



**PepsiCo Pursues
a Virtual Future:
Simulation for
Food and Beverage
Packaging**



Dr. Ellie Vineyard,
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Case Study

Like most consumer packaged goods companies, innovation is important to win market share and bring new products to market. This requires overcoming challenges related to materials selection, waste reduction, manufacturing, recyclability, and product transportation. Using a combination of modeling and simulation, and advanced rapid prototyping, PepsiCo is working on several initiatives to improve the packaging development process for gains in productivity, quality, and sustainability.

Pepsi is likely one of the first beverages one thinks of when it comes to soft drinks. PepsiCo is much more than just its popular namesake beverage. The corporation has a large Food and Beverage Portfolio, in which twenty-three of the brands—including Pepsi-Cola, Quaker Oats, Tropicana, Lay's, and Gatorade—are generating more than \$1 billion each in retail sales every year. All these brands' development work involves a lot of processing and packaging—and that's where simulation plays a large role.

Dr. Ellie Vineyard is an Associate Principal Engineer at PepsiCo, joining the company in 2019. She also made the time to share her expertise as a speaker at the 2021 Americas Regional User Meeting, as well as taking on the role of a SIMULIA Champion. At the time she started with PepsiCo, Dr. Vineyard did not have a great deal of experience in packaging, but she quickly became an expert on beverage packaging, which requires highly precise physics and engineering to create, despite the apparent simplicity of their shapes.

"If you don't take a systematic approach to design bottles, you're going to see failure after transportation," she says. "And when the bottles go to consumers' hands,

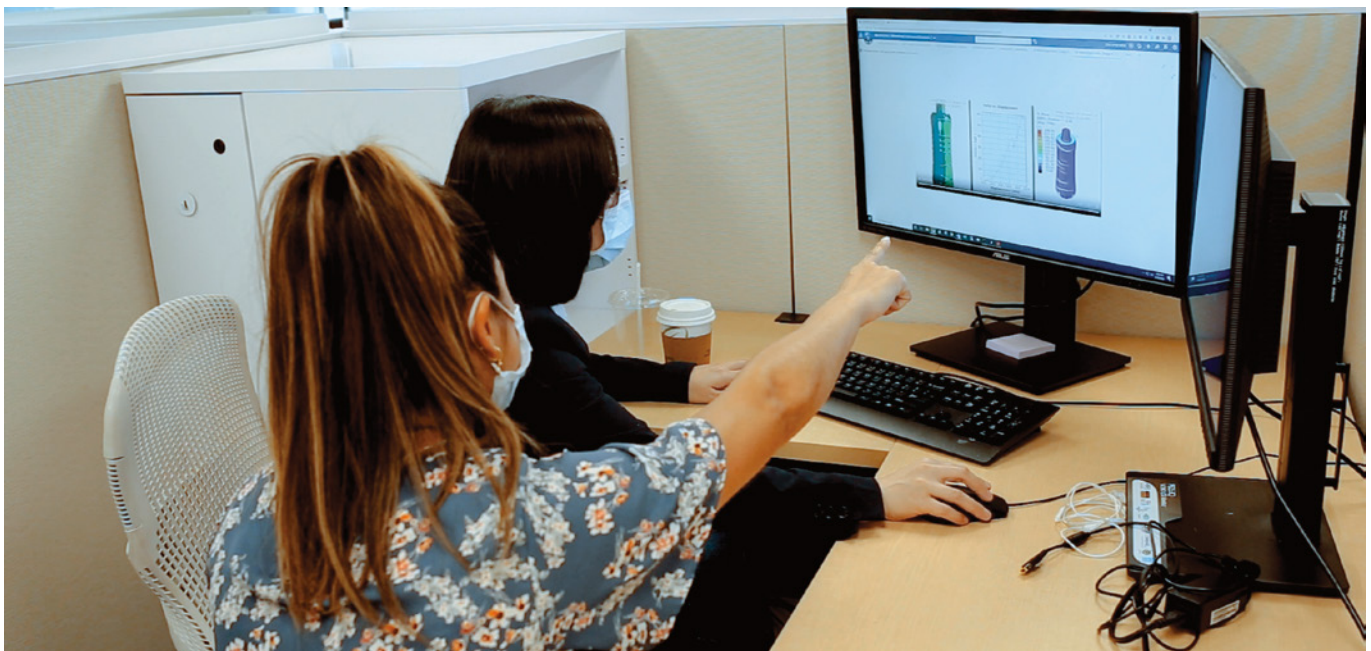
are you going to pick a bottle with denting on it? We all pick the best bottle on the shelf."

THE VIRTUAL FIRST PRINCIPLE

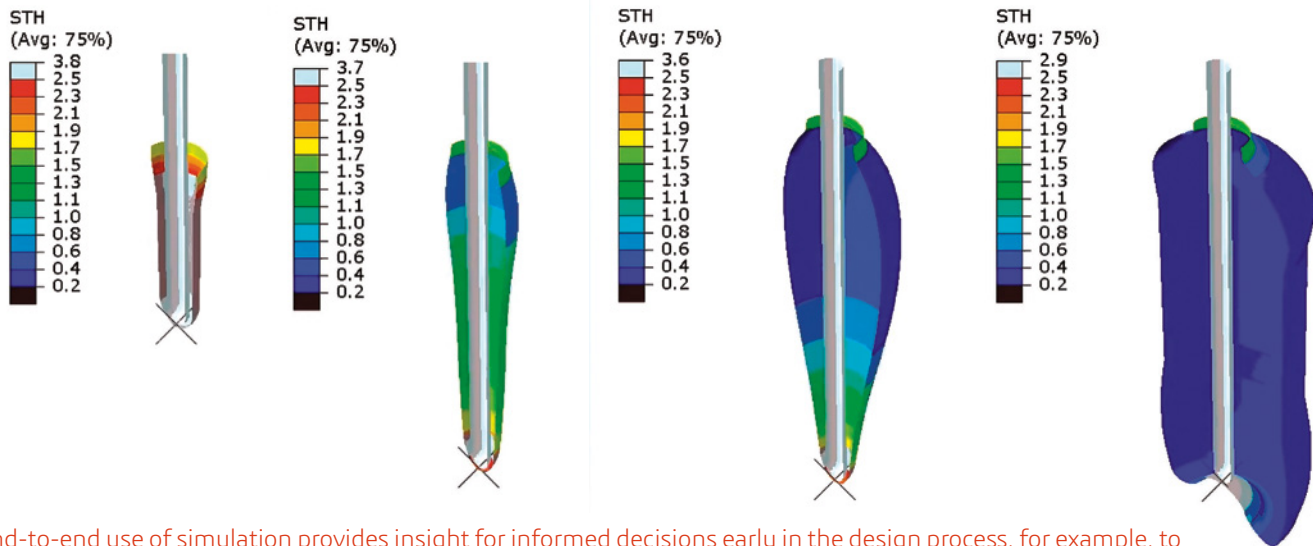
Dr. Vineyard and her team are highly involved with each phase of the packaging development cycle, relying on simulation the entire way. First is the ideation phase, in which the industrial design team comes out with a few design iterations for each new packaging design. Dr. Vineyard's team uses simulation to perform a design iteration analysis and select the best design among all the design iterations.

After the best design has been selected, it will be put into a proof of concept evaluation, in which a highly detailed evaluation is carried out using simulation to determine whether the packaging will meet PepsiCo's requirements. Then comes the transportation simulation, which actually involves line simulation (to evaluate the bottle's performance on the conveyor line) and vending machine performance. Sometimes they will also perform e-commerce simulation, to assess the package's performance when shipped from an online platform.

For example, to make design and manufacturing improvements earlier in the development process, PepsiCo used Abaqus technology from the SIMULIA brand of Dassault Systèmes to simulate stretch blow molding or extrusion blow molding, to decide which process conditions can produce the best wall thickness distribution for the bottles. In the later stages of design, the company combines process simulation and performance evaluation to optimize the bottles for the required performance. The



Dr. Vineyard and her colleague use simulation to perform a design iteration analysis and select the best design among the design iterations.



End-to-end use of simulation provides insight for informed decisions early in the design process, for example, to evaluate which combination of design elements and manufacturing conditions will result in the best bottle.

end-to-end use of simulation has helped PepsiCo greatly reduce trial-and-error—and cost. By bringing simulation and performance evaluation in-house, the company can produce direct and indirect annual savings of over one million dollars, according to Vineyard.

These methods are part of what PepsiCo calls the Virtual First Principle, a philosophy that involves testing products virtually before performing any physical tests.

“When we go to physical trials, we can make sure the packaging is going to pass all the requirements from a performance standpoint or from transporting standpoints,” says Dr. Vineyard. “So we are going to do the Virtual First Principle to reduce the cost and time like we did in the unit trial.”

WOMEN IN ENGINEERING: CHALLENGE AND INSPIRATION

Dr. Vineyard’s interest in engineering started at a young age. She grew up on a farm and her father always spent his time troubleshooting and fixing problems with farming machinery, which influenced her decision to pursue an engineering degree after high school. Choosing a specialization took some time and exploration; her first college major was in Process Equipment, which then led to a strong interest in mechanical engineering as she moved into graduate studies.

“At that time, I had a great passion,” she says. “I want to apply computer simulation in mechanical engineering, like in product development work. So that drove me to go to the USA to further my education in which my doctoral degrees focused on topology optimization in mechanical metamaterials.”

There are fewer women in mechanical engineering, Dr. Vineyard admits, but that did not dissuade her from pursuing her passion for the field. Instead, she pushed herself harder in order to excel over her male peers and to inspire other women and girls.

“Even though it’s rare, I do believe women engineers are a good inspiration to future girls and women,” she says.

“If they have passion, they can always pursue engineering careers...I think all girls should be encouraged to pursue engineering. Do not let the stereotype stop you from doing what you want to do. If you have some passion in engineering, in mathematics, physics, I think any kind of engineering is a good path for you.”

PEPSICO VIRTUAL TEST LAB: AUTOMATED SIMULATION FOR ALL

PepsiCo began collaborating with Dassault Systèmes in 2020 to expand their simulation capabilities and develop a web-based Virtual Test lab. Since then PepsiCo has been gradually transitioning manual offline simulations to fully automated, streamlined, simulation processes. The end goal is to bring roughly 70% of physical tests into the Virtual Test Lab, particularly for beverage packaging.

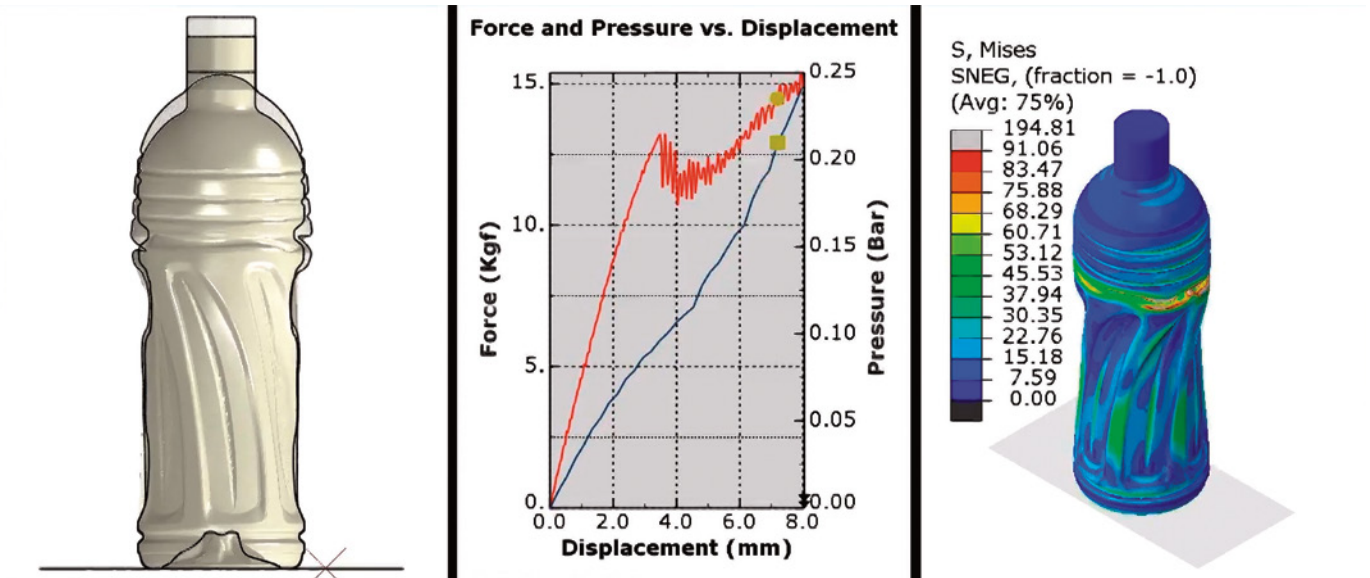
The Virtual Test Lab, according to Dr. Vineyard, plays a big part in the democratization of simulation. Because the lab is fully automated and streamlined, it does not require expert knowledge of a user and can be operated by industrial designers, packaging engineers, and other non-CAE experts. This then frees up experts for innovative tasks, such as developing more simulation applications.

In 2016, Dr. Vineyard says, her team conducted a comparison among different software on the market and chose SIMULIA’s Abaqus technology for its powerful nonlinear explicit functionality.

The company is also going to begin utilizing more rapid prototyping technology. PepsiCo developed and patented a modular blow mold, and has been able to blow thousands of functional bottles using this innovative technology. Currently PepsiCo is in the process of bringing its own blow mold in-house so that it can use the 3D printed modular mold to blow over 10,000 bottles in a 48-hour time period. This will allow them to quickly evaluate all of their packaging designs in, potentially, under a week.

“After we use the Virtual Test Lab to do some feasibility studies, we can then utilize our advanced rapid prototyping capabilities to produce functional blown bottles under one

Case Study



By leveraging a Virtual First Principle to test products virtually before performing any physical tests, PepsiCo ensures that new packaging will pass all requirements.

week," says Dr. Vineyard. "We can then use those bottles to do some consumer testing as well as some line trials without going to the cost-extensive production trials."

PepsiCo is also using simulation to reach its sustainability goals, such as reducing plastic usage.

"We want to use recycled plastic as much as possible," says Dr. Vineyard. "We also try to use alternative materials other than plastics, such as developing paper beverage packaging. We can use simulation to address these alternative material based packaging performances."

MOVING TO THE CLOUD WITH 3DEXPERIENCE

PepsiCo also uses Dassault Systèmes' 3DEXPERIENCE platform to help with collaboration and productivity. Currently, says Dr. Vineyard, the information is not housed in one central location, so they are trying to take a

cloud-based approach so that they can store their project information in a single platform and all stakeholders from different regions can access the information freely.

"I think the Dassault Systèmes 3DEXPERIENCE platform is a great cloud-based environment for collaboration, but also we can put our simulation data in a single platform, and we can track the information after," she says. "If you ask me how I could access the simulation results from three years ago, it's going to take me a long time to dig through my own hardware to find it, but if we can store all the simulation data in a single place, that can reduce the time. It increases traceability."

Dr. Vineyard describes how by using the 3DEXPERIENCE platform apps they can develop and deliver the "turnkey solutions" they are building up in their Virtual Test Lab, with applications like Process Composer serving as a sort of back end for building processes.

"Because Dassault Systèmes products is a Multiphysics simulation platform, it can help us conduct end-to-end solutions for our beverage packaging process," she says.

Dr. Vineyard is excited about the future of PepsiCo. She attributes much of this to simulation. PepsiCo is currently pursuing digital twin solutions as a Virtual First Principle to combine the physical and digital worlds, further improving product development, reducing cost, and improving productivity and efficiency.

Dr. Vineyard is a SIMULIA Champion, which enables her to learn more about the products, new advancements, and further improve PepsiCo's simulation capabilities.



Principal Engineer at PepsiCo, collaborates with a colleague at PepsiCo R&D Headquarters.

For More Information
www.pepsico.com