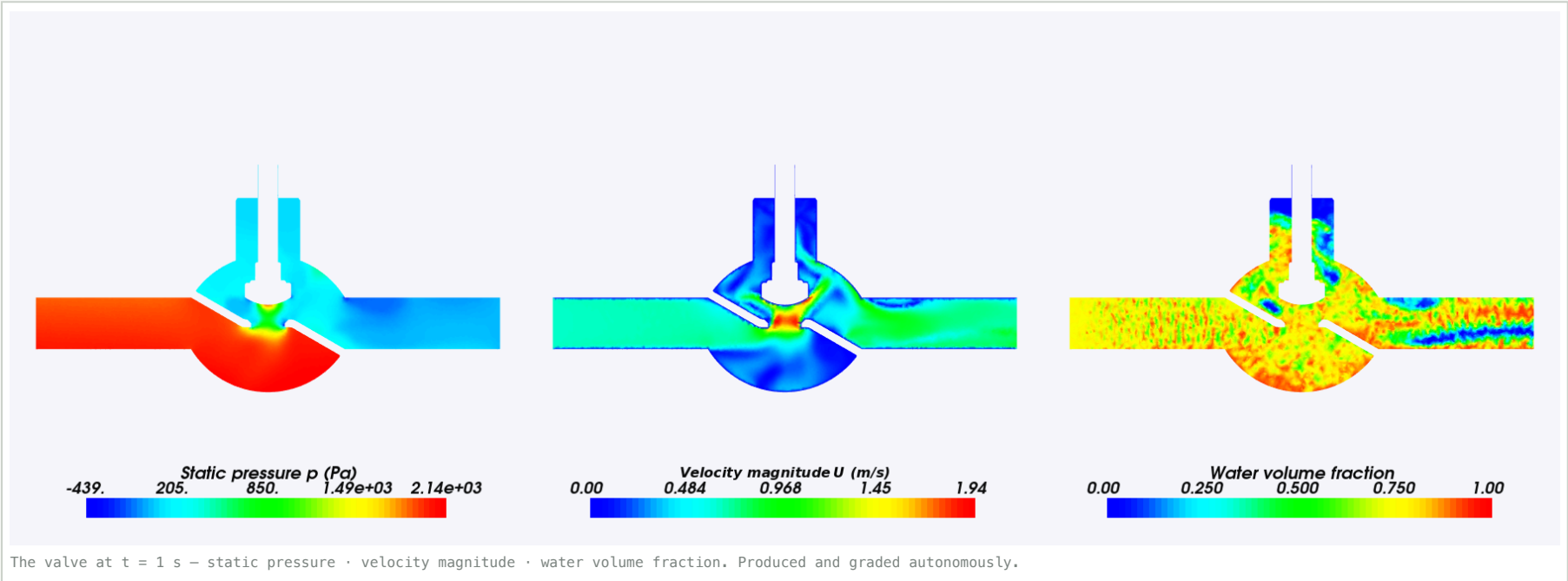


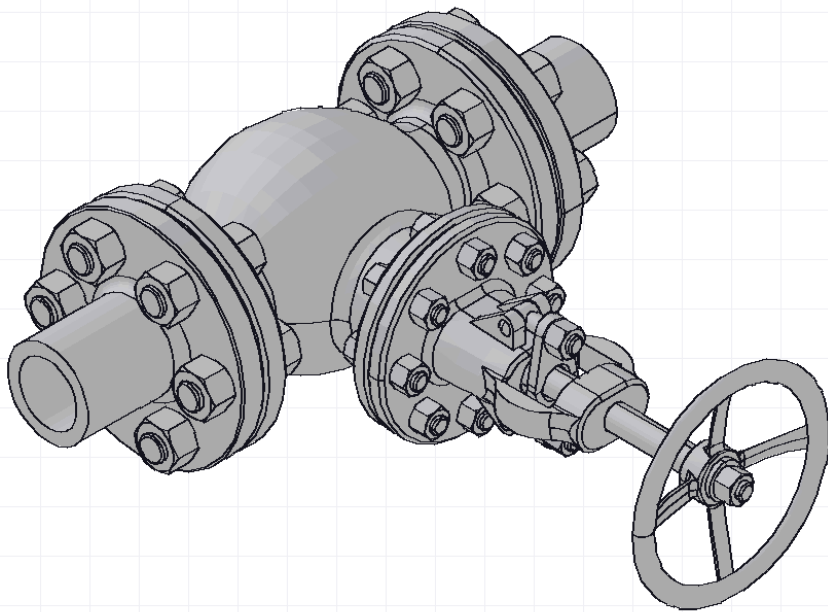
# The whole CFD job, run by an agent.

An LLM agent took SimScale’s public 36-solid globe valve from raw CAD to validated one-second two-phase OpenFOAM results — defeaturing, meshing, solving, and failure diagnosis included. Humans approved budgets; the agent did the engineering.



# Demo.

Six one-second solves from one original CAD assembly.



The source: SimScale's public 36-solid globe valve – flanges, fasteners, stem train, handwheel – as downloaded.

# Two days, forty dollars, no babysitting.

The demo campaign, end to end. The finest solve — 950k cells on the retained geometry — landed on the public reference to 0.03%.

~48 h

WALL-CLOCK, END TO END

~\$40

TOTAL CLOUD COMPUTE

\$4–19

PER ONE-SECOND SOLVE

6

ONE-SECOND RESULTS

–0.03%

ΔP VS REFERENCE, FINEST MESH

## WHAT THE AGENT DID

- **Derived the fluid domain** from all 36 solids; found and closed the leak path.
- **Defeatured with measured deltas:** one 0.1 mm dead-end annulus, 3 faces, –0.023% volume.
- **Meshed, solved, graded:** Ennova and Gmsh meshes, OpenFOAM v2412 to t = 1 s, machine-checked gates.

## WHAT HUMANS DID

- Approved cloud budgets and one scope decision.

**Stack.** Frontier LLM agents over our automation layer · Ennova 1.11.2 · OpenFOAM v2412 · on-demand cloud compute.

# It debugged the campaign, not just the happy path.

The agent diagnosed and repaired failed simulations autonomously.

EXAMPLES

GEOMETRY

Silent meshing failures

Volume meshes reported success while containing zero 3D cells. The agent caught it by inspecting the saved mesh files, traced it to a 0.1 mm annulus, and removed the annulus with a three-face CAD edit.

NUMERICS

Turbulence blow-ups

k-ε crashes on distorted cells, diagnosed from solver logs against the OpenFOAM source and fixed with standard stabilization schemes — then re-run cleanly to 1 s.

UNITS

mm / m traps

Metre-declared CAD files and model-unit mesh settings, isolated by one-variable experiments instead of guesswork.

RESILIENCE

Long solves, insured

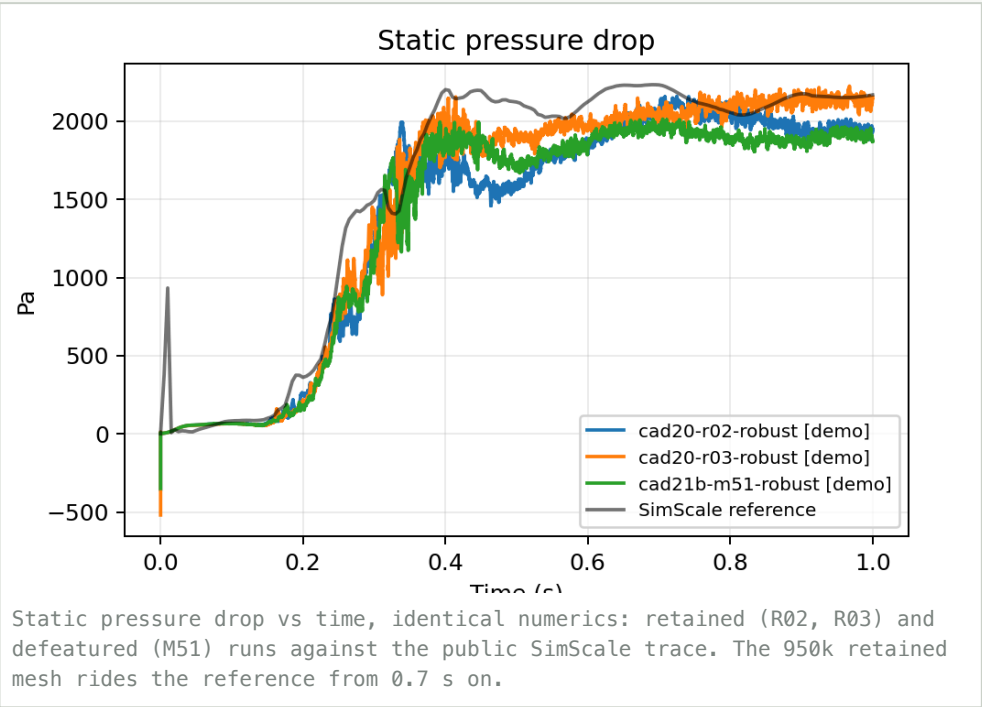
One solve projected to outrun its compute budget, so the agent built and tested a checkpoint restart before it was needed. (The run finished in time.)

# Six one-second results, one public reference.

Water/air filling transient, 0.2 L/s inlet, OpenFOAM v2412 interFoam.  $\Delta P$  is the last-0.2 s mean.

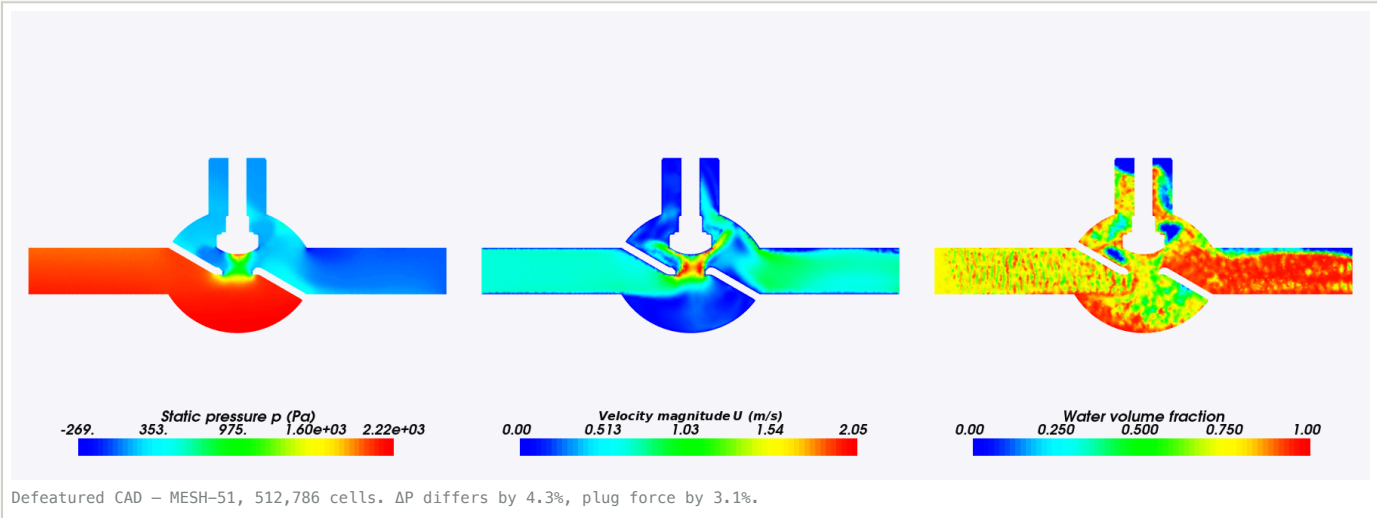
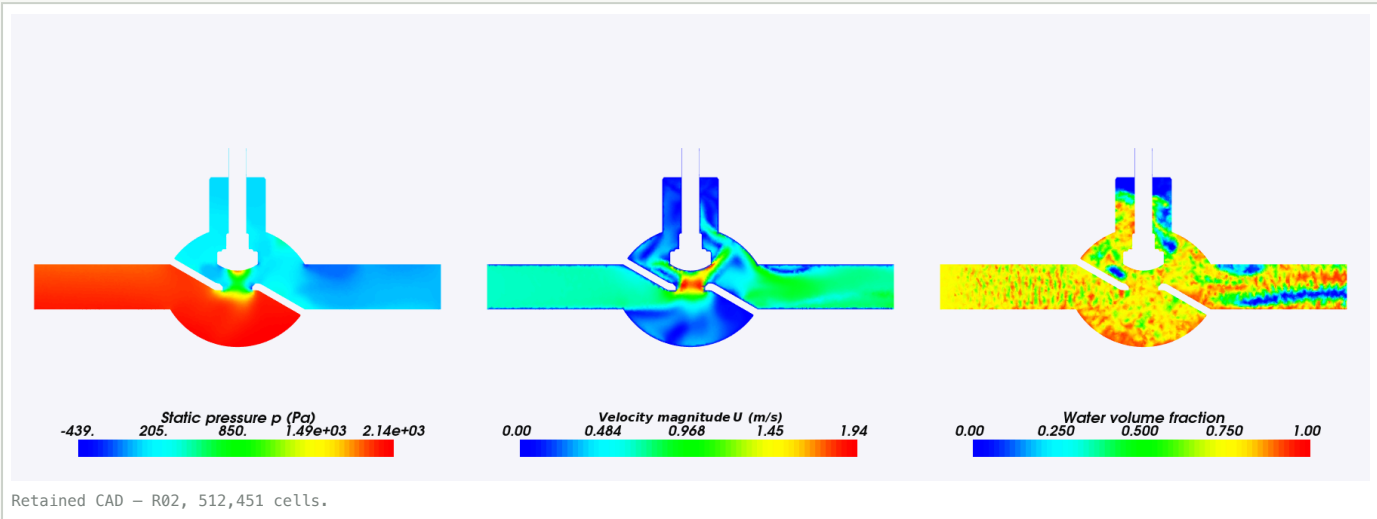
| RUN           | GEOMETRY    | MESH           | $\Delta P$ [PA] | PLUG F [N] |
|---------------|-------------|----------------|-----------------|------------|
| M51 · 3/2/10  | defeatured  | Gmsh 512,786   | 1967            | 0.091      |
| M51 · 3/3/10  | defeatured  | Gmsh 512,786   | 2010            | 0.092      |
| M51 · robust  | defeatured  | Gmsh 512,786   | 1891            | 0.090      |
| MESH-28       | defeatured  | Ennova 362,284 | 1778            | 0.071      |
| R02 · robust  | retained    | Gmsh 512,451   | 1971            | 0.087      |
| R03 · robust  | retained    | Gmsh 950,772   | 2127            | 0.101      |
| SimScale ref. | flow region | 257k auto      | 2128            | ~0.100     |

- **Defeaturing preserved the physics.** Retained vs defeatured, identical numerics:  $\Delta P$  +4.3%, plug force -3.1% — inside every criterion.
- **Leverage ranking.** Mesh moves the observables 8–23%; schemes 2.5–6%; the geometry edit 3–4%.
- **Convergence measured.** Refining the retained mesh 1.86× moved  $\Delta P$  +7.9% and plug force +16% — both toward the reference — landing within 0.03% and 0.4%. Coarse-mesh runs sit 5–16% low: a measured mesh-resolution effect.



# The removed detail is provably inert.

Top: retained geometry — the stem-packing annulus above the bonnet is gas-filled and stagnant. Bottom: defeatured.



# Ennova’s tools, driven by an agent.

The hardest CAD work in the campaign ran through Ennova 1.11.2 — the same diagnostics and repair tools an engineer would reach for, called autonomously.

DIAGNOSE

Found the failure

Ennova’s topology diagnostics located the 0.1 mm dead-end annulus behind the silent meshing failures.

REPAIR

Carried the CAD edit

Ennova’s repair and grouping tools carried the defeaturing — a three-face edit that removed 0.023% of the fluid volume and nothing else.

MESH

Solved a native mesh

An Ennova-native 362,284-cell mesh completed a full one-second solve, sitting with the other coarse meshes in the measured mesh-resolution band.

Next in the collaboration: boundary-layer meshing — prism layers for the wall-shear quantities the next case is built on.

# Where we're headed.

The valve was a demonstration. The destination is a product — built with the people who will use it.

DESIGN PARTNERS

Built around real workflows

We're looking for design partners to turn this into a product that matches their needs — their geometries, their solvers, their standards of evidence.

CAPABILITY

Harder problems, every day

Each campaign takes on a harder CFD problem than the last — more physics, bigger meshes, tighter validation against trusted references.

COVERAGE

A wider toolbox

We're expanding the tools we support and the types of problems we can handle — more meshers, more solvers, more problem classes.

**Get in touch.** If autonomous CFD could change how your team works, we'd love to hear from you.