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FrontloadingCFD für die Produktentwicklung

Produktentwicklung beschleunigen durch Frontloading der CFD Simulation in die Design Phase

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About Me

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Boris Marovic

- Business Development Consultant
- +13 Years at Mentor Graphics, A Siemens Business
- MBA, Frankfurt School of Finance & Management
- Dipl.-Ing. Aerospace Engineering, University of Stuttgart

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Agenda:

Modern Business Challenges
Introduction to Frontloading CFD
Simcenter FLOEFD Technology
Demo 1: Heat Exchanger Simulation
Demo 2: Electronics Cooling Simulation
Simcenter FLOEFD Customer Success Stories
Q&A

Manufacturers worldwide face the same challenges

- Lower development costs
- Faster time-to-market
- More innovative and better-performing products
- Bottleneck in the design process
- Reduced operational risk & compliance

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Manufacturing costs are sunk early in development

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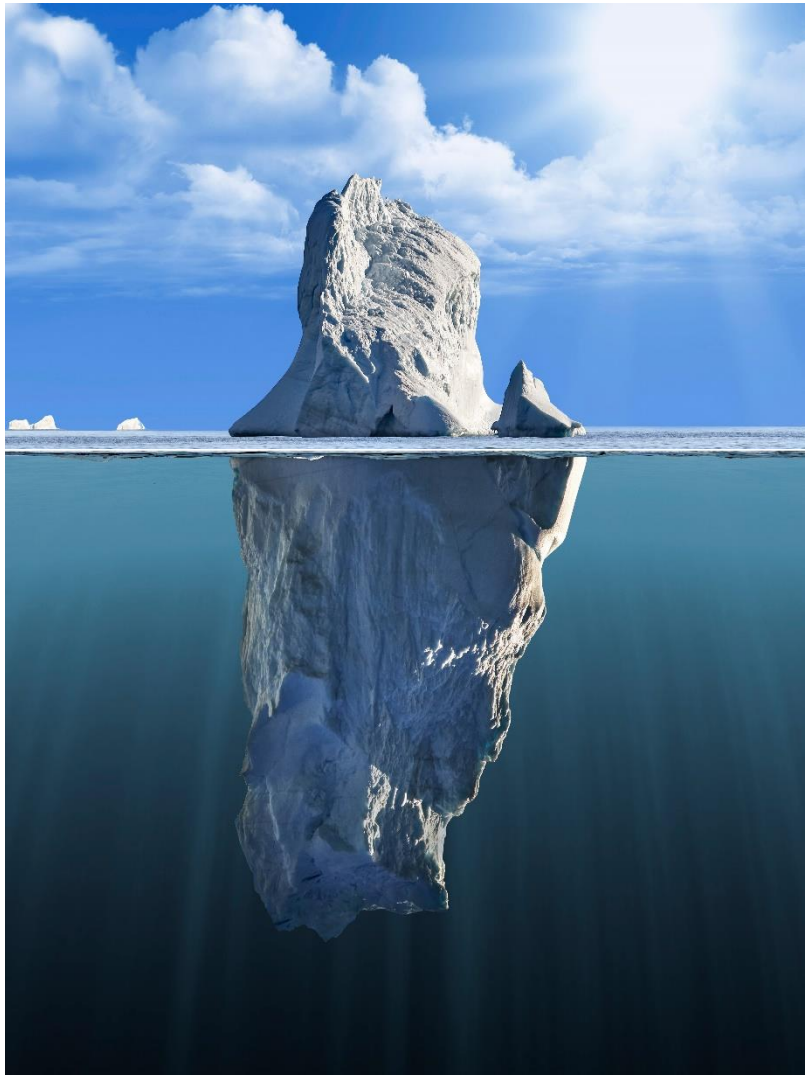

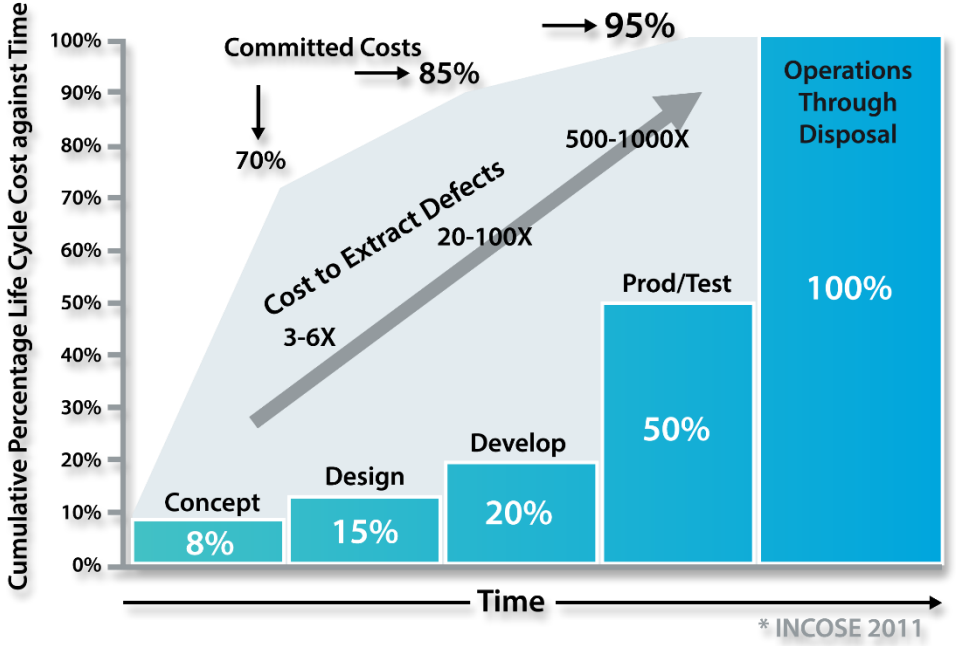

85% of US DoD projects' lifecycle costs were determined during early concept stages when little was known about final design*

*as reported by the Defense Acquisition University

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The most dangerous phrase in business is

“We’ve always done it this way”

Blocks companies from becoming more efficient and productive.

- A different approach is needed.
- One approach is being widely adopted across all industries.
- ‘Frontloading’ is changing simulation workflows.
- Frontloading delivers up to x40 productivity enhancements.

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Top 5 Hurdles for Product Design & Best-in-Class Strategies to Improve

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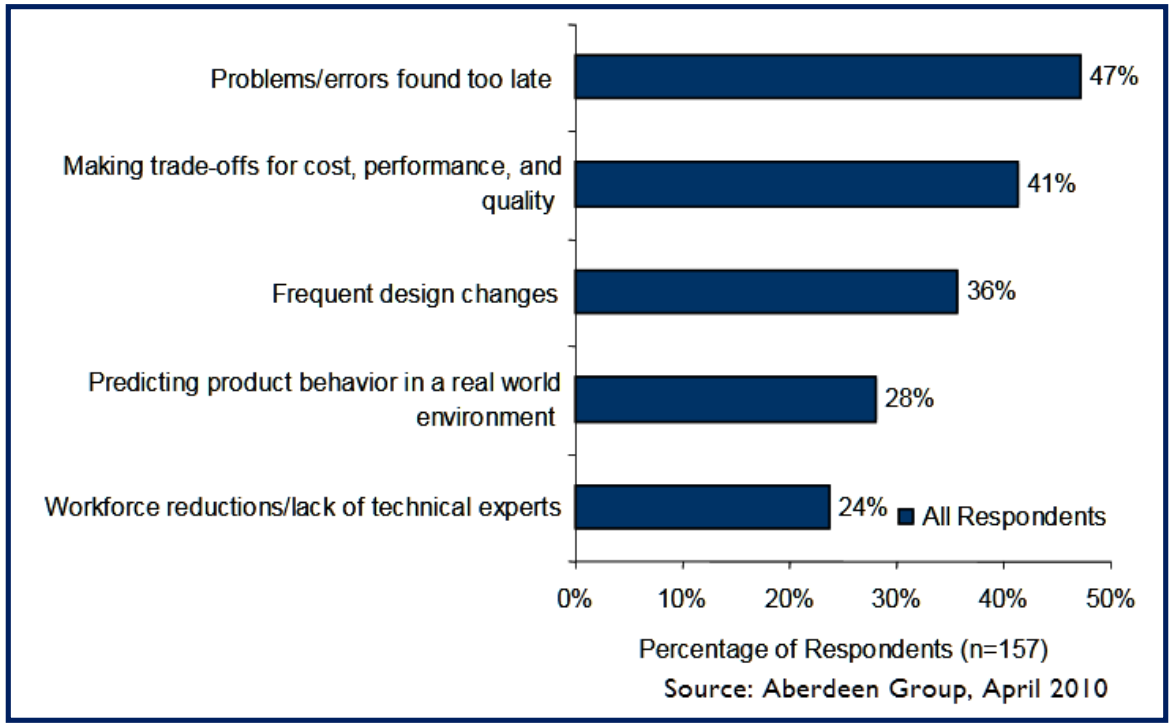
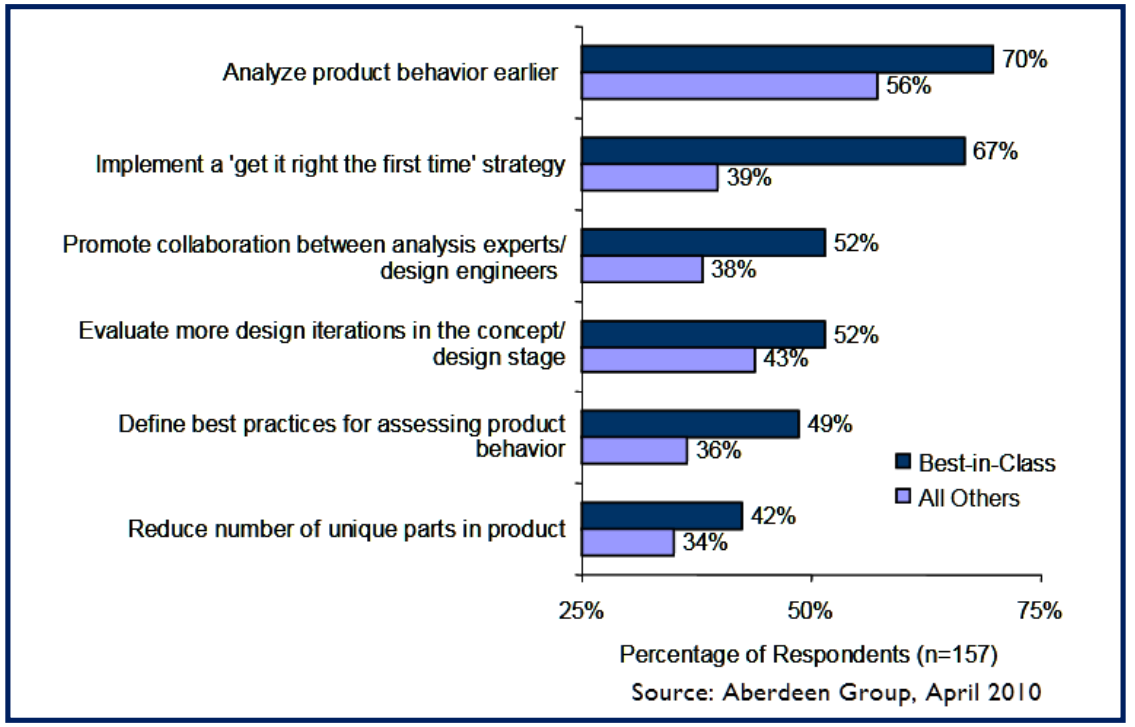
Problems are found too late



You need analyze product behavior earlier



You need Frontloading!

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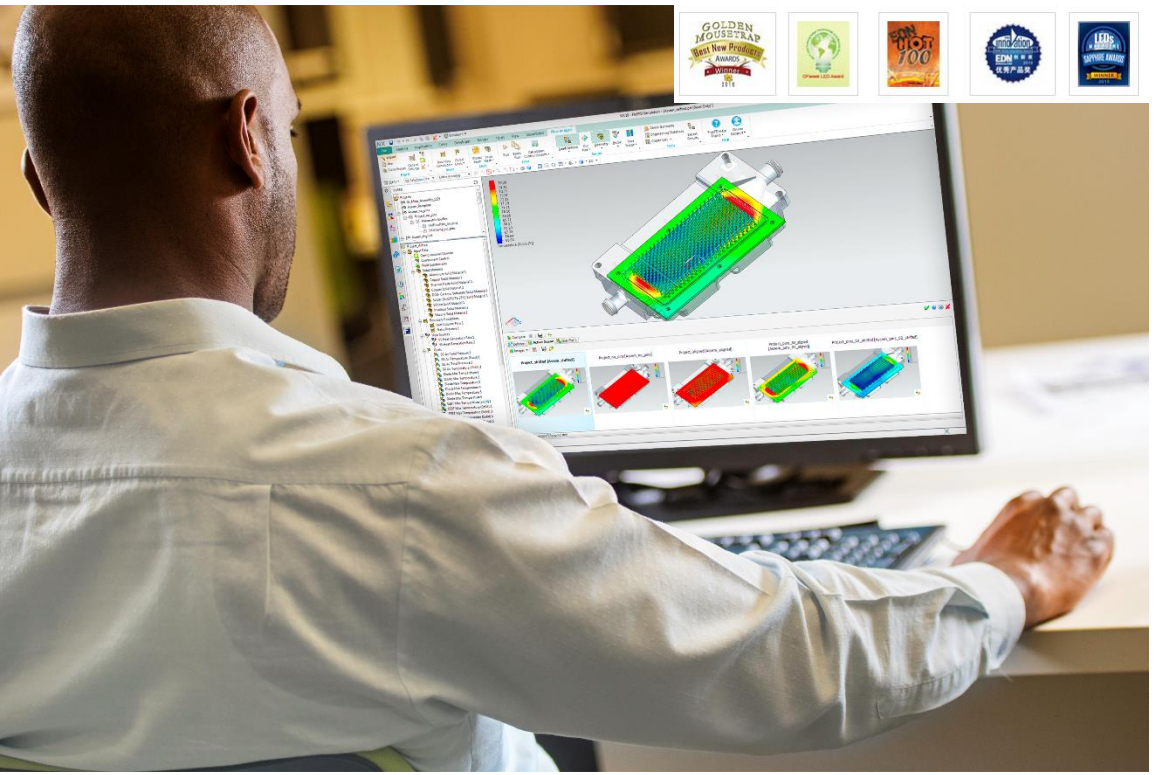
Siemens Frontloading Approach

How to Successfully Frontload CFD



- CFD simulation solution for easy, fast, robust and accurate fluid flow and heat transfer analysis inside your CAD system
- Fits into your workflow without any disruption and makes CFD “plug and play”
- Automation technologies make analysis easy, fast and accurate so design engineers can use CFD
- Offers speed and accuracy so simulation results keep pace with design process and assists with design decisions

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Extensive Experience of Frontloading with Simcenter FLOEFD Deployed Across All Industries and Applications

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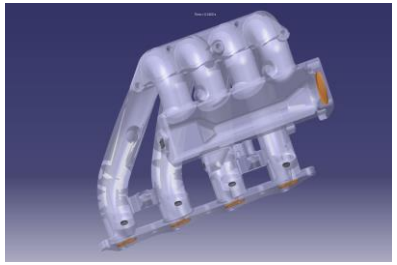
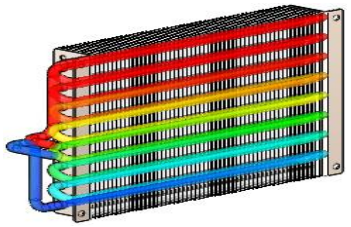
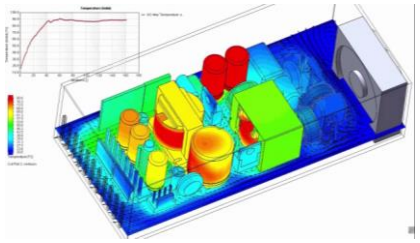


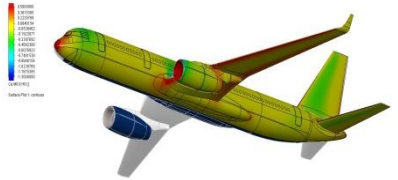
MIXING FLUIDS



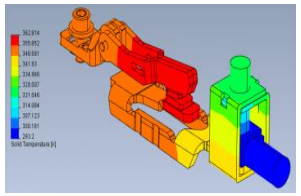
REFRIGIRANTS (Real Gas)



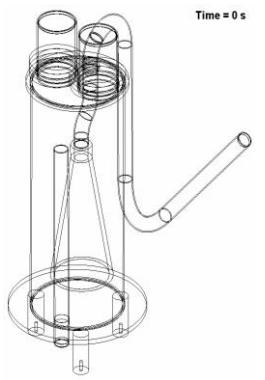
ELECTRONICS COOLING



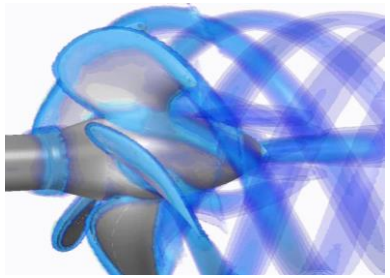
AERODYNAMICS



JOULE HEATING

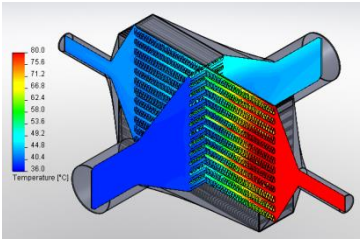


FREE SURFACE

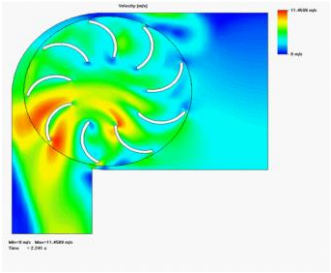


CAVITATION

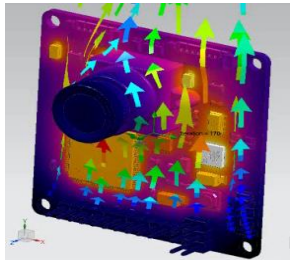
CONDENSATION



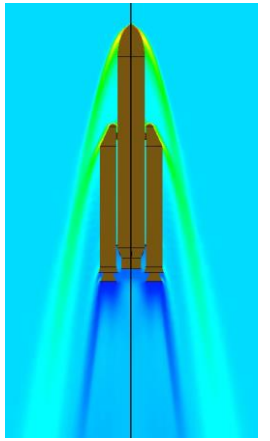
HEAT EXCHANGER



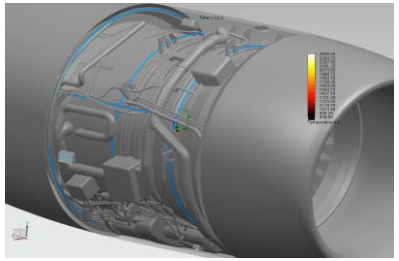
ROTATING EQUIPMENT



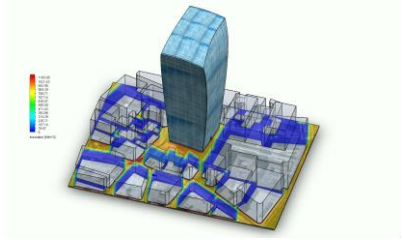
PCB MODELING



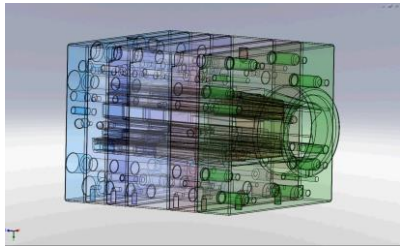
SYPERSONIC



COMBUSTION

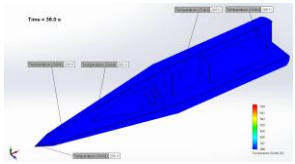


RADIATION



NON-NEWTONIAN

VENTILATION



AEROHEATING

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Simcenter FLOEFD
Technology Explained

Simcenter FLOEFD Extends CFD Technology in Two Key Areas

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Solver is augmented with special engineering empirical and analytical models

Unlike all other traditional CFD tools Simcenter FLOEFD **uniquely combines** numerical methods with empirical, analytical methods.

Traditional Approach

RANS with Wall Functions

FloEFD Extension

Prandtl BL Model

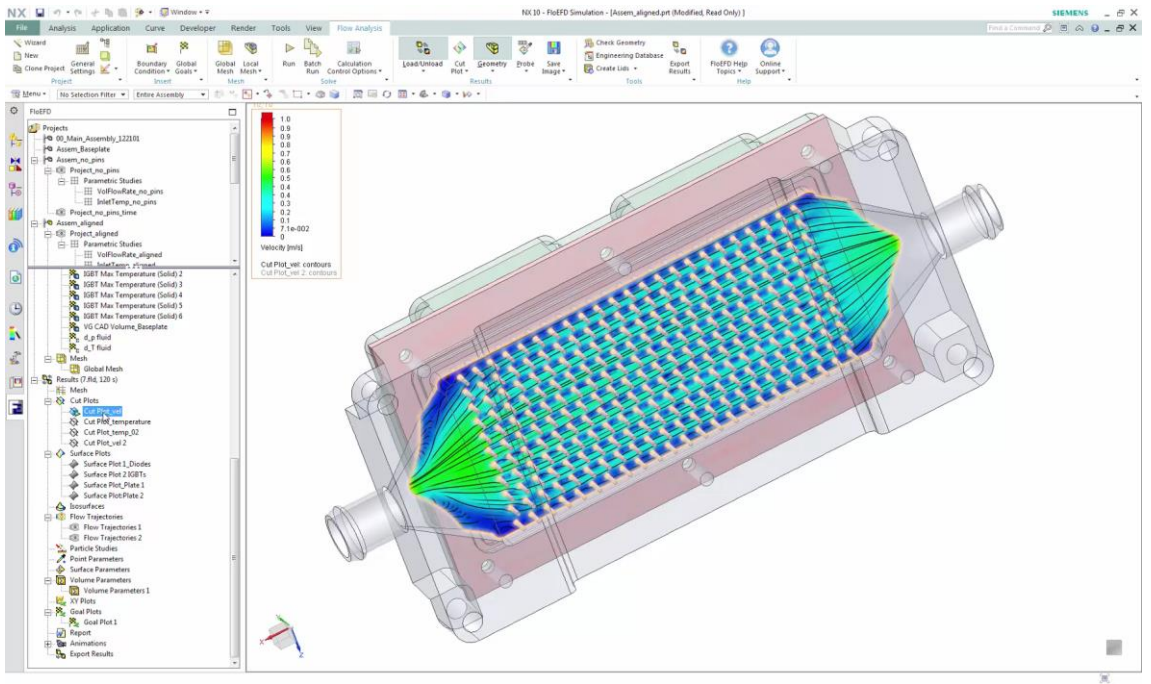
Analytical Equations

Empirical Models

Unique SmartCell™ Technology

CAD Embedding

Simcenter FloEFD is CFD Embedded in CAD.



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Simcenter FLOEFD Technology
Benefits from CAD Embedding

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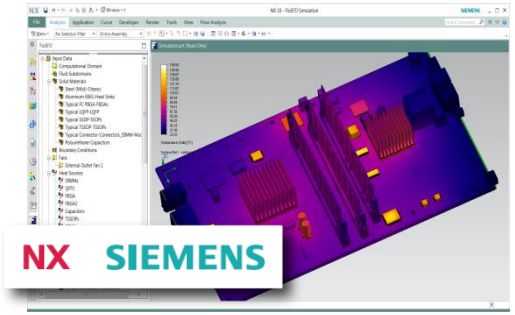
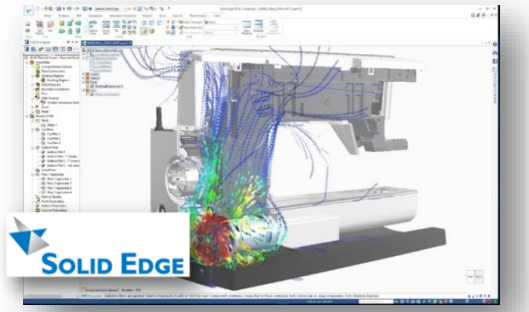
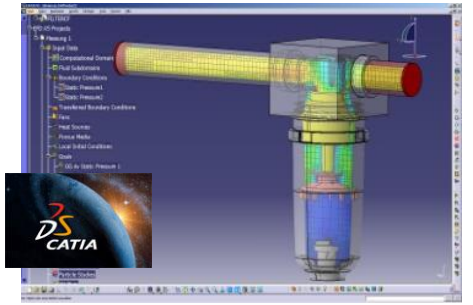
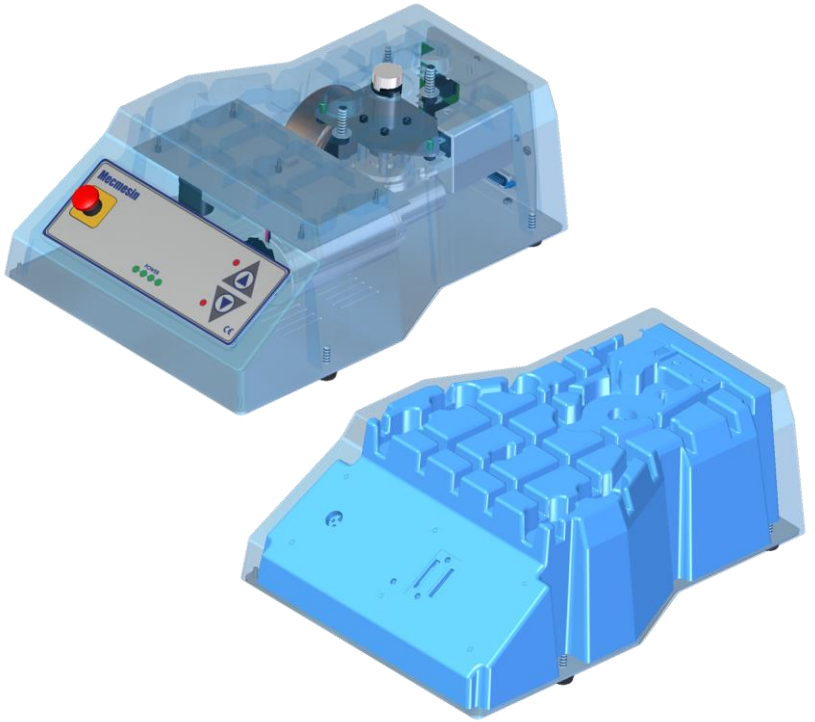






- Automatic fluid volume detection (no need for negative solid)
- Geometry change detection: model and analysis are synchronized
- Analysis input data (pre-processor) is defined inside CAD
- Results (post-processor) are displayed directly on CAD geometry
- Native CAD Look & Feel: CAD design engineer is familiar user interface and operations
- CAD used directly for meshing: **no need to simplify geometry**



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Simcenter FLOEFD Technology
Benefits from SmartCells™

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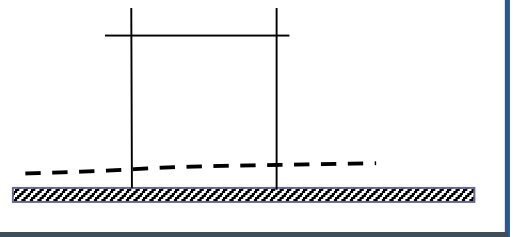
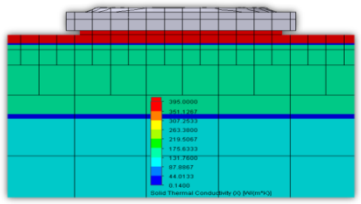
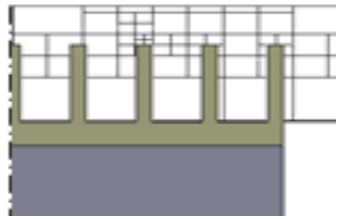
Simcenter FLOEFD automatically applies appropriate Analytical or Empirical solutions in places there mesh resolution is not enough for accurate (Numerical) solution – **Mesh generation is both Easy and Fast**



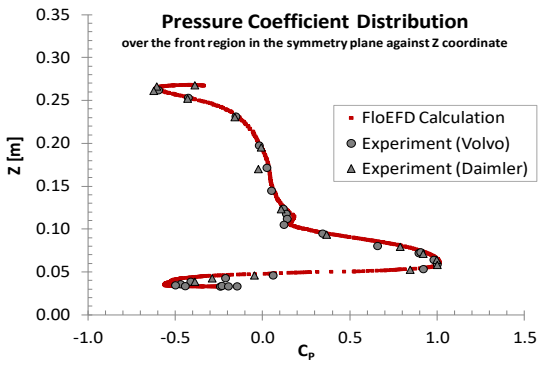
Thin Boundary Layer

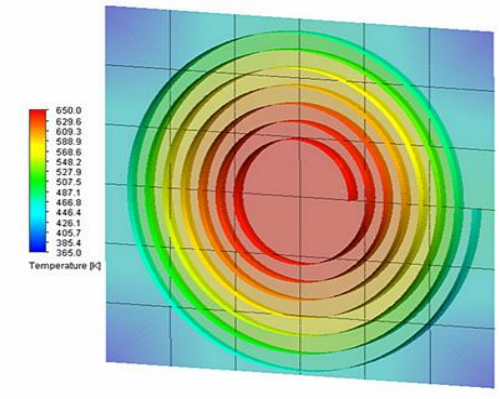


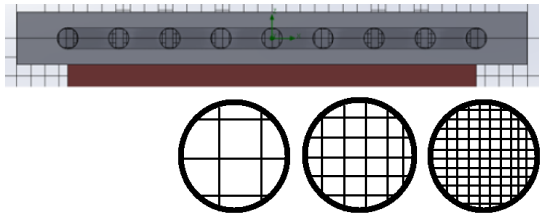
Thin Walls



Thin Channels







	1	2	3
N (mesh cells)	252 245	610 607	966 193
Δt_{water}	14.64	14.79	14.77
ΔP_{water}, Pa	270	277	276
Q_{water}, W	98.26	98.42	98.14

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Simcenter FLOEFD Encourages Design Exploration in Early Design

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What – If

- Set variation to easily calculate a number of designs and find the best by yourself with the help of the compare tool.

Goal Optimization

- Set range of variation for a single input variable and find the best design with the secant method (one parameter optimization).

Design of Experiment + Response Surface

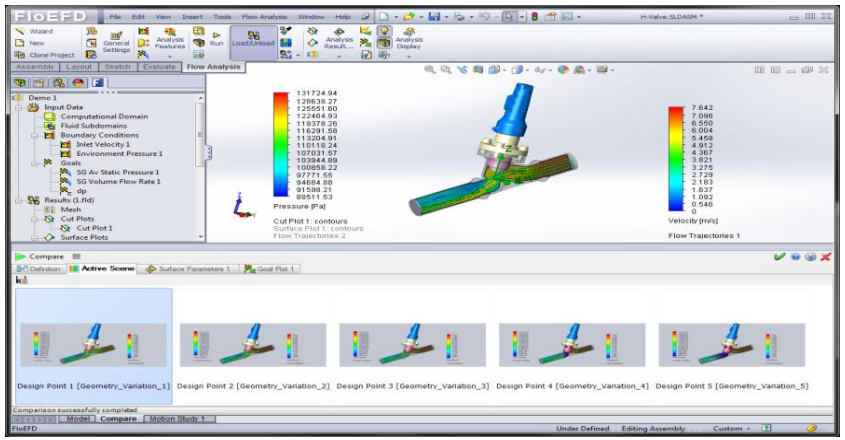
- Set range of variation for a number of variables, create and solve a matrix of design points and find optimum with the Response Surface interpolation method.

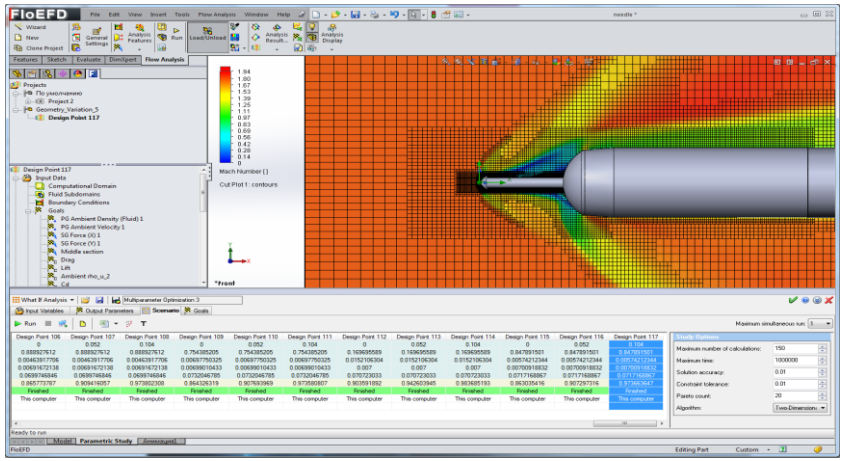
External Optimizer support

- Connect to external optimization software to find the best design with the help of 3rd party external optimizer.

Extended Design Exploration

- Efficient, robust HEEDS optimization algorithm inside Simcenter FLOEFD.





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Demo 1: Heat Exchanger Simulation

Demo 2: Electronics Cooling Simulation

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Simcenter FLOEFD Customer Success Stories

APEX Group
Comparing experimental and computational results

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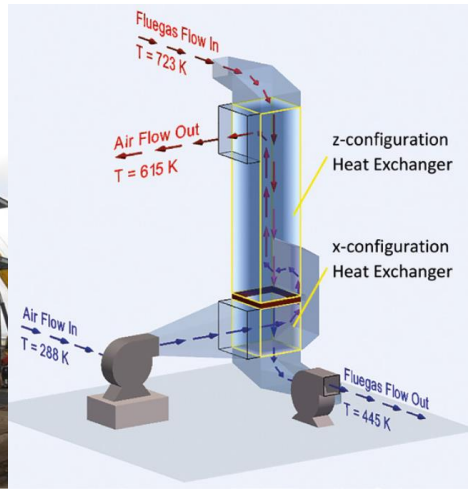
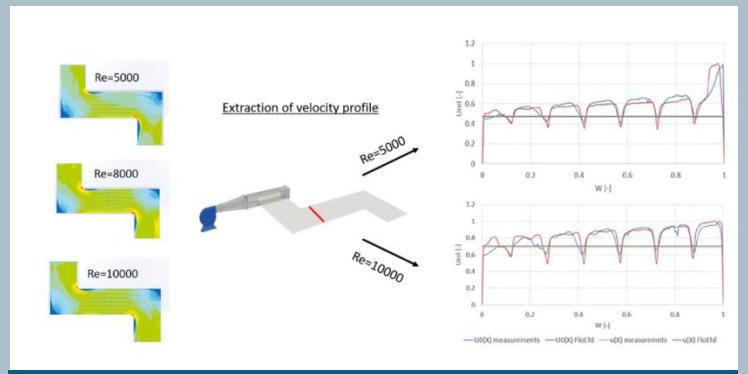
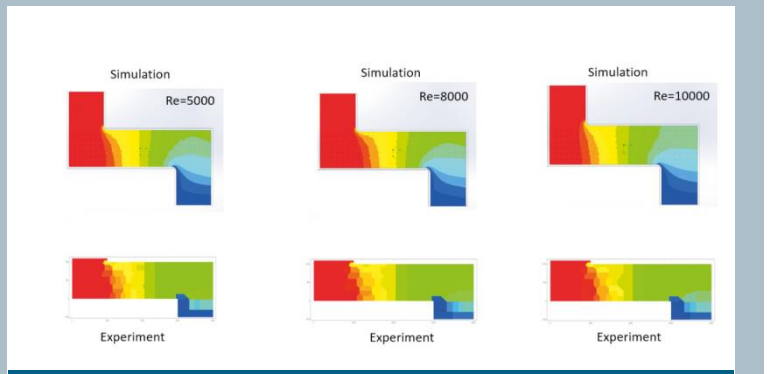


- **Investigated many different geometries according to specific project specifications**
- **Identified optimized configuration for production with the collaboration of simulation and experimental measurements**

Simulation and comparsion with state of the art measurement



Comparison of velocity profile



Simulation and test results

- Simulate multiple configurations with Simcenter FLOEFD as a result of the confidence achieved by the calibrating simulation with experimental data

"We at APEX-Research successfully used Simcenter FLOEFD for many years and now we have the increased confidence in its results through our own modeling experiment."

Mircea Dinulescu, APEX Group Founder

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Seiko Epson Corporation
Empowering engineers since 1989

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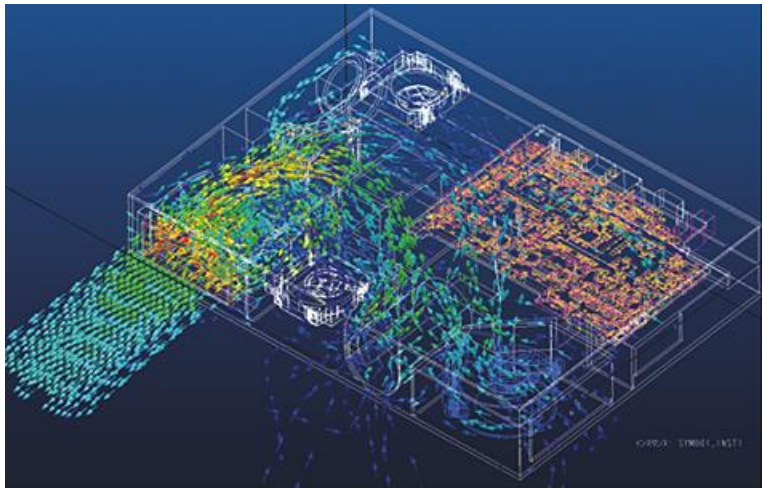
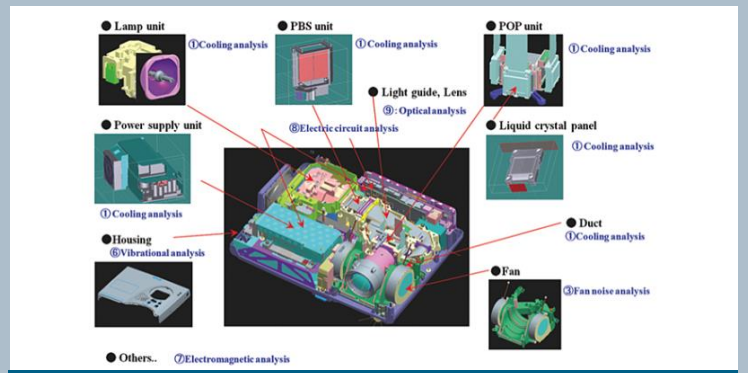
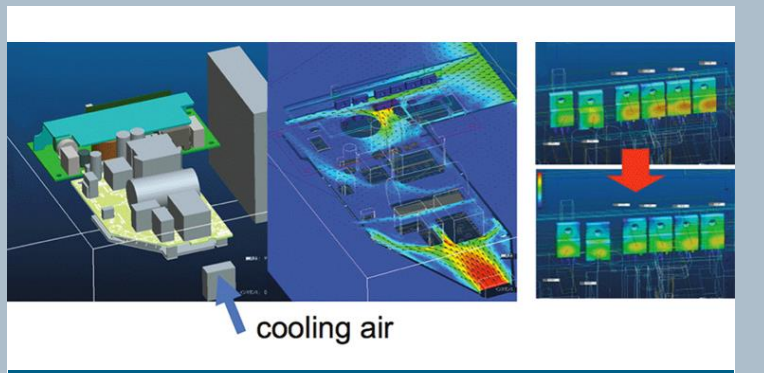


- **Empowered design engineers to conduct CFD simulation**
- **Simulation is an essential part of product development cycle**

Heat sources in projectors



Analysis required for the improvement of design quality



Verification of cooling airflow after changing a geometry path

- CAD-embedded Simcenter FLOEFD was able to assist in the challenges the team faced with design of semiconductors in projectors

“FLOEFD is essential in our daily work. In many cases, we can’t predict the results of analysis but FLOEFD leads us to correct results automatically.”

Mr. Fumio Yuzawa

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Groupe Renault, France
Slashing headlight costs

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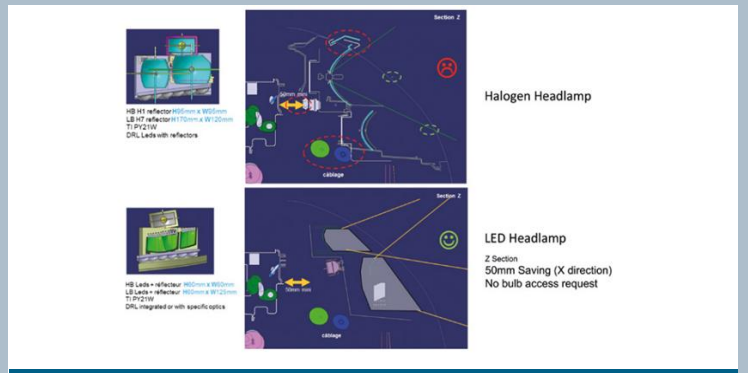
- **Reduced headlamp costs by 50% in 2 years**
- **Increased optical efficiency by 25%**
- **Reduced overall assembly size by 50 mm**
- **One thermal engineer is over twice as productive**

Driving down Headlamp costs



50mm saving between generation 1 and 2

Thermal predictions for halogen headlamp

- Frontload computational fluid dynamics (CFD) analysis
- Use CAD-embedded Simcenter FLOEFD for testing digital twins

"Because it is embedded and highly integrated into … our preferred MCAD tool, one thermal engineer can be over twice as productive..."

Paul-Henri Matha, Lighting Expert

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Hager Group

Simcenter FLOEFD, the Swiss Army Knife in the tool development

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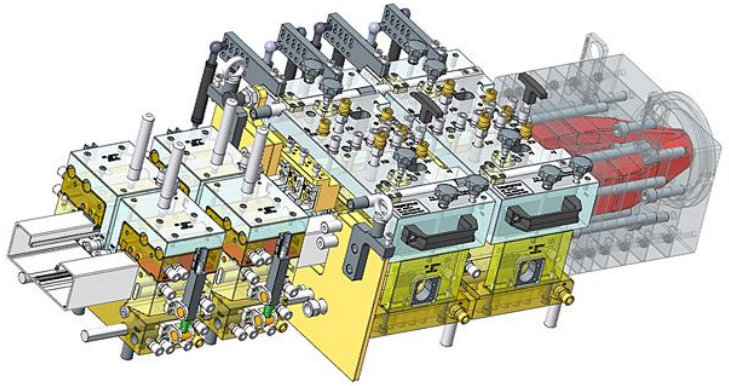
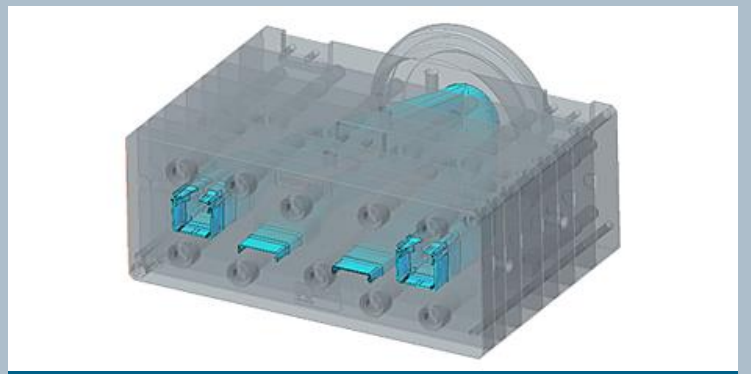
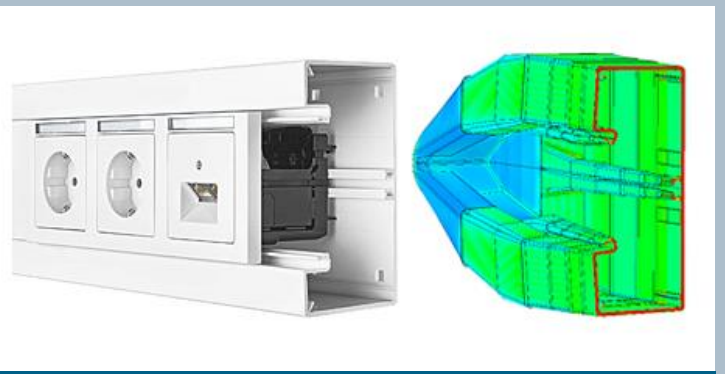


- **Multiple four-strand tools provide a unique competitive advantage**
- **Shortened tool development cycle times with increased complexity, functional requirements and quality demands**
- **50 new special-purpose tools are developed per year**

Mold and tool design, profile calibration and layout of the cooling



Multi strand tool



Melt distribution optimization

- Multiple four-strand tools were successfully put into operation in a shorter time with the help of Simcenter FLOEFD
- More and faster optimization runs were made possible

"The requirements on our tools in terms of quality, output capacity and cycle times are continuously increasing. At the same time, our trunking systems are becoming more complex. With Simcenter FLOEFD we cope with these challenges very well."

Stefan Spies, Head of Tool Development

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Conclusion & Action

Conclusion & Action

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Key Takeaways:

- Modern business challenges require a more agile product development approach
- Frontloading of CFD simulations into the design process enables fast and agile design explorations
- Simcenter FLOEFD technology is made for ease-of-use for the designers and non-CFD experts

You have seen Simcenter FLOEFD in action. If you want to experience it for yourself, contact us for a demo, training and evaluation.

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Boris Marovic

Business Development Consultant
Mechanical Analysis Division
Mentor Graphics, A Siemens Business

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Thank you.