



# ESTECO Innovation Milestones and Technology Overview



Enrico Nobile

Board member and Scientific Advisor

ESTECO is an independent software company, highly specialized in **numerical optimization** and **simulation process and data management**.

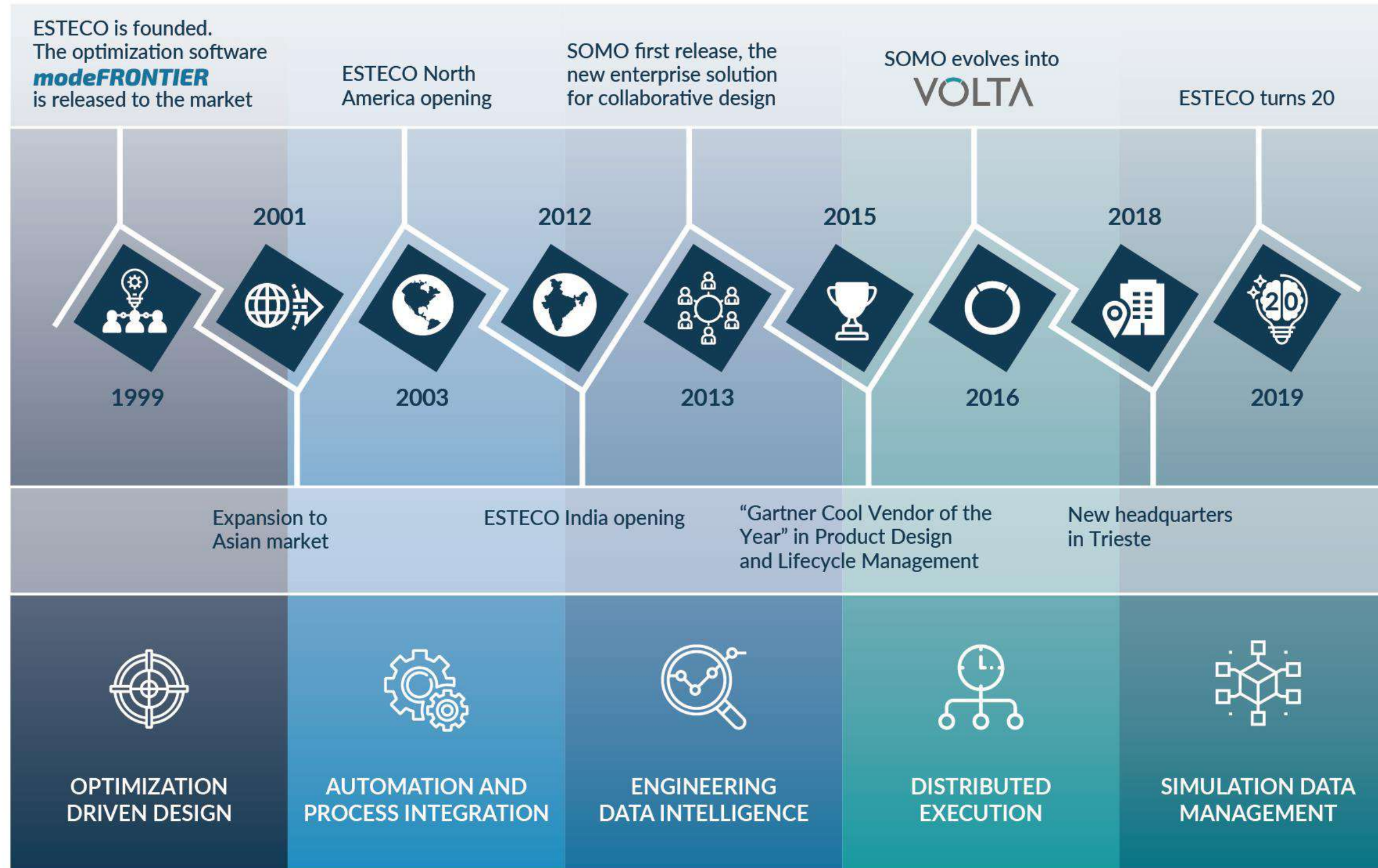
An aerial photograph of a lush green valley with rolling hills. Several white wind turbines are visible on the ridges under a dramatic, cloudy sky. The text 'ESTECO SOFTWARE TECHNOLOGY' is centered horizontally across the middle of the image.

ESTECO SOFTWARE TECHNOLOGY

**INNOVATE** *FASTER*

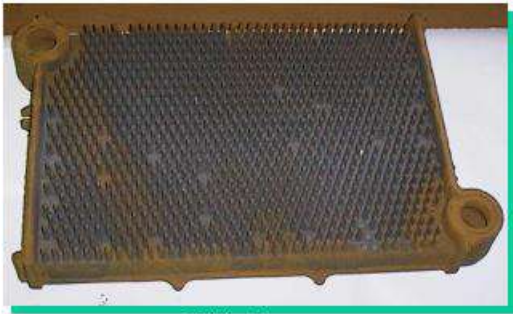
# 20+ years of innovation

ESTECO was founded after a successful EU project code-named “FRONTIER”



# Pioneering time

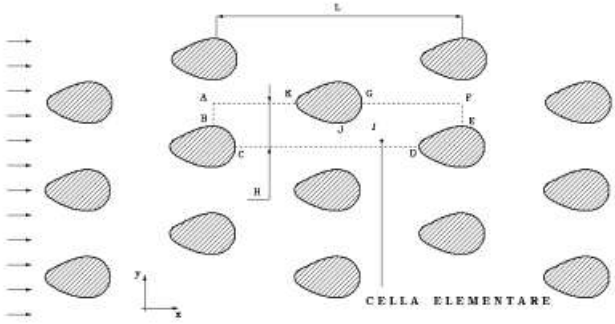
**Results from case studies**  
 (3) Heat exchanger design (Calortecnica s.p.a.)



Old design

- **Objectives**
  - Maximise convective heat flux
  - Minimise pressure loss
- **Design Variables**
  - Control points of the Bezier curves
- **Geometric Constraints**
  - Bounds on control point variation
  - Minimum radius of curvature of fins is 1.5mm
- **Fixed Dimensions**
  - The overall area of the heat exchanger is fixed
- **Design Evaluator**
  - FIDAP (Commercial code for CFD/HeatAnalysis)

**Results from case studies**  
 (3) Heat exchanger design (Calortecnica S.p.A.)



Original

High friction, high heat exch.

Low friction, lower heat exch.

Final selection

**Results from case studies**  
 (3) Heat exchanger design (Calortecnica S.p.A.)

		BASELINE DESIGN	ULTRA LIGHT	%variation
power	kW	34,9	37,2	6,6
width	mm	75	70	-6,90
height	mm	330	325	-1,53
length	mm	550	420	-26,80
fin height	mm	2,5	3,5	33,33
weight	Kg	50	40	-22,22
volume	m <sup>3</sup>	0,0136	0,00956	-35,03




New design

- First shape optimization with Genetic Algorithm and Navier-Stokes solver (1993)
- Multiobjective optimization of airfoils (transonic/subsonic shapes) (1994)
- First engineering tool to adopt Java language for portability (1995)
- Adoption of Artificial Neural Networks for performance prediction (1998)



# Industrialization

mode **FRONTIER** Multiobjective Optimization & Design Environment

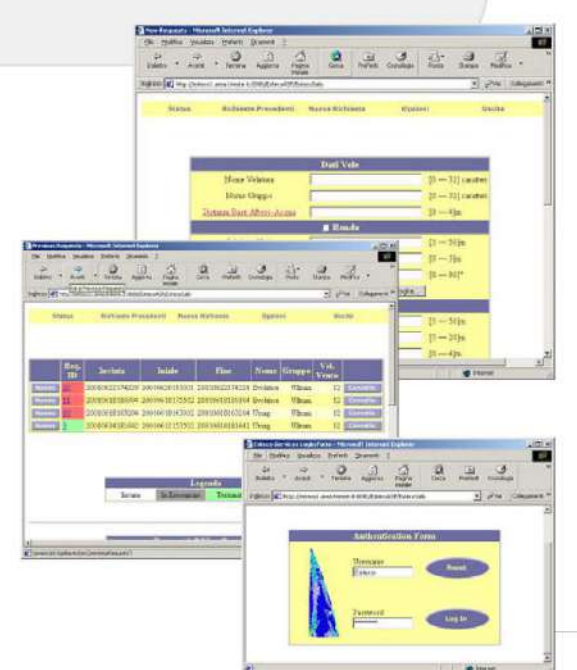
ESTECO Achieving Perfection

## Products

- **SPF2** A framework for Web-based engineering computation

CAE services feasible through intranet or internet served by an Application Service Provider capable of:

- accounting and access control
- automatic report creation
- interaction with any queuing system



Courtesy

8

mode **FRONTIER** Multiobjective Optimization & Design Environment

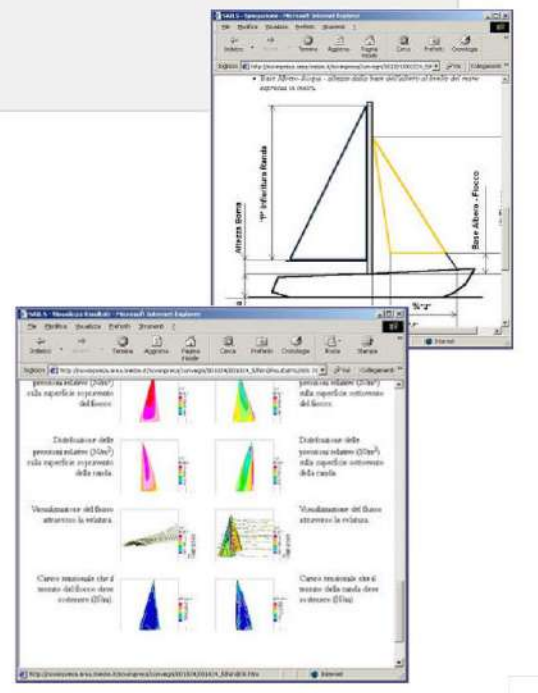
ESTECO Achieving Perfection

## Services

- **Web based engineering computation**

ESTECO can configure ASP services that activate complex engineering simulation from a browser

The results of the analysis are then summarised in an automatically produced engineering report



Courtesy

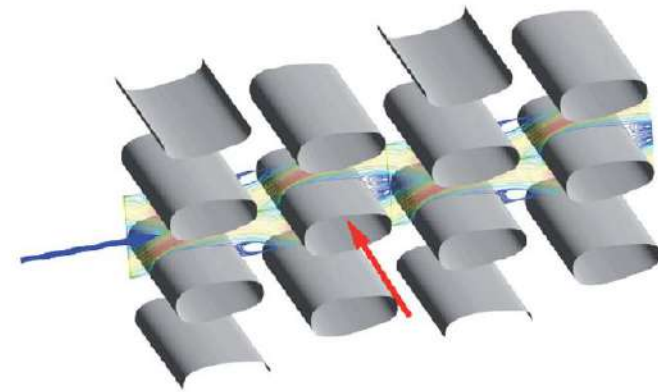
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- Introduction of the Parallel Coordinate Chart for decision support in engineering design (1999)
- Self Organizing Maps to analyze high dimensional datasets (2006)
- Polynomial Chaos for uncertainty quantification (2008)

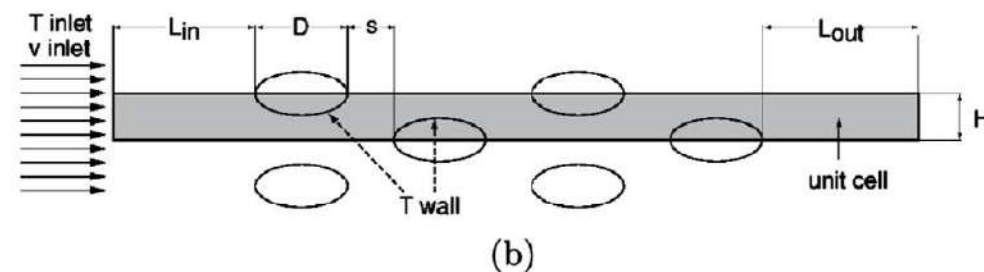
# Refinement

## Multi-objective shape optimization of a tube bundle in cross-flow

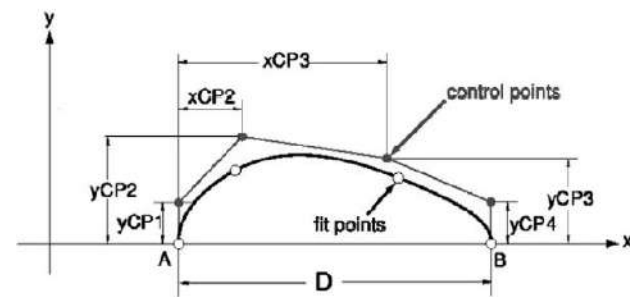
Paola Ranut <sup>a,†</sup>, Gábor Janiga <sup>b</sup>, Enrico Nobile <sup>a</sup>, Dominique Thévenin <sup>b</sup>  
 International Journal of Heat and Mass Transfer 68 (2014) 585–598



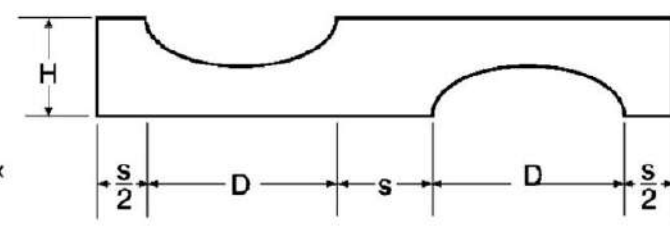
(a)



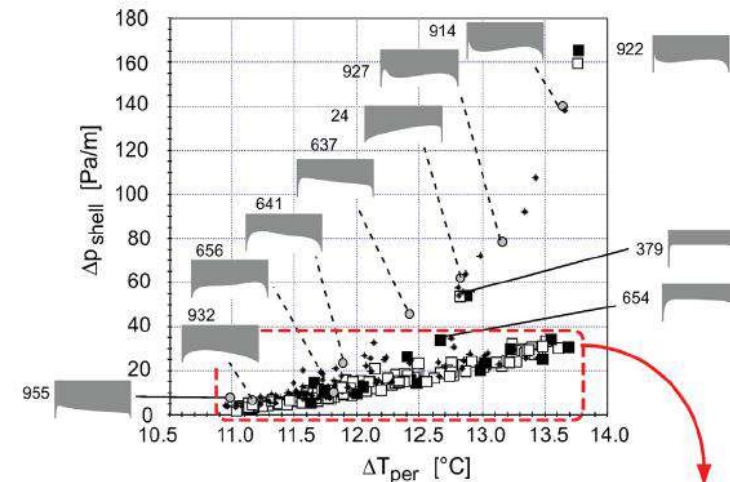
(b)



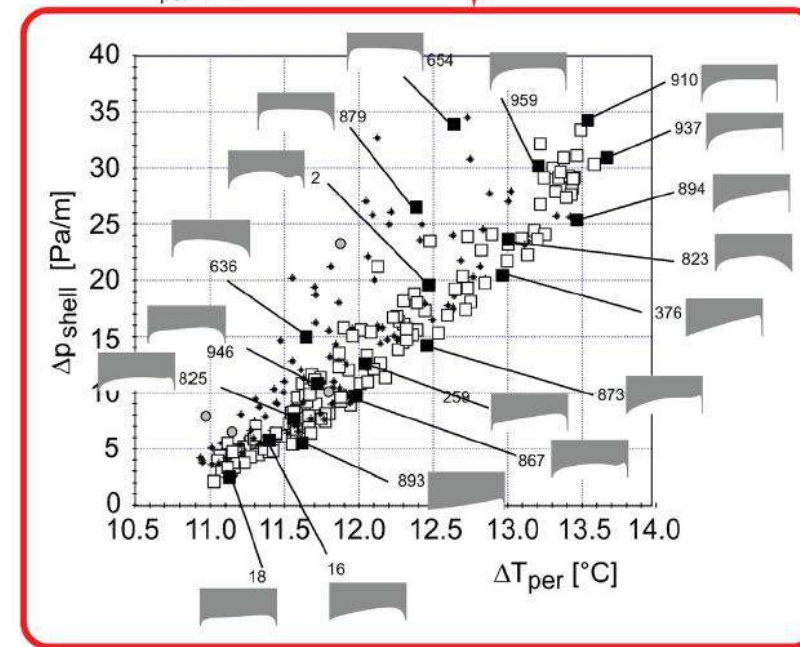
(c)



(d)



\* Designs  
 □ Pareto  
 ○ Analyzed no Pareto  
 ■ Analyzed Pareto



- First to introduce MORDO and Reverse-MORDO (multi-objective robust design optimization) (2006 to 2008, 2006 with Montecarlo sampling, from 2008 with Polynomial Chaos)

- Service Oriented Architecture for distributed computing (SOMO which became VOLTA) (2010 started, commercial v1 in 2013)

# Looking forward



- Adoption of the BPMN standard for process modeling and execution of engineering simulations (2020)
- First to adopt container architecture (2022)





**Our people**  
our staff is our strength

**140+**  
professionals

**95%**  
with a university degree

**17%**  
with a PhD

# Our values



## INNOVATIVE

Our development is at the forefront of technology



## FLEXIBLE

We respond quickly to customers' demand



## RELIABLE

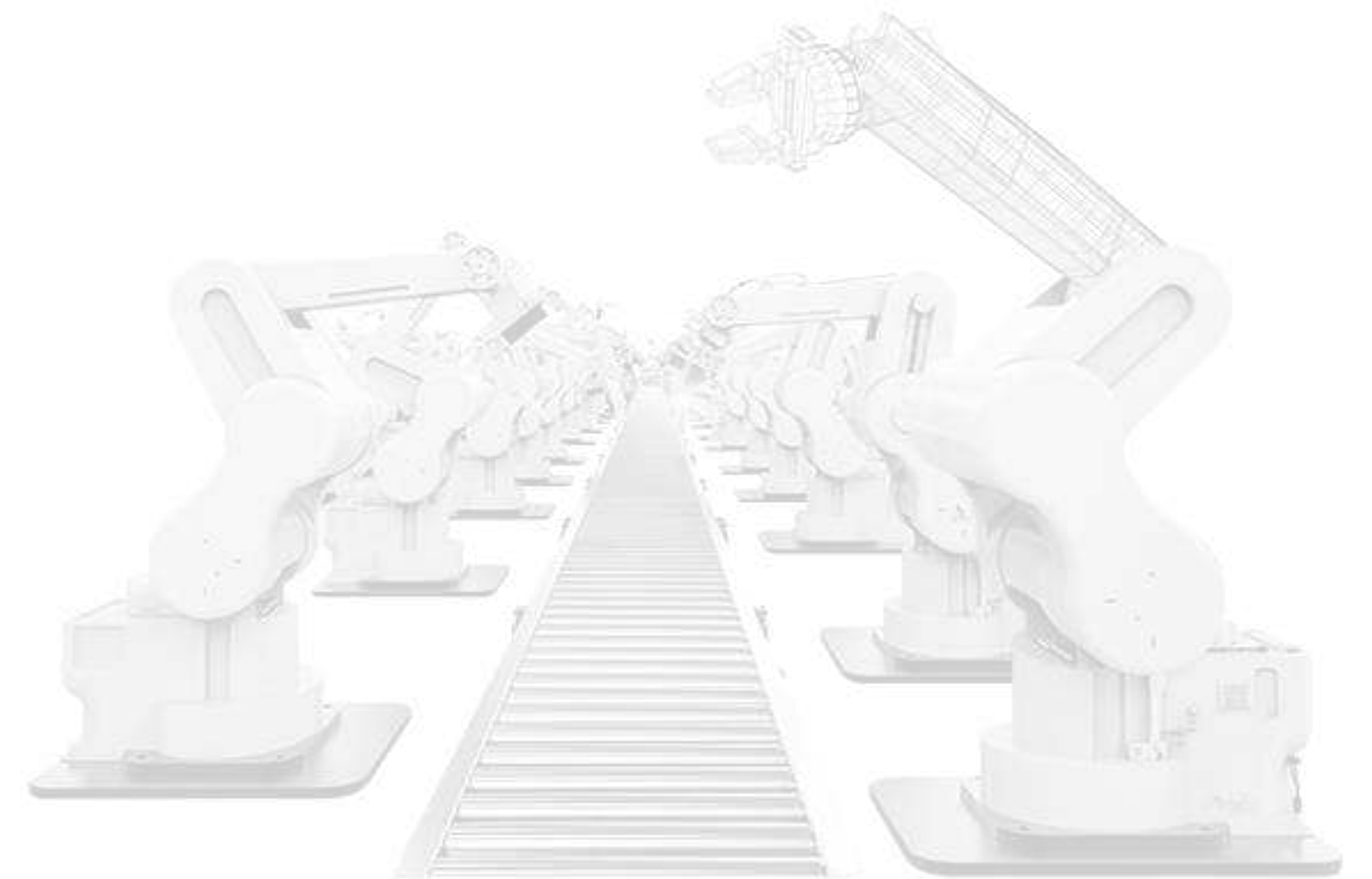
Continuous development and on-time delivery



## INDEPENDENT

We integrate with any software

We provide **modularity**,  
**standardization** and  
**interoperability** within  
the engineering design  
process.



# ESTECO Technologies



Simulation Process and Data  
Management



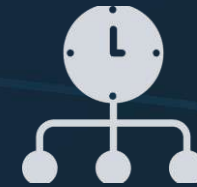
Simulation Process  
Integration and Automation



Design Optimization



Business Process  
Management



HPC and Cloud



Robust Design  
and Reliability



Response Surface Models



Simulation Data Analytics

# Our products

## ***modeFRONTIER***

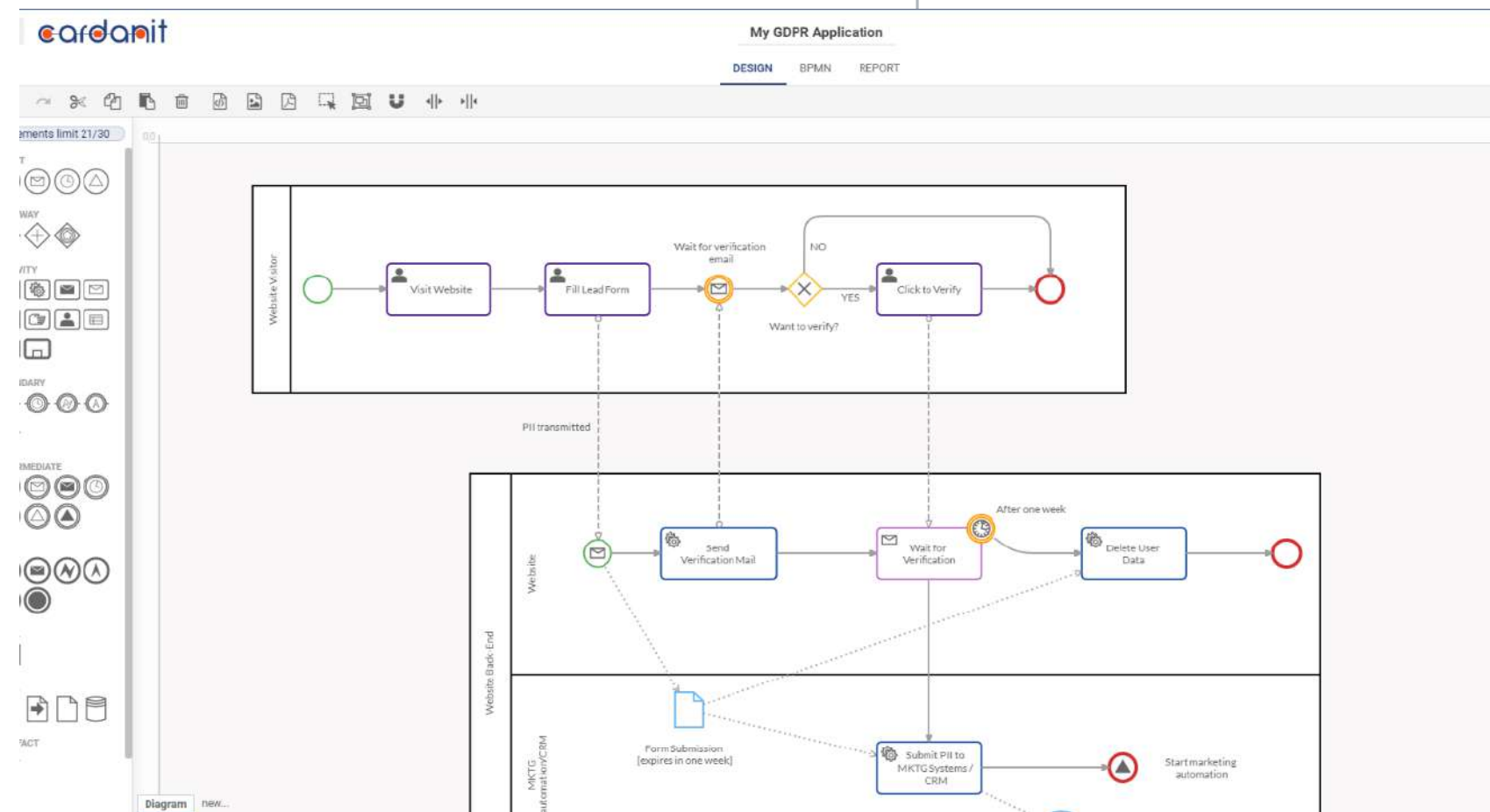
The leading software solution for simulation process automation and design optimization

## **VOLTA**

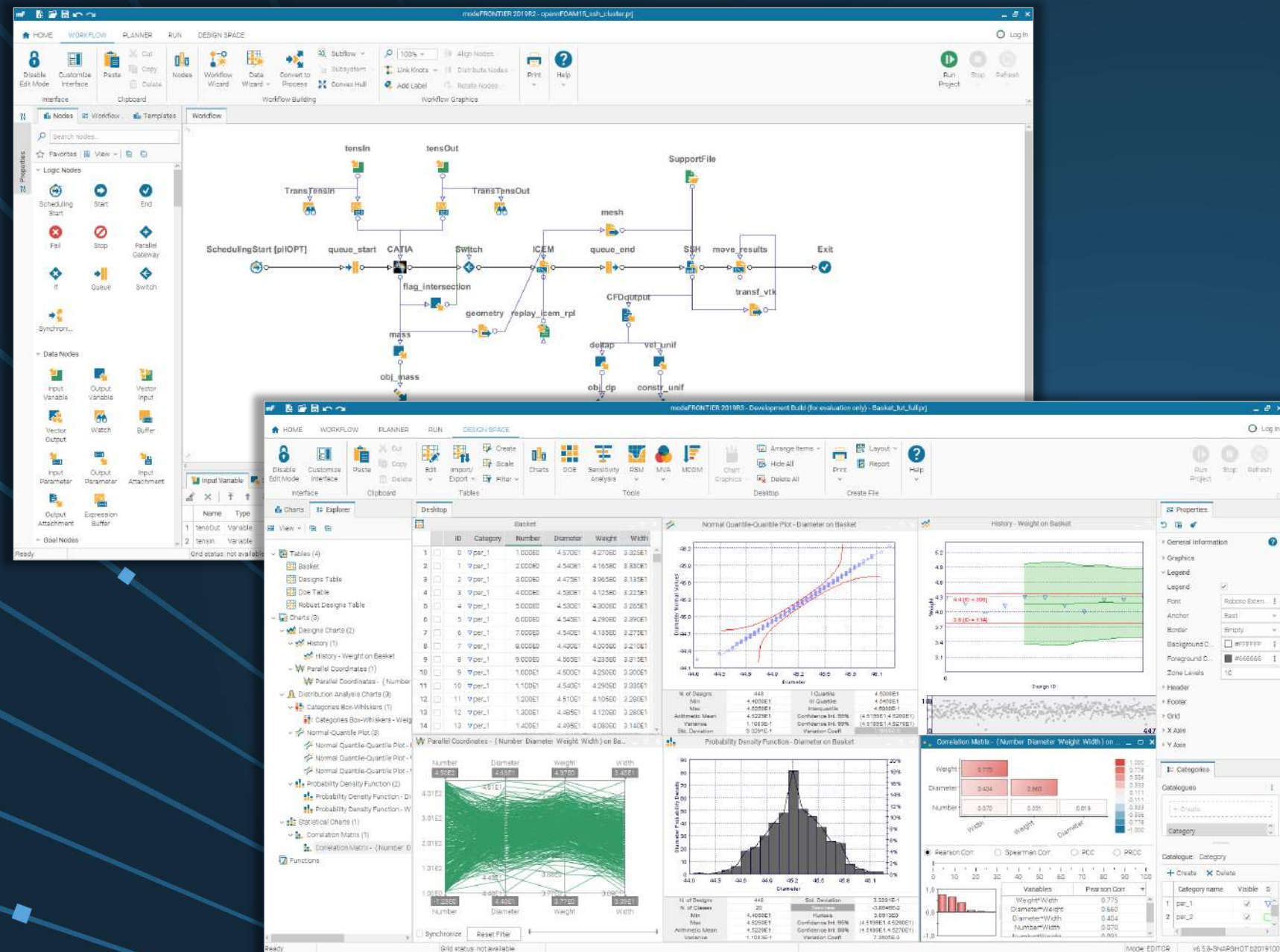
The innovative enterprise platform for Simulation Process and Data Management (SPDM) and design optimization

# Our SaaS application

Born as a research project, Cardanit is the next generation collaborative tool for designing business processes.

The logo for Cardanit, featuring the word "cardanit" in a blue, lowercase, sans-serif font. The letter "c" has an orange circle inside it, and the letter "a" has an orange square inside it.

# modeFRONTIER



Find the optimal design

Handle your design parameters and balance conflicting objectives.

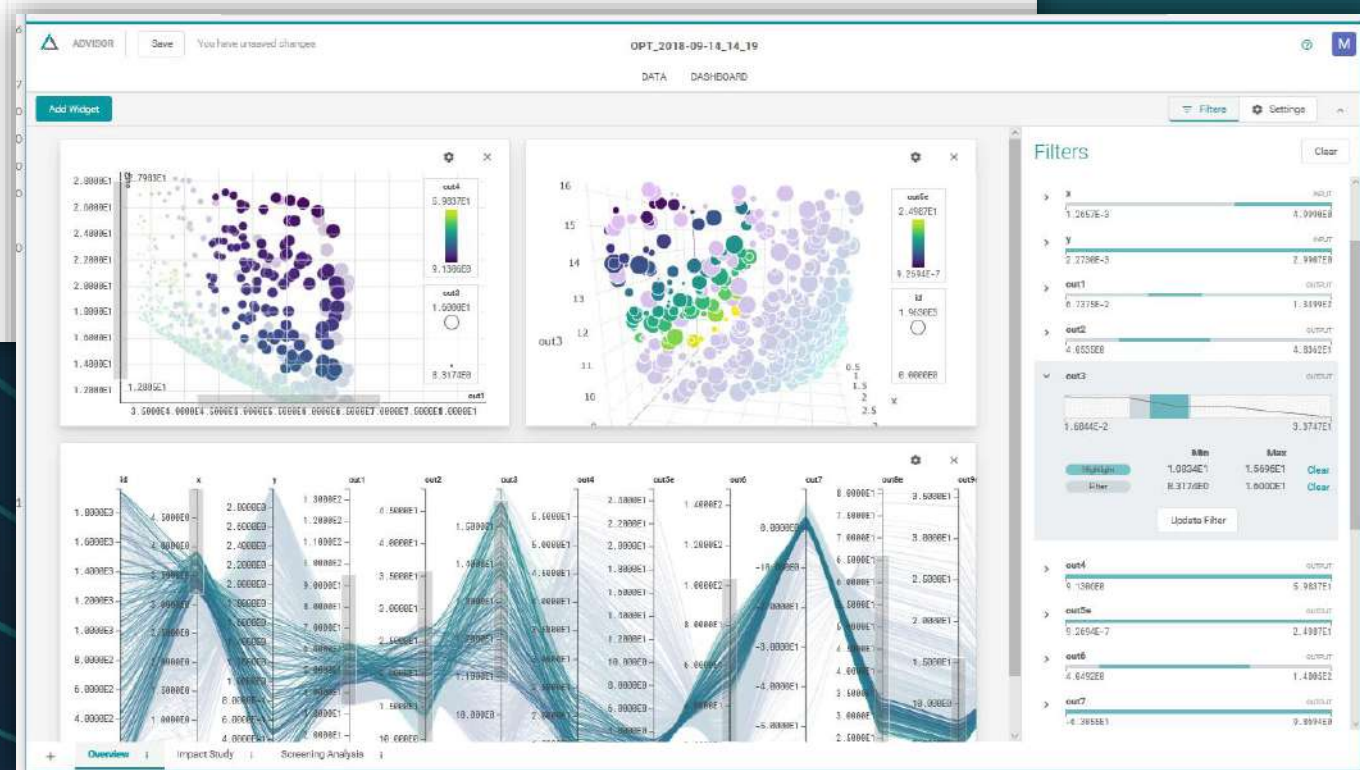
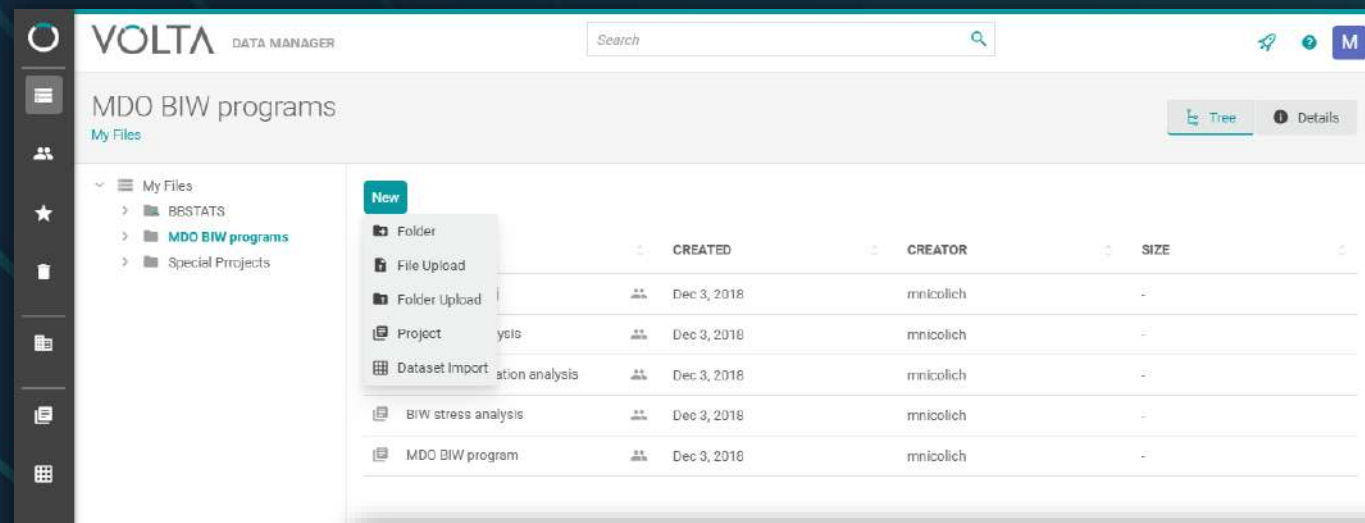
Maximize IT resources

Exploit all computational resources and engineering solvers.

Deliver results on time

Accelerate the engineering process and run multiple simulations.

# VOLTA



**Make simulation data accessible**

Expand the usage of engineering simulation across teams.

**Reduce time-to-market**

Fast deliver the best product by applying intelligent algorithms to the simulation process.

**Lower costs**

Maximize the investment in engineering solvers and IT resources.



We facilitate engineering work, regardless of the level of expertise within one team, and our independent position ensures **fast responses to customer demands.**

# Our customers and industries

Embraer

General Atomics

Leonardo

Lockheed Martin

Raytheon

Ford

Honda

Stellantis

Toyota

Volvo Cars Corporation

Mahindra

TAFE

Volvo Trucks

ABB

Bajaj

BASF

Cummins

FAW

Whirlpool

Sony



Automotive and Ground Transportation



Aerospace



Architecture, Engineering and Construction



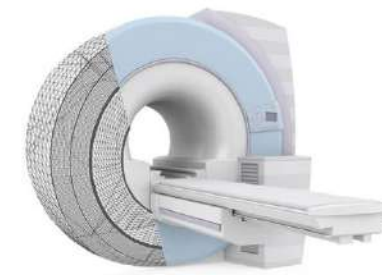
Manufacturing and Industrial Equipment



Marine



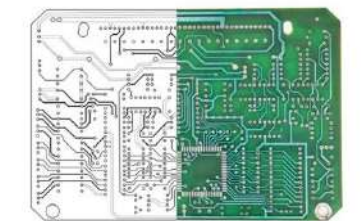
Energy



Healthcare



Consumer Goods

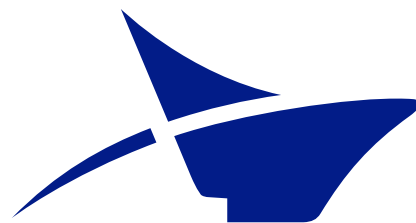


Electronics

# Less intuitive applications / customers



Centre Public d'Action Sociale  
de la Ville de Bruxelles



Port Network Authority  
of the Eastern Adriatic Sea  
Ports of Trieste and Monfalcone

Optimization of sport equipment dynamic response

Robust design / analysis of assets in the supply chain  
(refrigeration systems, transit, storage, etc.)

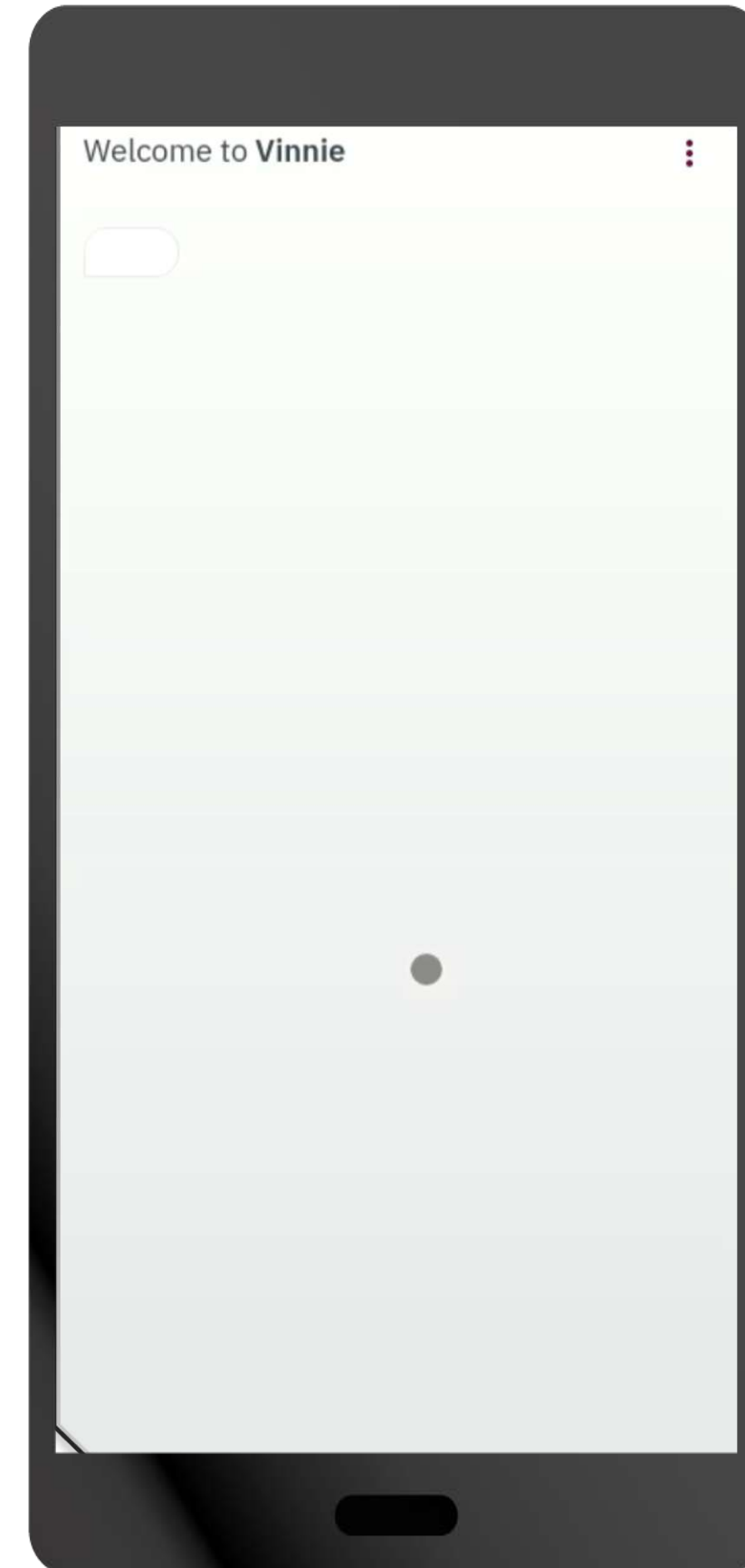
Social and Health services planning in Bruxelles City

Port multi-modal transportation modelling and optimization

# Our adventures



- Machine Learning
- Social login
- Progressive web apps
- Cloud

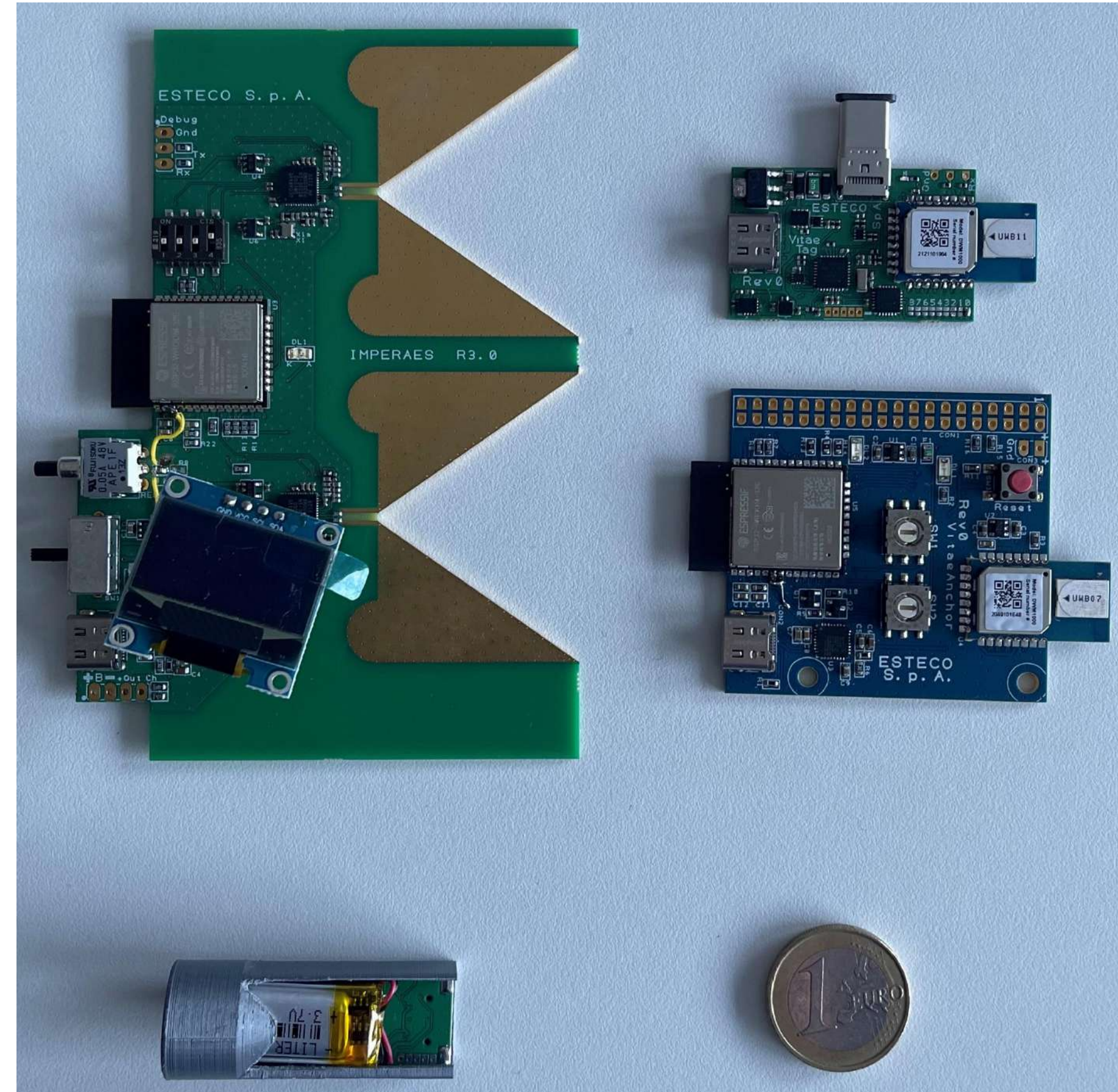


# Our adventures

## HW prototypes

(es. Indoor localization, UWB based, proprietary algorithms and hardware)

- IoT
- Machine Learning

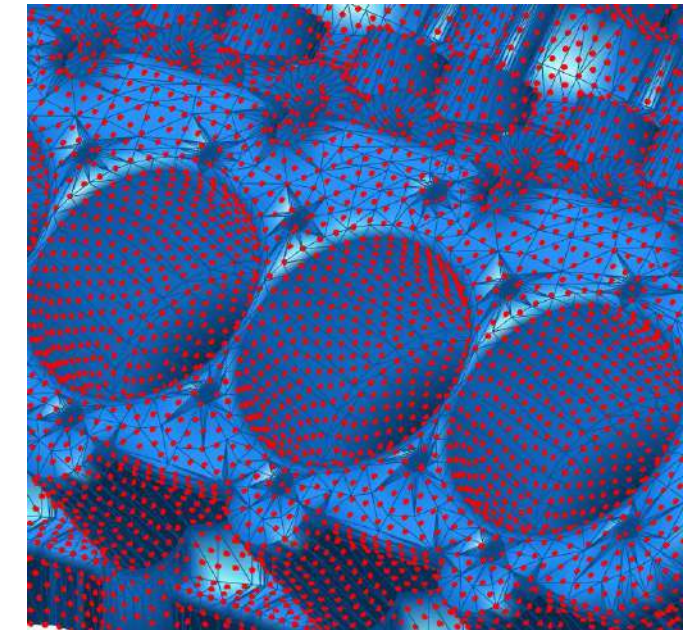
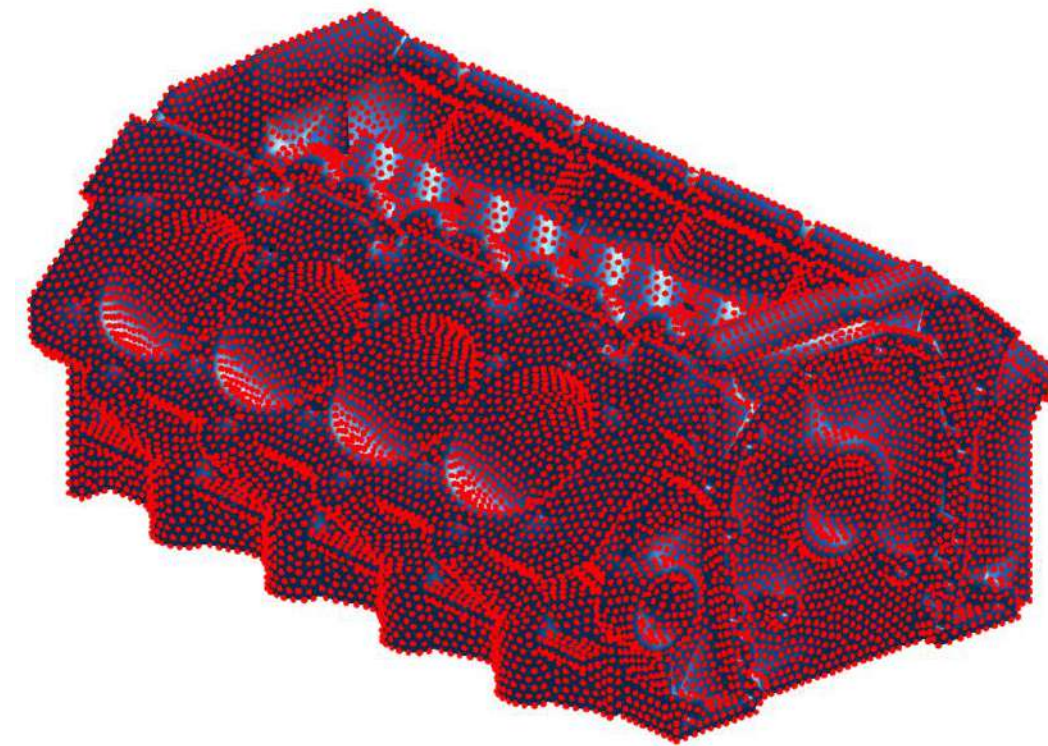
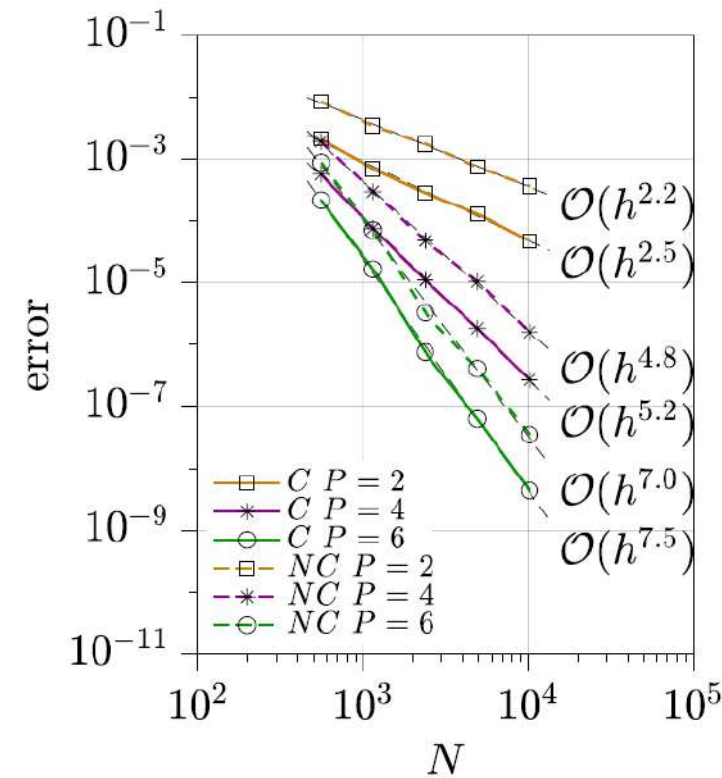
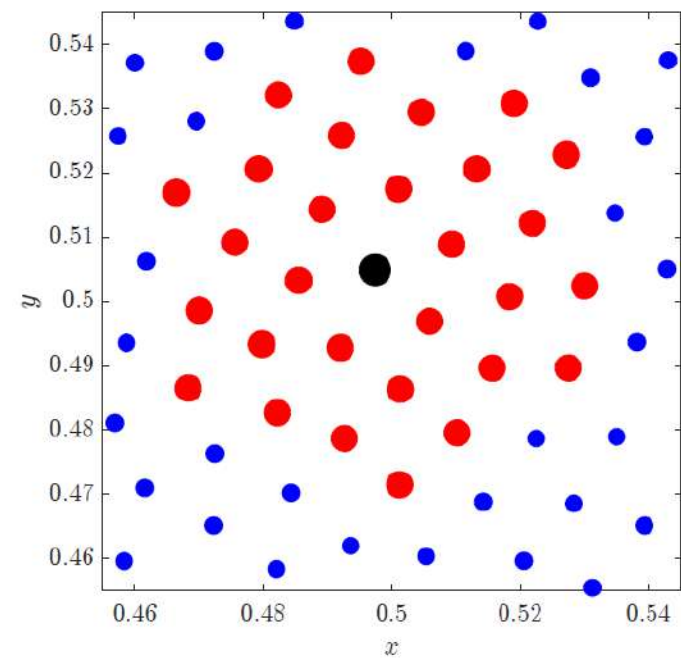


# Our adventures

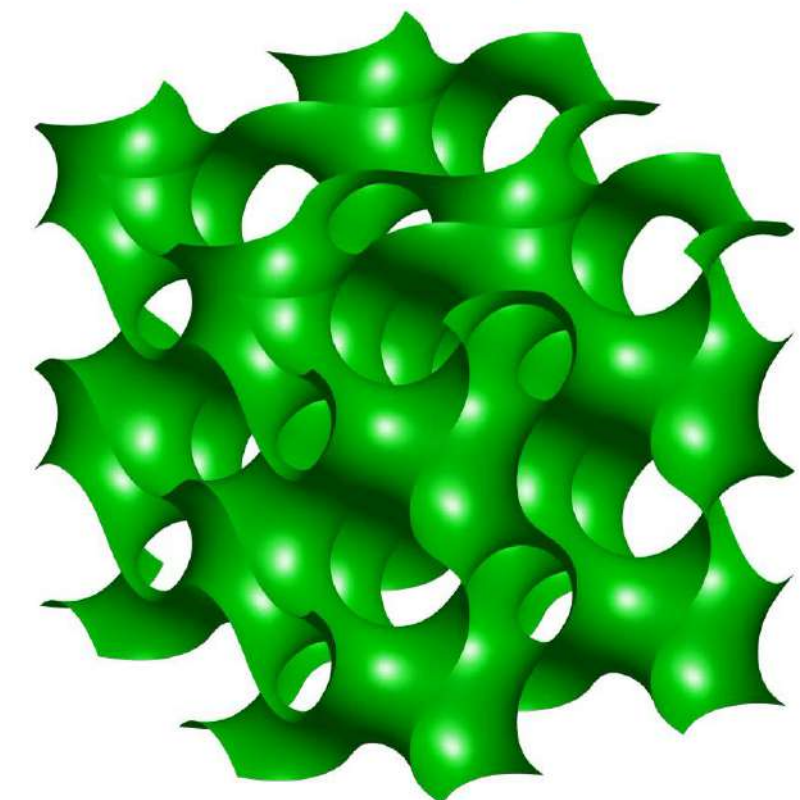
## Meshless RBF-FD

(Radial Basis Function Finite Difference)

- Direct solution of fluid flow and heat transfer problems
- Physics-Informed Neural Networks (PINNs)



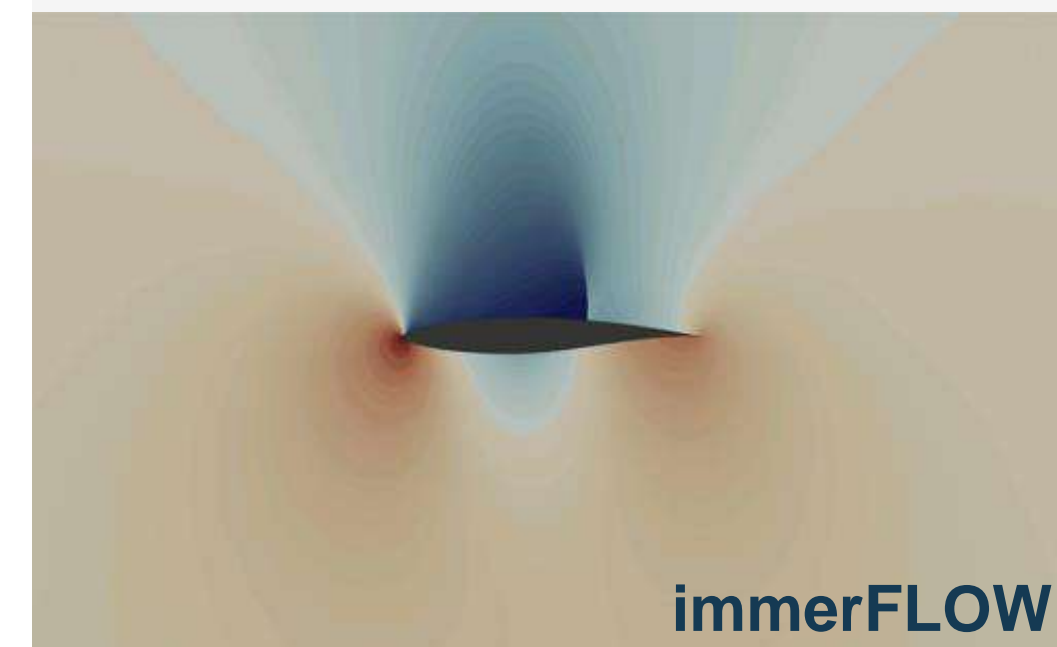
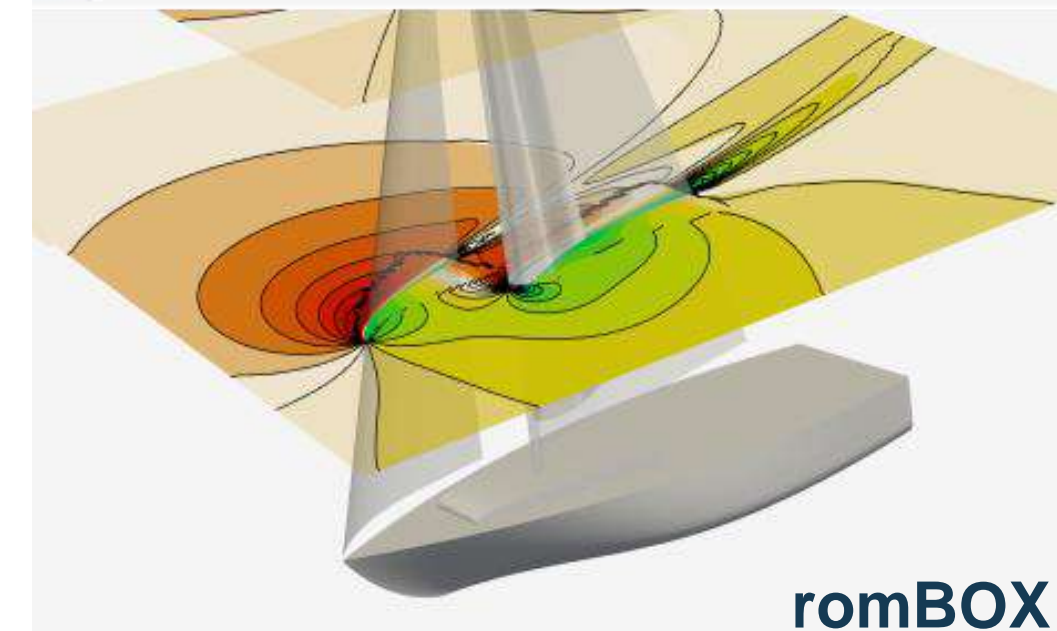
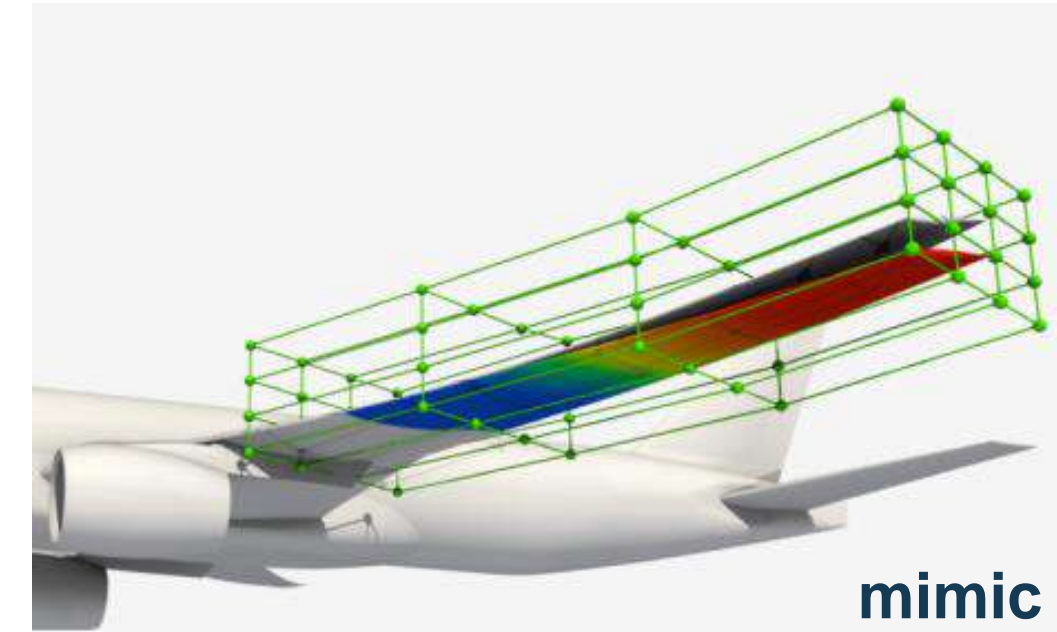
Gyroid



# Our adventures



- Geometry morphing
- Reduced Order Models
- Immerse Boundary CFD



# Our Global presence







# Thank you!

[esteco.com](https://www.esteco.com)



ESTECO Users' Meeting India 2023, Bengaluru, Karnataka, August 23