WOLFRAM CONSULTING SERVICES

Developing the World's Most Efficient, Fuel-Agnostic, Net-Zero Powertrains

Industry: Sustainable Energy

Applications: Modeling, Simulation, Computational Tools

ABOUT

Decarbonizing long-haul transport, off-grid power and heavy industry, Carnot is leading the way in tackling this trillion-dollar challenge. Through the use of next-generation materials, sustainable fuels and innovative engine design, Carnot is developing high-efficiency, lightweight powertrains, creating new pathways to net zero.

70%

The key benefit of Carnot engines is **70% thermal efficiency.** Traditional engines typically operate at 35% thermal efficiency.

NET ZERO

Carnot Engines' mission is to reduce global CO2 emissions by 13% to **net zero** by bringing clean, affordable and scalable power.

£1.7 MILLION

Carnot Engines raised over **£1.7m** in funding, including two heavily overfunded Crowdcube rounds.

THE CHALLENGE

Creating the world's most efficient, net-zero powertrain is no easy challenge. Carnot's use of advanced technical ceramics and superalloys to create engines and cooling systems requires serious innovation, and serious innovation requires serious tools.

Disruptor's dilemma

As a disruptor in its industry, Carnot has to deal with strict budgets, smaller teams and pressure from investors to deliver on tight timelines. Expensive, off-the-shelf, black-box toolkits did not allow Carnot the agility and flexibility that would enable true innovation and often required significant training investment and huge amounts of computational power.

Evolving ideas with computation

Ceramic engines have been pursued by traditional powertrain manufacturers for decades—but they're not thinking from scratch. Instead, they use traditional, industry-standard tools that have been designed to deal with traditional, industry-standard ways of thinking.

When Carnot introduced a significant step change in ideas, those systems often stopped working as expected, with no way to investigate why. Carnot needed an industrial-grade computational modeling and simulation toolkit that enabled them to move beyond evolving existing ideas to creating revolutionary innovations.

Engineering challenges

Engineering challenges like the one faced by Carnot are dominated by a process of verification and validation. This can be extremely slow and expensive, especially when iterating hardware designs.

"Mathematica has provided the foundation for all our engineering. The power it offers us has been critical in accelerating our technology development and it was early support from the Wolfram team that enabled the early evolution of our company, on the pathway to developing our game-changing decarbonising technology."

— Archie Watts-Farmer
CEO & Co-Founder
Carnot Engines

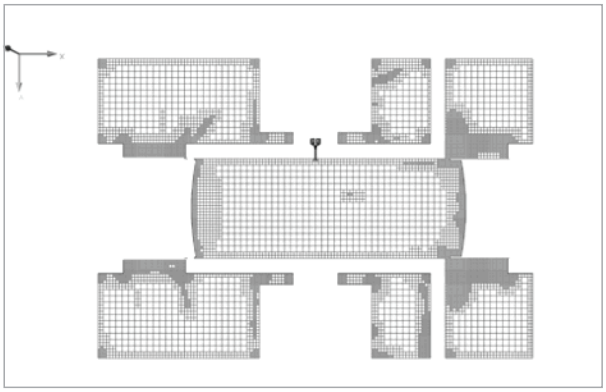
THE APPROACH

First principles of true innovation

True innovation often starts at first principles, so that's exactly where Carnot started. Carnot employed Wolfram to create multi-node simulations, all the way from zero dimensions to 3D simulations at a component system level, to optimize and streamline their verification and validation processes—often slow and expensive, especially when iterating hardware designs.

Efficient powertrain modeling

A key element of designing a new breed of powertrain was modeling gas flows through the engine—an extremely resource-intensive process using 3D computational fluid dynamics or finite element simulations that build up quickly as designs are iterated upon.



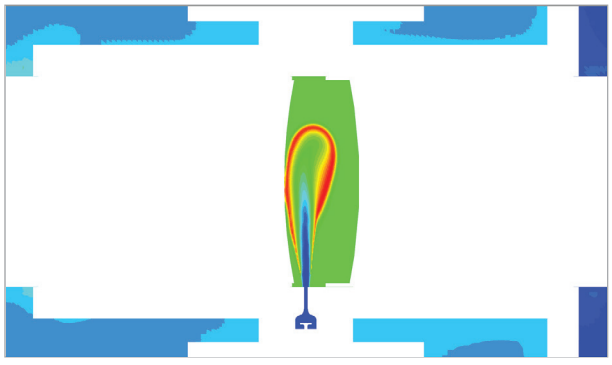
Gas Flow Simulation

To reduce the time and computation costs of this process, Carnot used the Wolfram System to build a 1D model based on applying a steady-state energy equation to a control volume to predict key performance parameters.

Comparing the results of the 1D simulations in the Wolfram System to the 3D CFD models, Carnot found they matched up incredibly well. This validation allowed Carnot to expand the use of their 1D model, simultaneously consider multiple design options and quickly explore different scenarios.

Wolfram System's data advantage

A key feature of the Wolfram System that enabled models to be built quickly and cost-effectively was Wolfram's built-in, curated data. Carnot was able to incorporate the thermo-physical properties of a range of gases into their models with just a few lines of code, with no external packages or data required. The flexibility of the Wolfram System even enabled Carnot to manipulate, adapt and augment the built-in data to suit the specific needs of their simulations and increase performance even further.



3D Combustion Simulation

ACHIEVEMENTS

Powerful, Flexible Workflow through Unified Computation

With the Wolfram System's single, unified approach to computation, Carnot was able to build a powerful yet flexible workflow. This workflow has enabled Carnot to iterate quickly through various designs, simultaneously considering multiple options and quickly exploring different scenarios, while still producing accurate and reliable results.

Supercharged Productivity with Built-in Data

Utilizing the curated data built into the Wolfram System, Carnot was able to hit the ground running with their designs, not having to worry about sourcing the data, validating it or pre-processing it to get it ready to use in their calculations. Because all of Wolfram's built-in data is stored in a ready-to-use computable form, Carnot was able to adapt and augment the data with ease, safe in the knowledge that common causes of errors, like measurement units, were already taken care of.

Greater Transparency and Flexibility versus Off-the-Shelf Systems

With the Wolfram System, Carnot had much greater insight into how their models and simulations were operating versus traditional off-the-shelf products. This made it much quicker to develop, prototype and iterate on their designs with the Wolfram System working with them to explore new ideas rather than forcing them into traditional ways of thinking. The high-level approach of Wolfram Language enabled Carnot to focus on their ideas, not the code, while offering the flexibility to adapt to and complement Carnot's revolutionary approach to powertrain design.

"You can't innovate if your tools lock in pre-conceived ideas. We have designed Wolfram Language to give the widest set of tools with the fewest constraints, and Carnot has shown how this lets them redefine the assumptions of their industry."

—Jon McLoone

Director of Technical Communication and Strategy
Wolfram Research Europe

LET'S TAKE YOUR PROJECT TO THE NEXT LEVEL

Find out how the Wolfram Consulting Services team can jump-start your project with in-depth troubleshooting, code optimization, custom training or production deployment.

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