



FULL STEAM AHEAD

Startup Nebia is poised to transform the experience of taking a shower. While developing its innovative new showerhead, the company's engineers made thermal improvements to ensure that a shower, using much less water than average, would be warm and comforting.

By Gabriel Parisi-Amon, Co-Founder and Chief Technical Officer, and Corey Lynn Murphey, Mechanical Engineer, Nebia Inc., San Francisco, USA

Often, protecting the environment means making some sort of personal sacrifice — taking time to sort your recyclables, making the effort to walk or ride a bike, carrying reusable grocery bags along with you.

Nebia was founded to deliver a personal benefit alongside an environmental benefit. The company's innovative showerhead not only reduces the water consumed during a typical shower by 70 percent, but it also delivers an improved personal experience that early users are describing as “transformative.”

The company's name comes from the Italian word *nebbia*, which translates to “fog” or “mist.” Nebia's groundbreaking showerhead technology, inspired by the

nozzles in jet engines and agricultural equipment, delivers water in very fine droplets — cutting water consumption dramatically, while creating a comforting, enveloping warm cloud. It is a truly revolutionary idea that has the power to change the way people around the world take showers every day.

A DROPLET OF INNOVATION TAKES SHAPE

The concept behind Nebia was inspired by co-founder Carlos Gomez Andonaegui, a fitness club executive in Mexico. In 2010, Carlos wanted to reduce the water consumed by the 20,000 people showering in his company's clubs every day, without

compromising the quality of the bathing experience.

He and his father, Emilio, a retired engineer, came up with a few early prototypes of an atomizing showerhead capable of producing an ultrafine mist of water. To perfect and commercialize that idea, Carlos recruited a management team that included Gabriel Parisi-Amon and Philip Winter. Parisi-Amon's experience was in managing the product supply chain at Apple, while Winter had worked on delivering clean-water technologies to developing countries. With the right blend of expertise in place, Nebia was officially founded in 2013.

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SIMULATION HEATS UP ENGINEERING EFFORTS

Before Nebia could launch its innovative showerhead to the global marketplace, however, the product development team needed to solve one tough engineering challenge — which would represent a deal-breaker for consumers used to taking hot, steamy showers.

Nebia's core atomization technology — called H₂MICRO™ — is based on agricultural and aerospace applications, where water temperature is generally not a concern. But when employed in a showerhead, the technology showed one significant engineering flaw: The large surface area created by all those tiny droplets meant that thermal energy was quickly lost when the spray met room-temperature air. The water, which was hot when it left the showerhead, was much cooler by the time it reached the person taking a shower. Nebia's engineers knew they needed to address the issue of thermal loss.

Historically, Nebia's engineering approach was based on building showerhead prototypes, testing them and then creating new prototypes. Not only was that process expensive, but it was also very time-consuming. It might take weeks for new parts to arrive, for those parts to be assembled, and for a new design to be exhaustively tested.

Because Nebia is committed to innovation, the management team began to search for an alternative design and verification process that would accelerate the market launch, while also leveraging advanced engineering technology. Once the design team at Nebia began to leverage the power of ANSYS CFX and ANSYS Fluent to address the issue of thermal loss, the change was incredible. Suddenly an engineer could study the thermal performance of 12 design iterations per day — instead of spending a week on one physical test of a single prototype.

THERMAL LOSS: A CASCADE OF DESIGN CHALLENGES

Using CFD solutions from ANSYS, Nebia was able to analyze the thermal effects of hundreds of thousands of variables in its showerhead design — including the angles at which nozzles disperse water, the size of water droplets, the pressure and velocity of water streams, nozzle geometry, and internal flows within the showerhead.

The Nebia design team found that each of these factors played a role in managing thermal loss. But these design aspects also affected other critical aspects of the shower experience, so the company's engineering team had to make a series of design trade-offs.

For example, a larger droplet size



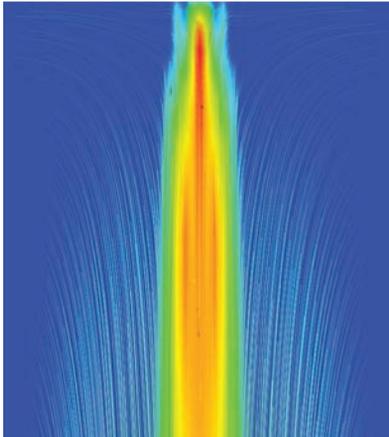
▲ Nebia's engineering team has created a game-changing showerhead system that balances a feeling of luxury with significant environmental benefits — delivering beauty, functionality and sustainability in an intuitive package that's easy to install and use.



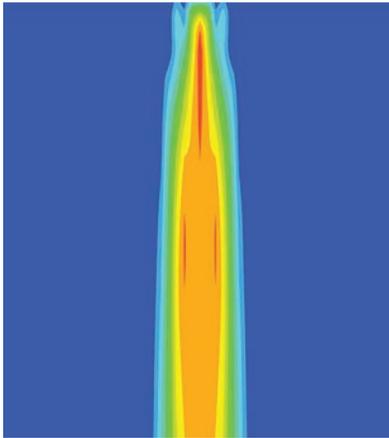
▲ Nebia's patent-pending H₂MICRO nozzle array — designed using ANSYS software — is housed in a high-density polymer head.

might retain thermal energy more effectively, but it might hit a human body with too much force to maintain the fog-like effect the brand is based on. It might also consume too much water to meet Nebia's aggressive water-conservation targets. Similarly, a high water velocity might reduce heat loss, but deliver adverse results in other performance areas.

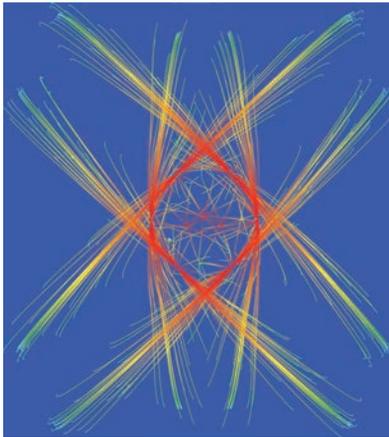
The Nebia product development team combined its ANSYS thermal-loss simulation data with experiential information collected by human test subjects — blending the quantitative with the qualitative. This enabled engineers to achieve the right balance of water temperature, flow rates and directions, droplet patterns and sizes, and other characteristics to create the ideal



▲ By using ANSYS software to simulate the water streams output by Nebia's nozzles, Nebia engineers vary and diversify droplet sizes of the streams — and understand how different water flow speeds, droplet sizes and spray patterns would affect droplet temperatures across the spray. As the velocity and droplet size were adjusted, engineers could optimize the range of droplet sizes needed to maintain a pleasant temperature — while also meeting water-conservation goals.



▲ The Nebia team needed to optimize both water temperature and air temperature, not just at the core of the shower spray, but also at its edges. This would create the warm fog-like effect so critical to the company's foundational product promise.



▲ Nebia's greater dispersion of droplets yields a larger volume of air surrounded by — and intermixed with — warm droplets of water. ANSYS software helped engineers ensure that a large volume of air was effectively heated around the user's body, creating a steam-room-like experience that's unique to Nebia.

shower experience. The simulation results were verified using late-stage physical prototypes.

By using ANSYS software to simulate different showerhead designs, instead of building and testing early-stage prototypes, Nebia was able to significantly compress its research and development efforts. In fact, research activities that previously took nine months were accelerated to just one month.

Today, engineering simulation via ANSYS has become part of the company's DNA. Simulation is used every day, and eventually the company plans to begin using finite element analysis (FEA) solutions from ANSYS to ensure the durability of all its individual showerhead system components over time.

FUNDING COMES POURING IN

Engineering simulation made a huge contribution at Nebia by dramatically accelerating the market launch for its H₂MICRO technology. But simulation had another critical application: It helped Nebia attract the funding required to support a commercial launch and compete with established players in the residential plumbing industry.

In August 2015, Nebia launched a Kickstarter campaign with a goal of raising \$100,000 in startup funding. Simulation images created using ANSYS software were used in the campaign to provide visual proof of the showerhead's performance to potential investors.

Nebia's goal of \$100,000 was reached in just eight hours. After 36 hours, the company's campaign had topped \$1 million. In total, the one-month campaign raised over \$3.1 million in pre-orders — making it one of the top 25 highest-funded projects in Kickstarter's history. More than 8,600 backers all over the world chose to invest in Nebia's technology, which provides strong evidence that reducing water consumption is truly a global concern.

Nebia has also attracted some high-profile investors and philanthropists concerned with the worldwide availability of clean water, drought abatement and other water-related issues. Like the funders attracted via Kickstarter, these individuals have been impressed by the science behind Nebia's technology, as demonstrated graphically via engineering simulation.

FLOODING THE GLOBAL MARKETPLACE IN SUMMER 2016

With the issue of thermal loss confidently addressed, Nebia will be ready to launch its flagship showerhead in summer 2016. But the founders are just getting their feet wet in terms of addressing the world's urgent water-consumption concerns.

Nebia executives made the decision to begin their water-conservation innovations with showerheads because the typical eight-minute shower consumes 20 gallons (76 liters) of water. By reducing that to just six gallons, Nebia can make a rapid and enormous impact. As an example, if everyone living in California switched to a Nebia showerhead, the net water savings would be 203 billion gallons (768 billion liters) per year.

Looking toward the future, Nebia's management team hopes to build on this success by introducing other groundbreaking sustainable solutions that make a positive impact on the world. Nebia wants to help people rethink the role of water in their daily lives. One particular area of focus will be on delivering sustainable technology solutions to the developing regions of the world, where water conservation and sanitation are most vital. But Nebia also wants to reimagine and improve many of the everyday plumbing technologies we've used for decades — and come to take for granted.

As Nebia develops new products, it will continue to encounter the kinds of tough engineering challenges associated with reinventing current products for a new generation. Engineering simulation will remain a vital part of the team's toolkit for driving time and costs out of the product development cycle, without sacrificing product quality or reliability. Just as ANSYS software helped accelerate the launch of Nebia's flagship showerhead, it will continue to help the company introduce other revolutionary products that deliver personal benefits, while also fulfilling our collective responsibility to protect and conserve natural resources. ▲

NEBIA AND ANSYS — VIDEO
ansys.com/nebia101