



# *Accelerating CFD Simulations through HPC and AI on Rescale*

SPE GCS - Annual Symposium

August, 2024

# Company Overview

- Founded in 2011, HQ in San Francisco, locations in Amsterdam, London, Seoul, and Tokyo
- 300+ enterprise customers across all major Fortune 500 and Global 2000 enterprises
- #1 HPC solution for all major cloud providers
- Leading solution for R&D digital transformation

**Enterprise HPC category leader**

Venture backing  
**\$200M**

Ranked  
Deloitte Fast 500  
Y-Combinator Top 50

HPCwire awards  
Readers & Editors  
Choice Winner

**Customers Leading Digital Transformation**

Enterprise customers  
**300+**

Top Aerospace Companies  
**7 of 10**

Top Automakers  
**7 of 10**

**Broadest Application & Infrastructure Ecosystem**

Software marketplace  
**1000+ Apps**

Cloud infrastructure  
**4 of top 4**

Software vendors  
**80+ ISVs**

## Investors



Sam Altman



Jeff Bezos



Richard Branson



Paul Graham



Peter Thiel



Ben Horowitz



## Industries



Aerospace



Automotive



Energy



Higher Ed



Life Science



Manufacturing



Government

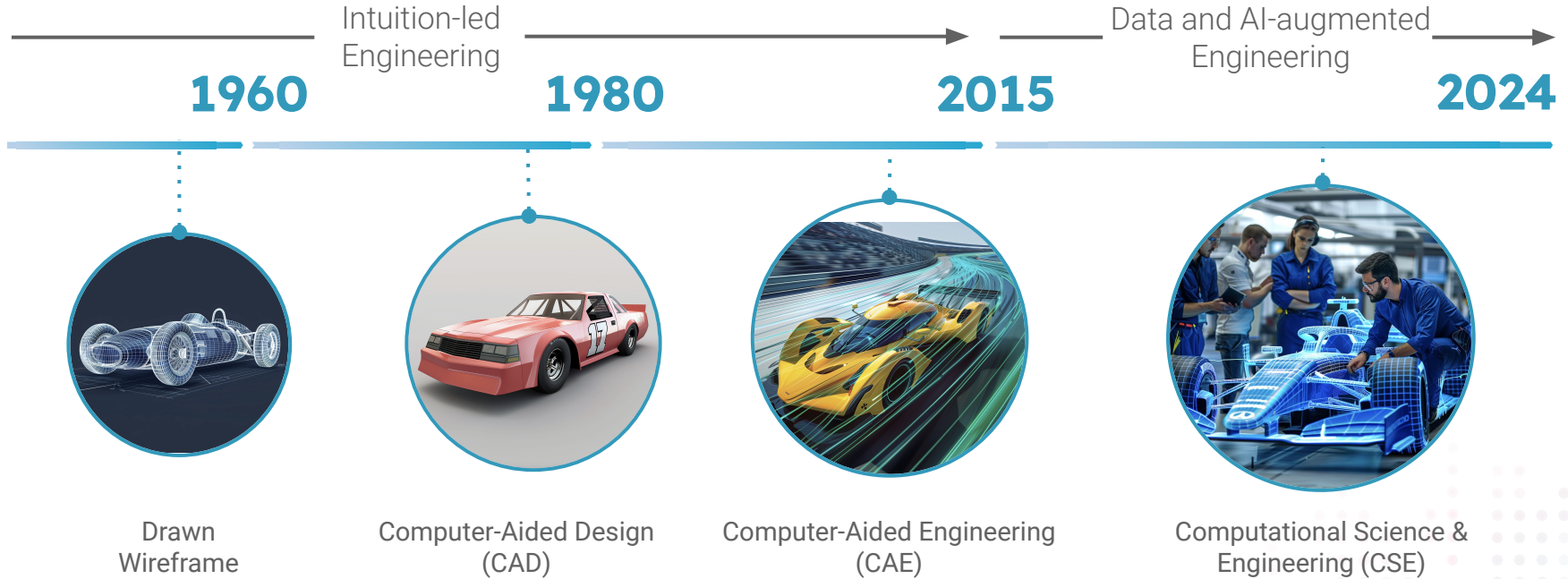


Semiconductor

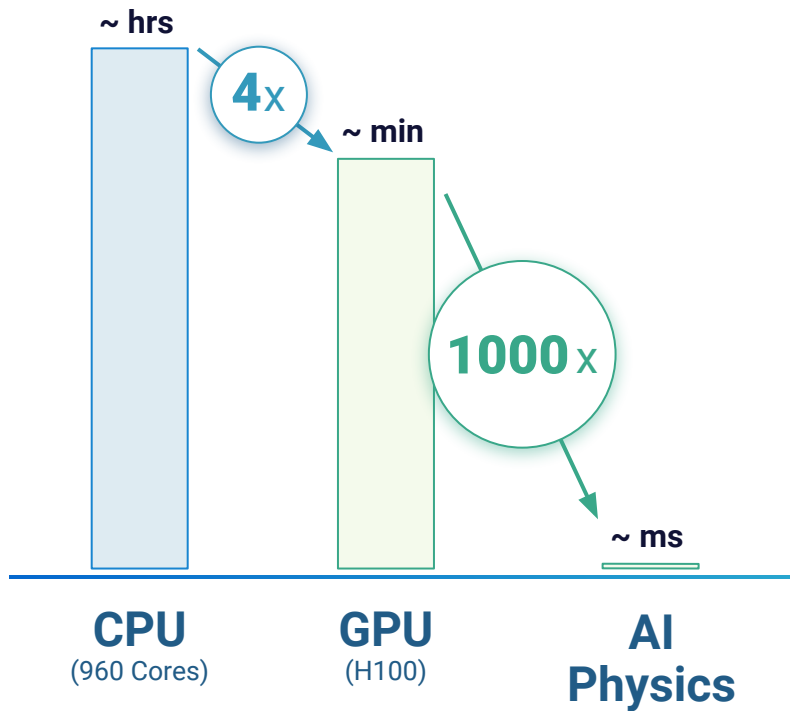
## Analyst Recognition



# AI is Driving Transformation in Engineering



# AI and Accelerated Computing Enable AI Physics Breakthroughs

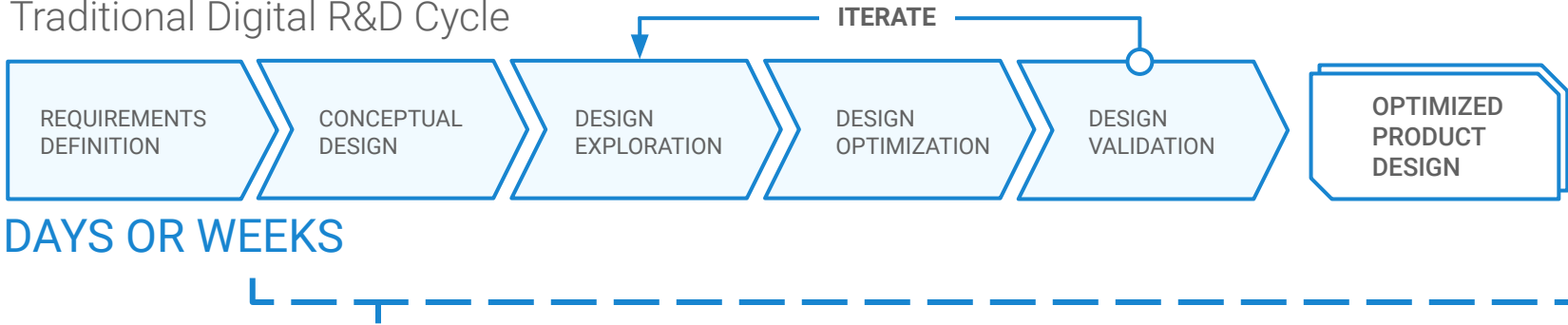


## Recent Advancements / Enablers of Business Outcomes

- Computational reducibility unlocks accurate predictive physics
- Breakthroughs in AI frameworks, and neural network development
- Accelerated computing further fuels accelerated algorithms
- Pre-trained physics models can provide compounding advantages

# Modern Engineering Teams Harness AI to Accelerate R&D Cycles

## Traditional Digital R&D Cycle



## AI-Augmented Digital R&D Cycle



MINUTES OR HOURS

**1000X+** Accelerated  
Results for Design Evaluation

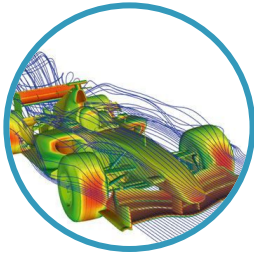
**99%+** Accuracy Compared to  
Traditional CFD Simulation

**85%** Improvement in  
Computing Resource Efficiency

# Deploy Custom AI Models for Continuous Product Improvement

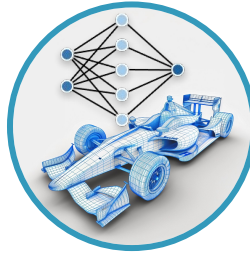
Design Exploration & Optimization Cycle with Simulation + AI

**1** Simulation Data Generation



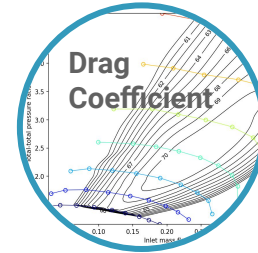
Generate physics-based CFD data, label data & prepare training datasets

**2** Model Training & Deployment



Automate workflows for training & deploying custom AI models

**3** Inference & Prediction



Run inference to rapidly evaluate one or many designs with AI-driven predictions

Validation & Tuning

Validate prediction accuracy and improve AI models with additional simulation

# Example: Optimizing Aerodynamics with AI Physics Inference

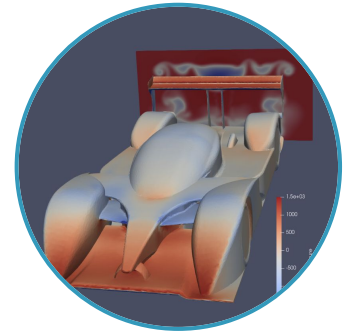
**Description:** Le Mans Hypercar Prediction Model Training with CFD data from STAR-CCM+ and Inference Predictions from NAVASTO NAVPACK

rescale + NAVASTO

**1,000X**

Acceleration of  
CFD Design  
Evaluation

[View Full Video Demonstration](#)



Evaluate a Design in  
Milliseconds or  
Thousands of  
Designs in Minutes

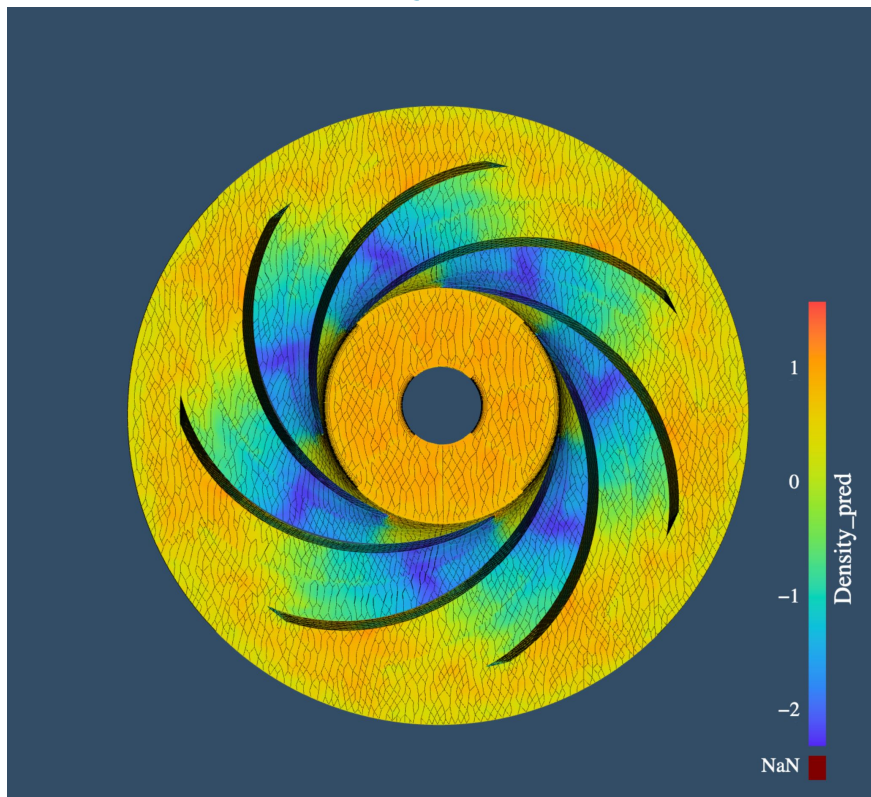
## Turbomachinery Flow

Feature [unit]	Value range		
	min	baseline	max
r1: inner radius [mm]	20	21.5	23
r2: outer radius [mm]	55	57.5	60
$\beta$ 1: at inlet [°]	20	23	26
$\beta$ 2: at outlet [°]	17	20	23
b2: at outlet [mm]	15	18	21
$\omega$ [rpm]	28000	30000	32000
p [kPa]	110	120	130

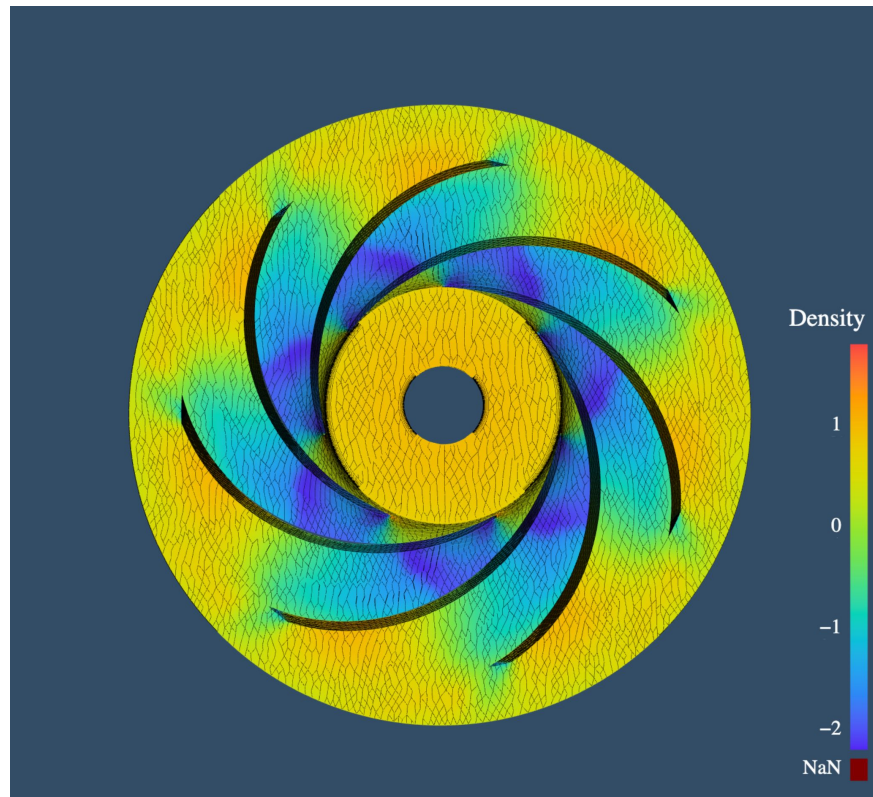
- 2,000 design & operational condition variation
- 5 mins on 4 cores per run to generate dataset
- Network training - 31000 epochs, 3 mins on a V100 GPU



# Turbomachinery Flow

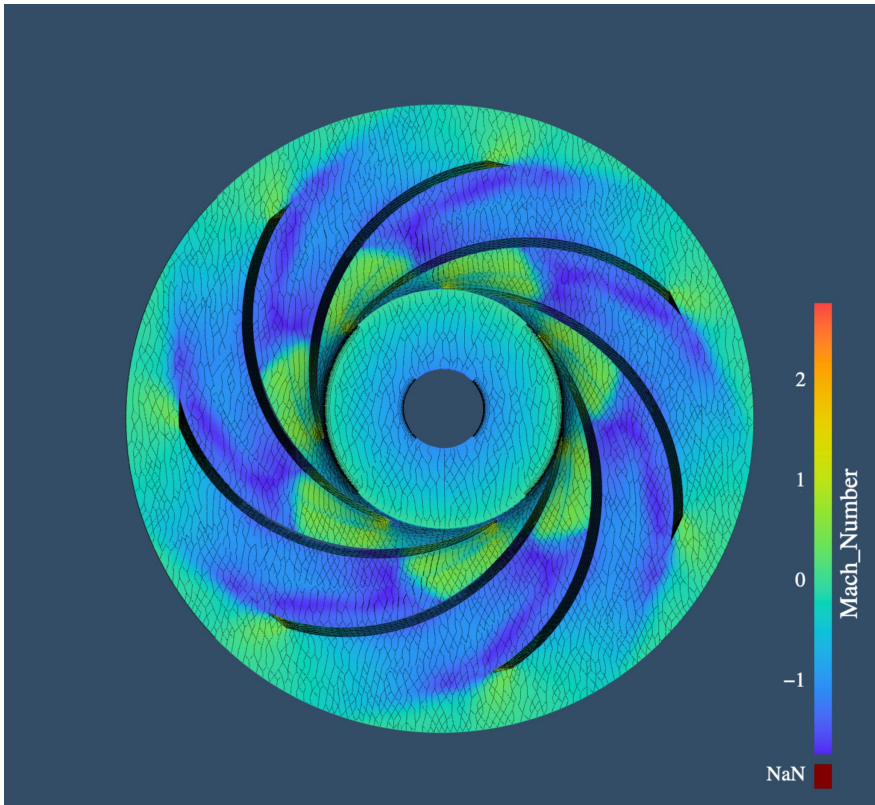


Predicted

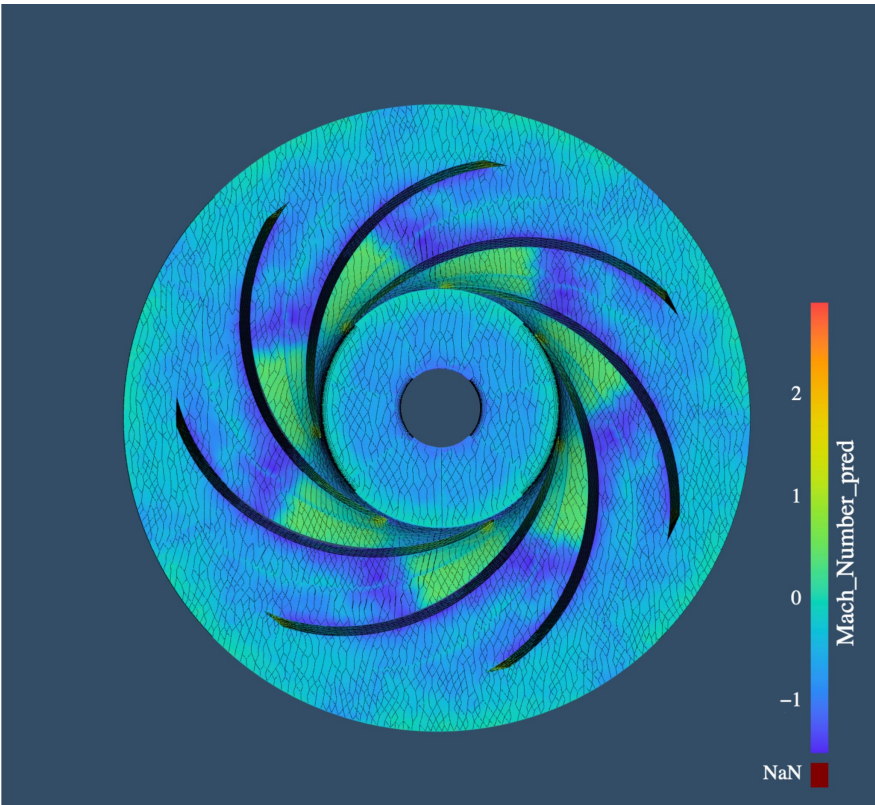


CFD

# Mach number comparison

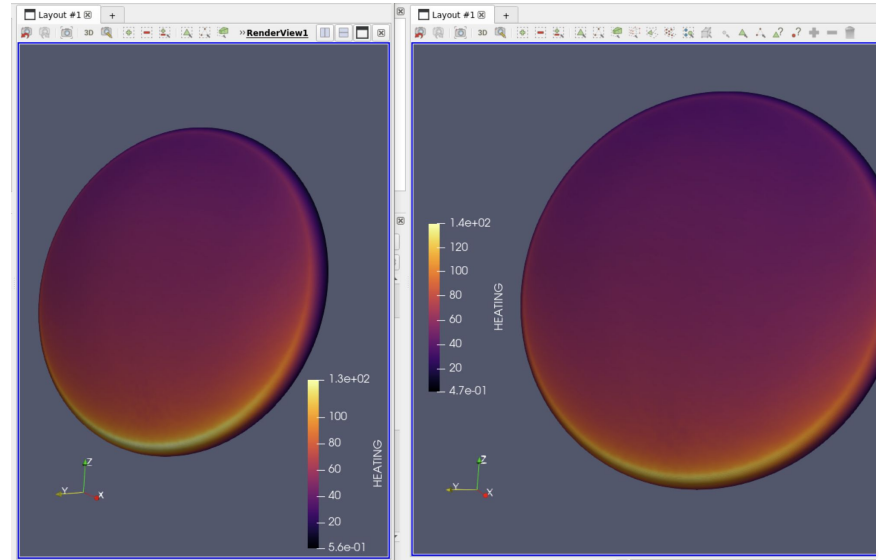
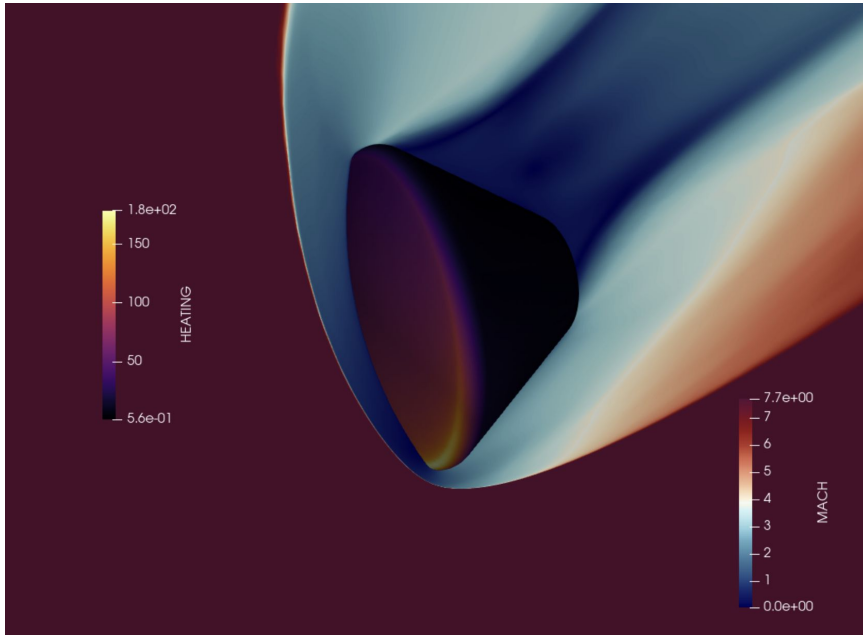


CFD



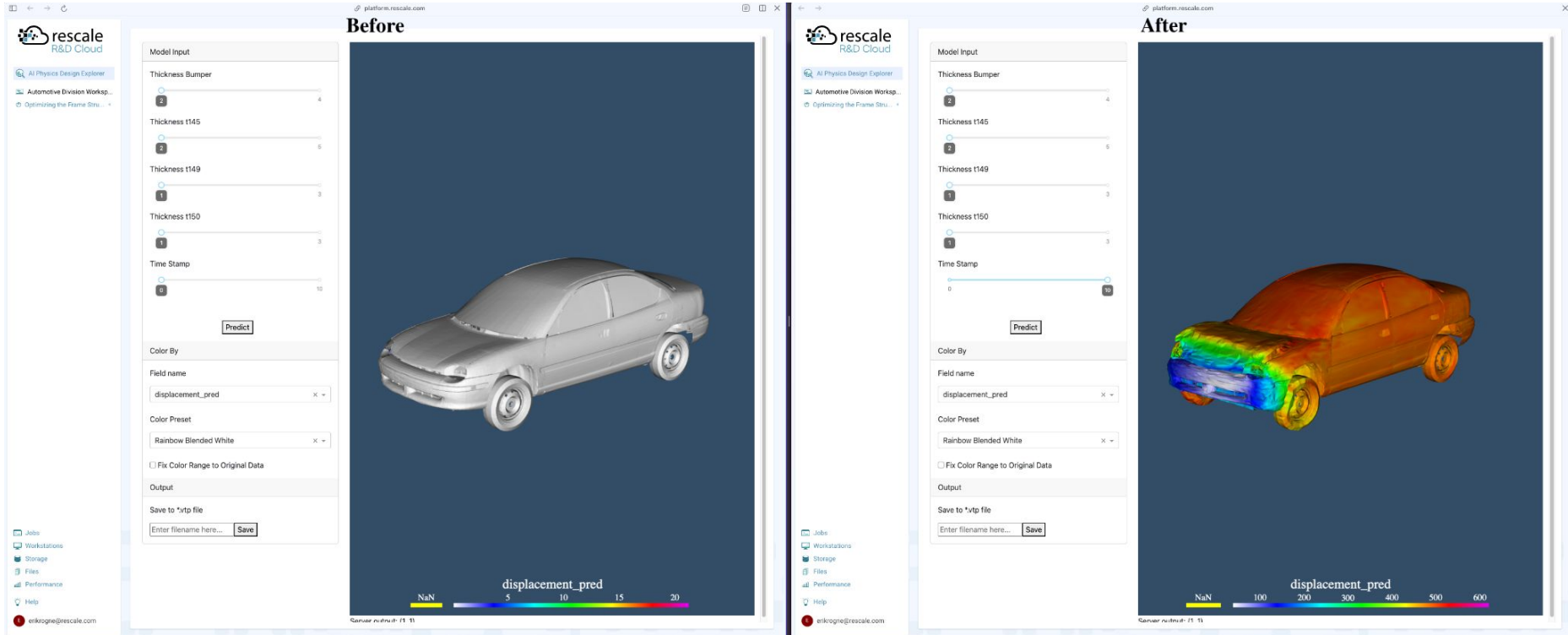
Prediction

# Flow over a reentry capsule



Predicted (left) vs. FUN3D (right)

# Crash simulation



# AI Physics Powered by NVIDIA

**NVIDIA  
AI Enterprise**



**Rescale  
HPC Built for the Cloud**



Full-Stack  
Data Science & AI/ML

50+ AI developer tools and  
AI accelerated hardware

**Frameworks & Pre-Trained Models**  
Modulus, NeMo, Clara, and more

**Data Prep, Training, Optimization, Deploy**  
TAO, RAPIDS, Triton, CUDA and more

**Multi-Cloud Infrastructure**  
A100, H100, H200, GH200

[Learn more](#) about NVIDIA AI Enterprise

Fully-Automated  
R&D & IT Computing

1,200+ R&D applications and  
Full-stack HPC+AI Automation

**AI Application Marketplace**  
NAVASTO, Neural Concept,  
Physics X, Navier AI,  
Monolith AI, and more...

**AI Workflows**  
Training Pipelines  
Data Labeling  
Inference Prediction  
Results Visualization  
Simulation Validation



Cloud Platform for  
Engineering Computing

PERFORMANCE

AUTOMATION

GOVERNANCE



# NC + Rescale

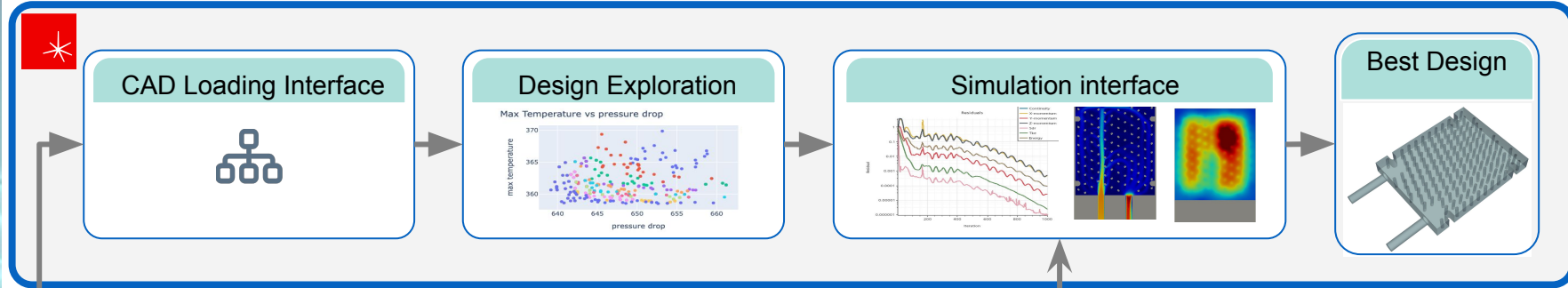
A FULLY PACKAGED, REPLICABLE AND SCALABLE END-TO-END WORKFLOW

REQUIREMENTS

EXPLORATION

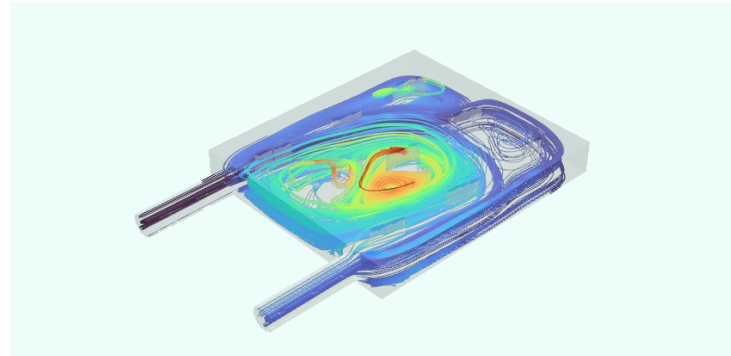
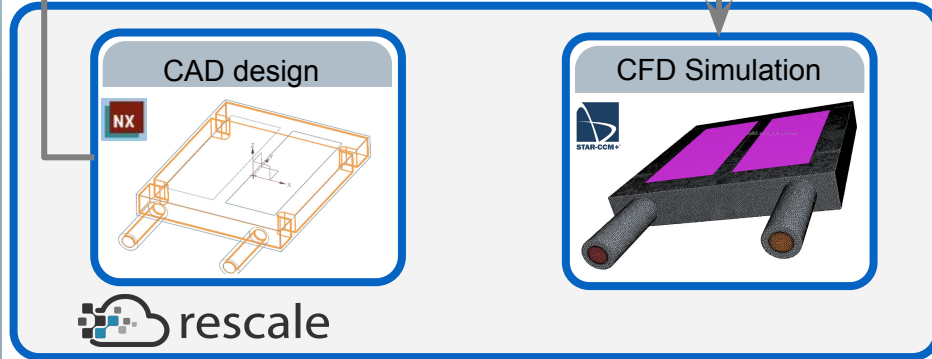
VALIDATION

EXTRACTION



CAD Export

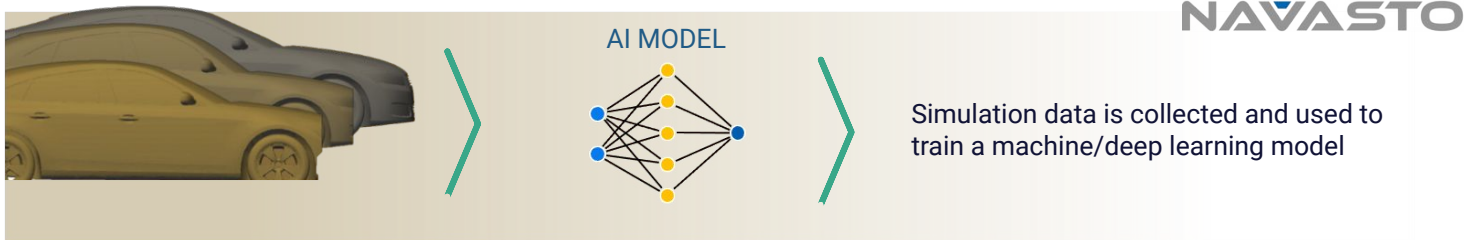
Rescale REST API



# AI: Models: Real-time Capable 3D Surrogates for Simulation

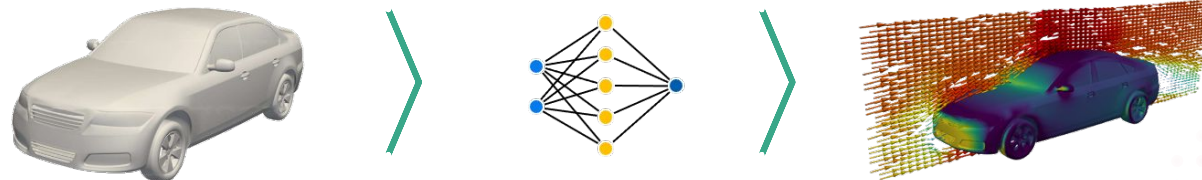
Train, Predict, and Validate Designs using Navasto on Rescale

TRAIN



Geometries and/or Parameters

PREDICT



New Design Candidate

The trained AI model can be queried with new design candidates to **predict the result of a simulation within milliseconds.**

# Built for Seamless Integration for Any Enterprise

## AI-ENABLED ENGINEERING



## COMPUTER-AIDED ENGINEERING

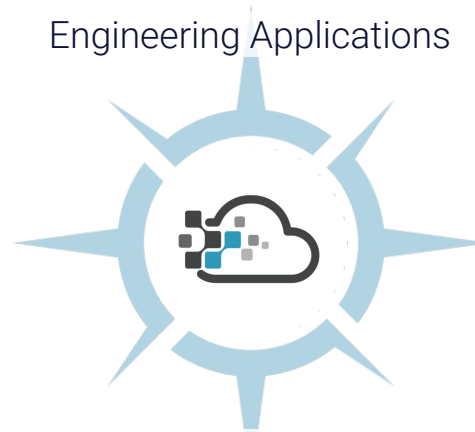


Engineering Applications

3DEXPERIENCE



Product Knowledge and Process Orchestration



Storage Services and Data Management

lustre



Cloud Infrastructure



HYPERSCALE CLOUDS

SPECIALTY CLOUDS



# Rescale Metadata Management

Transfers Help ERIKROGNE@RESCALE.COM Erik's Rocket Lab

**Job Details**

Project: Model 3

Job Type: Basic

Tags: aerodynamics CFD drag-reduction

Date Created: Templated from Model 3: Aero Wheels - Drag Reduction (Template)

This study is to reduce the coefficient of drag to under 0.29 on the Model 3. We aim to do this by optimizing the aerodynamic wheels.

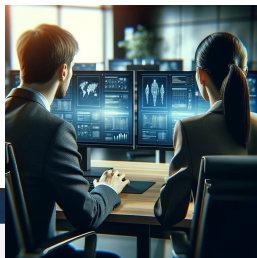
**Context**

- \* Study: Aero Wheels - Drag Reduction
- \* Study Requestor: erikrogn@rescale.com
- \* Study Expected Completion Date: 2023-12-01
- \* Development Status: Exploration
- \* Objective: Reduce coefficient of drag to <0.29

What is the purpose running this simulation?

**User-Centric Experience**  
Flexible, Seamless and Automated

**Simulation Governance**  
Consistent Data Capture



**Simulation Traceability**  
Search and Find Simulation Jobs, Files, and Decisions

rescale Jobs Workstations Storage Devices Files Performance

Transfers Help SURANKAR@RESCALE.COM Automotive Division

**Jobs**

Download CSV

My Jobs	Name	Software	Hardware	Run Time	Status	Tags	Shared	Created	Lineage	Comments
Active Jobs	AeroTemplate	Ansys	Emerald (26 cores)	26:30:55	Completed	Responsible: Sandeep aerodynamics KPI: Cd@0.31		Nov 21, 2023 @ 9:01 AM	New Job	
All Jobs	DesignA	Ansys	Emerald (72 cores)	18:43:06	Completed	aerodynamics KPI: Cd@0.31 Design: A		Nov 19, 2023 @ 7:11 AM	Templated from Hinc@B	[1w] reference thermal simulation #ticXQB
Jobs Shared with Me	DesignD	Ansys	Emerald (26 cores)	0:01:13	Completed	Design: D status: fail KPI: Cd@0.31		Nov 18, 2023 @ 3:36 PM	Templated from krcXQB	[1w] reference thermal result #ticXQB
Stopped Jobs	DesignC (from template Aero-Template)	Ansys	Emerald (1 core)	0:00:59	Completed	aerodynamics Design: C status: fail		Nov 18, 2023 @ 3:28 PM	Duplicated from ifv@UC	

Tags: Responsible: Sandeep, aerodynamics, KPI: Cd@0.31, status: fail, Design: A, Design: C, Design: D

**Model-Based Collaboration**  
Share Simulation Models and Insights

# Resource Tags: Share Simulation Context Fast and Flexibly

The screenshot shows a table of simulation jobs with the following data:

Name ↑	Tags
Tire Analyses	program:Acura:TLX Project:TireDesign
Seat Belt Analysis	Project:DriverSafety Responsible:Sandeep
Brake Sc...	Example-Problem Project:Brakes status:pass fea structural
DesignB...	AnalysisPhase:Released Responsible:Sandeep Pass
ExteriorA...	Responsible:Sandeep Project:Drafting program:Acura:TLX

A search dropdown menu is open, listing various tags such as aerodynamics, AIML, AnalysisPhase:In-Development, AnalysisPhase:Released, AnalysisPhase:Troubleshooting, ansys, battery, cfd, completed, Demo, Design:A, Design:B, and Design:C.

Schemaless, User-defined tags for grouping and categorization

Jobs

Elastic Cloud Workstations

Apply existing tags or add new

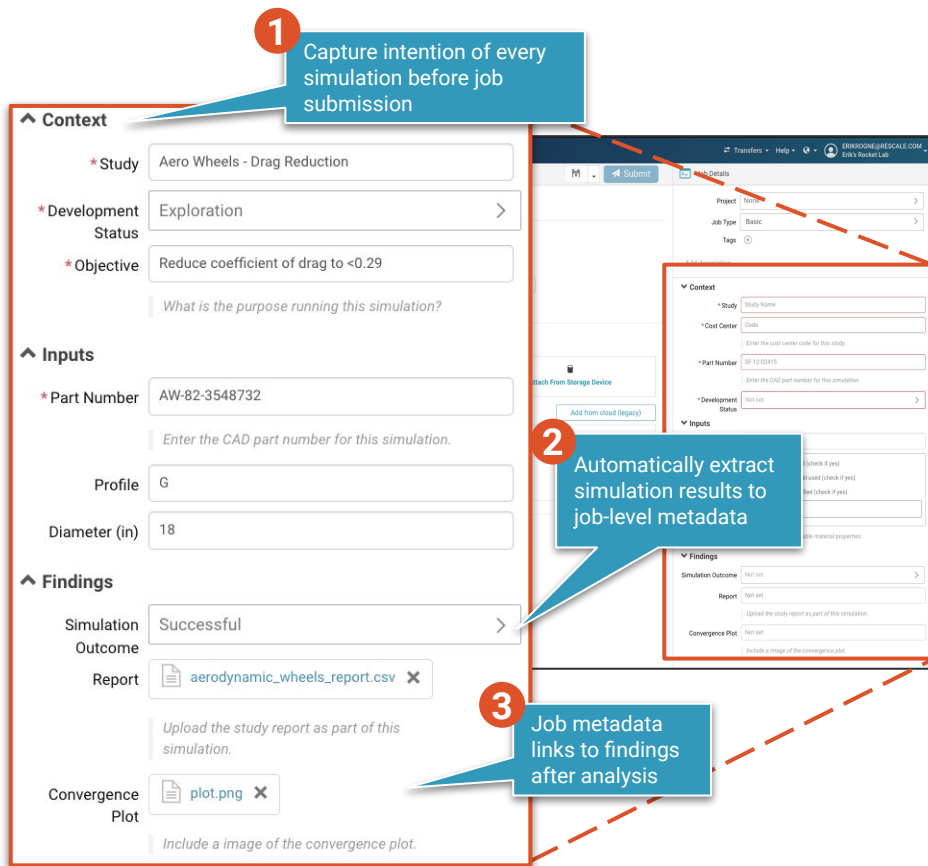
## Features

- Schemaless tagging for flexible categorization
- Apply tags to Jobs, Elastic Cloud Workstations, and Files

## Benefits

- Shared context on computing activities across projects and teams e.g. related studies, goal, outcome, stage
- Efficient organization of most important resources for increased visibility via search, sorting, and filtering
- Flexible schema-less format for customization and extensibility

# Custom Fields: Capture Complete Details on Every Simulation



**1** Capture intention of every simulation before job submission

**2** Automatically extract simulation results to job-level metadata

**3** Job metadata links to findings after analysis

**Context**

- \* Study: Aero Wheels - Drag Reduction
- \* Development Status: Exploration
- \* Objective: Reduce coefficient of drag to <math><0.29</math>

*What is the purpose running this simulation?*

**Inputs**

- \* Part Number: AW-82-3548732
- Profile: G
- Diameter (in): 18

**Findings**

- Simulation Outcome: Successful
- Report: aerodynamic\_wheels\_report.csv
- Convergence Plot: plot.png

**Job Details (Pop-up)**

- Project: None
- Job Type: Basic
- Tags: [None]
- Context**
  - \* Study: [None]
  - \* Cost Center: [None]
  - \* Part Number: SP 12-02415
  - \* Development Status: [None]
- Inputs**
  - [None]
  - [None]
  - [None]
- Findings**
  - Simulation Outcome: [None]
  - Report: [None]
  - Convergence Plot: [None]

## Features

- **Admin-Enforced Fields:** Ensure data consistency and governance with mandatory fields.
- **User-Defined Fields:** Enrich jobs with custom simulation parameters and results.

## Benefits

- **Governance:** enforce process compliance with mandatory fields
- **Traceability:** revisit findings and decisions for audits, error detection, and revisions
- **Organization:** search by context rather than HPC data
- **Analytics:** connect various jobs and resources into a digital thread for enhanced collaboration and insight extraction

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## Let's Get Started!

- Contact Rescale team
- Arrange discovery calls
- Scope out a pilot program
- Set a routine customer meeting
- Celebrate the successful pilot
- Launch it in production

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**Mark Jackson**  
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**Madhu Vellakal**  
madhu@rescale.com