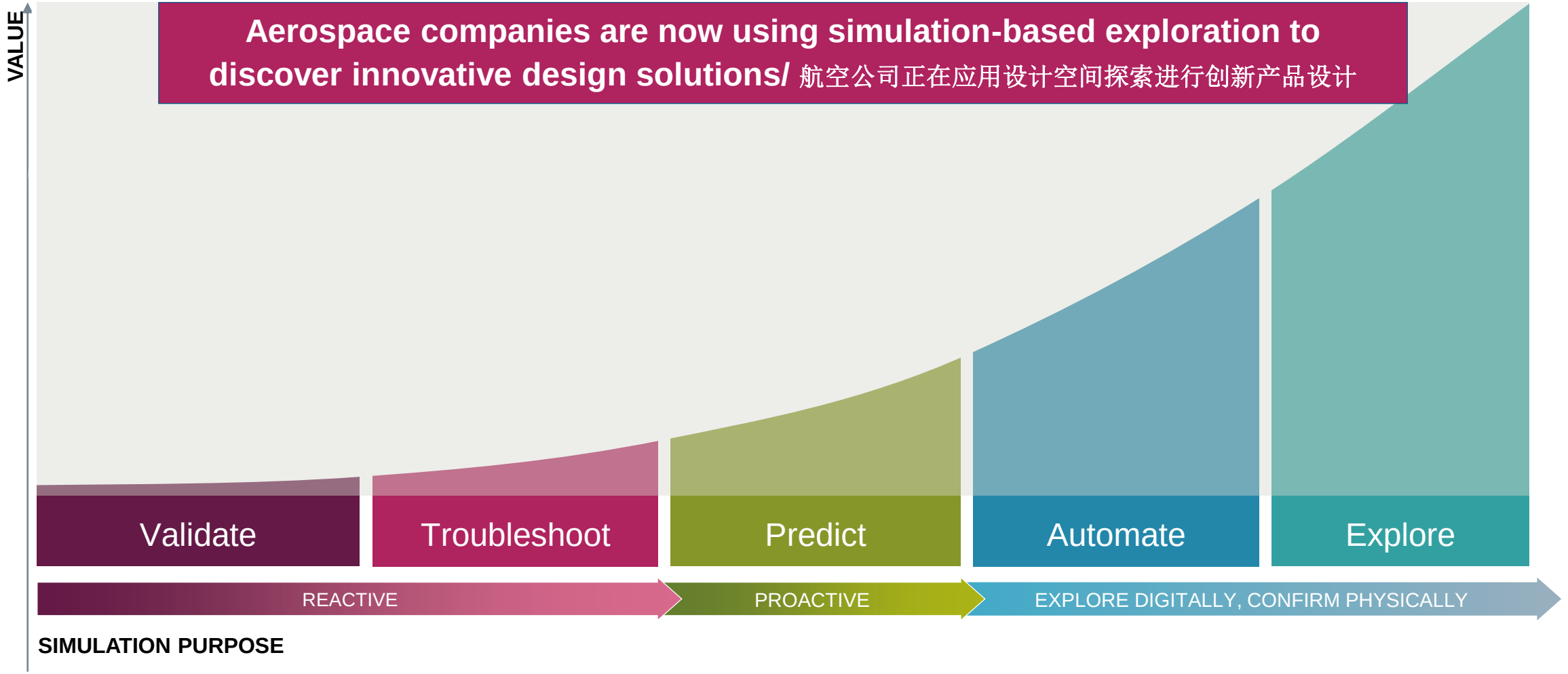
ΔT = 13.7K ΔP = 4.9kPa

Temperature variation reduced by over 90%

Pressure drop constraint met



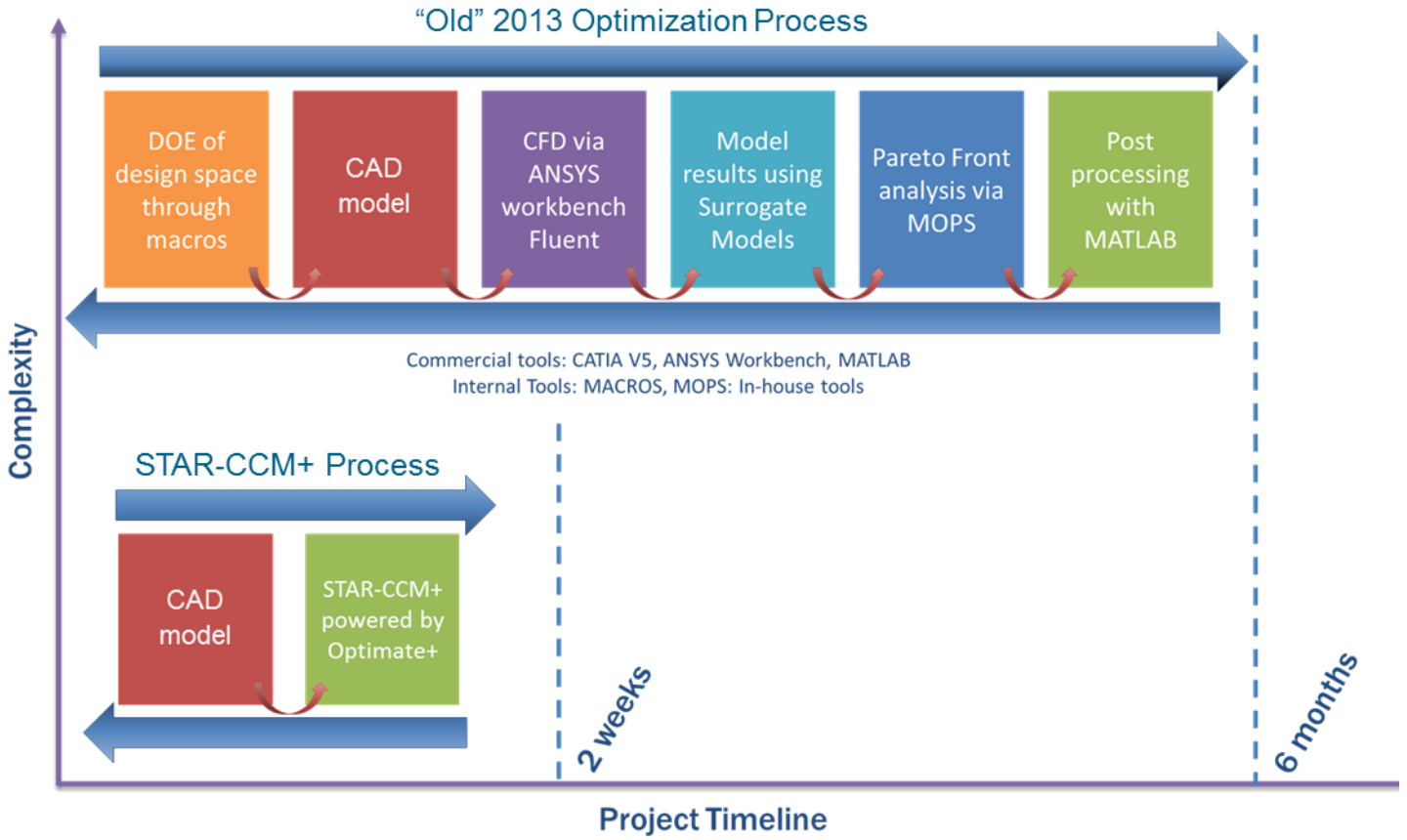
Conclusion: Better Designs, *Faster*
结论:更快发现更好的设计



Airbus: Static Air Mixer in ECS Design
空客:空气混合器设计

With STAR-CCM+, Airbus reduced exploration time from over 6 months to less than 2 weeks.
使用STAR-CCM+, 空客空气混合器设计时间从6个月减少到2周

This allows simulation-based design space exploration in a production environment
在产品研发环境中已容许运用模拟进行设计空间探索



Conclusion: Better Designs, *Faster*
结论:更快发现更好的设计

SIEMENS

BUILD → TEST → EXPLORE → ASSESS

STAR-CCM+
Multiphysics Platform

STAR-CCM+

DARS	STAR-CD /es-ice	Battery Design Studio	SPEED
Chemical Reactions	In-Cylinder	Batteries	Electric Machines

Quickly Predict Real-World Performance and Find Better Designs

- Parametric Models
- Flexible & Robust Meshing
- Multiphysics
- Efficient Parallel Computation
- Workflow Automation
- Intelligent Design Exploration

Innovative Products and Technologies
创新的软件功能与技术

Quickly Predict Real-World Performance and Find Better Designs

Flexible License Models/ 灵活的授权使用模式

Making Design Exploration Possible

Individualized Customer Support/ 独特的客户支持系统

Ensuring Success Through Knowledge Transfer and Expertise

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