SIMULIA

amcor
Creating a new world of packaging

AMCOR
Case Study

Image courtesy of Amcor

DASSAULT SYSTEMES

Challenge:
Leading plastic container manufacturer Amcor is continually looking for ways to reduce the amount of material used in beverage containers while keeping them strong and cost-effective to produce.

Solution:
Simulation of containers throughout the design process using SIMULIA tools helps engineers identify strain areas and potential failure points, leading to lightweight, optimized designs.

Benefits:
Amcor customers enjoy lower production costs and less risk of product failure, while Planet Earth and its inhabitants enjoy less waste in landfills and a greener future for all.

It's something that many of us take for granted: you twist the lid off a plastic bottle, consume the iced tea or soft drink within, and never give a second thought to the container except when you drop it in the recycling bin. If the bottle is poorly designed, you might complain about its flimsiness, and how it collapses if squeezed too hard, but as long as the thing doesn't spill all over your lap, who cares?

Hansong Huang does. As the director of advanced engineering at Amcor Rigid Plastics, he and his colleagues spend their days designing plastic containers that are both lightweight and strong, yet meet the additional customer requirements of being aesthetically pleasing and cost-effective to manufacture.

It's not an easy job. With concerns on the rise globally over sustainability and the environment, never mind the need to meet the demands of an increasingly competitive marketplace, Huang faces tremendous pressure to design robust packaging that uses less raw material, and does so in as short a time at the lowest cost possible.

Without Abaqus Unified Finite Element Analysis (FEA) software from SIMULIA, the Dassault Systèmes brand for realistic simulation, meeting those goals would be extremely difficult, if not downright impossible. "We pride ourselves on having some of the highest performance, quality, and speed to market in the industry," he says. "Starting with the product's design all the way through to end of its lifecycle, Abaqus helps us achieve that."

ART AND SCIENCE AT AMCOR

Amcor Limited boasts more than 35,000 employees and 200 manufacturing sites worldwide. The 150-year old company designs and manufactures a wide variety of responsible packaging for the food and beverage industry, healthcare, home, personal products and more. The cup of coffee you drank this morning may very well have come from an Amcor container, as did the yogurt you had for lunch, the TV dinner you will eat tonight, and the blood pressure medication you'll take before bedtime. Amcor is everywhere.

The Amcor Rigid Plastics division is responsible for many of those containers. Headquartered in Ann Arbor, Michigan, its 65 plants and 6600 employees service everyone from Pepsi Cola and Coca Cola to Kraft Foods, Jim Beam to Bausch and Lomb, producing more than 20 billion containers, preforms, and closures annually.

To design these products as quickly and effectively as possible, Huang and the other members of the research and development department in nearby Manchester R&D center use advanced digital engineering techniques that include Abaqus, CATIA and other software tools from Dassault Systèmes. This allows them to move from concept to production within just a few months.

LESS IS MORE

Consider this: shaving off a gram or even a half gram of material from each of the billions of containers that Amcor and its customers produce annually adds up to big savings all around. Because less PET (polyethylene terephthalate) and other thermoplastics are needed, consumption of the fossil fuels used to make them is reduced. This also means less energy used while processing the raw materials, less energy needed to manufacture the finished products, and less burden on recycling and disposal.

Amcor understands all this. Since 2006, the company's lightweighting initiatives have reduced its PET resin consumption by more than 100,000,000 pounds annually. Over the past decade, this has helped to bring down the weight of typical hot-fill beverage bottles by 35-50%. The company has also recently pledged to develop all of its packaging

Simulation of container bulging when dropped.

85°C 23°C

Flexible Powerstrap base offsets vacuum as liquid cools.

recyclable or reusable by 2025 and use significantly more recycled materials. "Our products protect food, baby formula, juices, etc. that consume resources and energy to produce," says Huang. "By engineering high quality containers that reduce spillage and waste, we probably contribute more to sustainability than many realize."

SETTING A HIGH BAR

Prior to investing in advanced design and simulation software from Dassault Systèmes, Amcor's design process was similar to most in the industry. Engineers would develop a few designs for customer approval, prototype molds were then manufactured, prototype containers blown and tested in the lab. One or two designs would then go into pilot production and be tested in customers' filling lines and supply chains. All those costs and time added up quickly. Engineers had to be conservative, and were reluctant to push the lightweighting envelope. Simulation with Abaqus changed all that.

Today, Amcor designers can quickly and easily generate as many virtual design iterations as they like and validate performance before any metal is cut. Using Abaqus throughout the process, each one can be verified for structural integrity, with potential failure points identified and real-world usage evaluated. With confidence in the virtual process, in-house rapid molding and pilot production becomes more for customer trials than for design iteration.

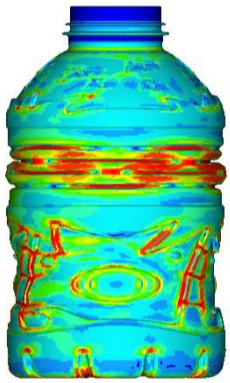
"Our engineering simulation capability is one of the things that make Amcor unique in the industry," says Huang. "We're able to produce some of the lightest containers because we leverage the best engineering tools to accurately forecast potential problems early and optimize our products. Our speed and responsiveness to customer needs sets us apart from our competition."

POWERING THROUGH

Pick up a bottle of Vitaminwater or other leading sports drink and flip it over; see the flower-like pattern on the base? That's called a PowerStrap, and it's Amcor's patented design. It makes the bottle stronger but uses less plastic than competing or legacy designs. So does the ribbed area two-thirds of the way up, and the reinforced section at the top. All of these enhancements were delivered through simulation and finite-element analysis using Abaqus.

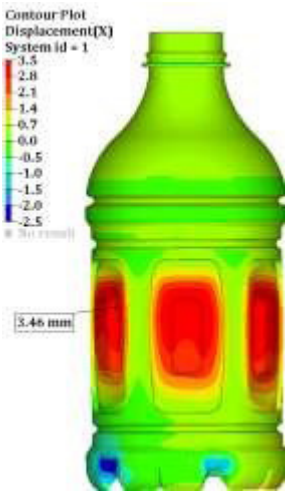
There's much more to the lightweighting story than taking material away. Because sports and energy drinks, bottled tea, and flavored water have lower pH levels than their carbonated counterparts, they are more prone to contamination and must be "hot filled" to kill microorganisms. As liquid cools from about 85°C fill temperature, the vacuum generated could collapse the bottle. Instead of increasing weight, Amcor now engineers containers to be flexible in certain areas, such as in the base or ribs, to offset that vacuum while still maintaining overall rigidity.

"Development of a thin-wall structure that is both flexible and strong is difficult enough on its own, but when you add in the need for continuous weight reduction, it becomes a highly



Using Abaqus FEA from Dassault Systèmes SIMULIA, designers are able accurately simulate real-world product loading under a variety of conditions.

The buckling shown here is one of the many failure modes of lightweight plastic packaging, something that Amcor has helped eliminate using SIMULIA's simulation software.



This Abaqus simulation clearly illustrates side panel displacement when a rigid plastic bottle is subjected to pressure.

technical exercise of optimization," notes Huang. "For instance, we realized a 30% weight savings for a hot-fill sports drink container after more than 60 iterations. We could not have done that without simulation."

REDUCING TIME AND COST FOR COMMERCIAL SUCCESS

The ability to simulate product designs is good for business as well. Engineers regularly use animation and plots to show customers virtual bottles, and help them understand the complexity behind their design and manufacturing. Says Huang, "Having a visual illustration makes it easier to convince customers that removing that last gram of material they want could actually be a bad idea."

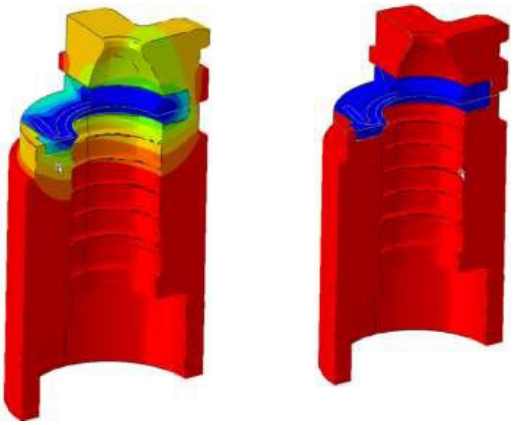
Once the ideal design for a given set of requirements is determined, Abaqus makes it easy to share the design with the customer and ask for approval while still in the concept stage, long before prototyping. The outcome is less risk downstream, greater customer involvement and more confidence up front.

Since the concerns over investment in prototype tooling and testing are vastly reduced with Abaqus, Amcor engineers are now free to brainstorm new ideas and prove them out. Achieving an optimal design is no longer a luxury, but rather necessary and increasingly expected. Industrial designers and engineers can afford to iterate designs daily for the lightest possible bid with confidence. And, for example, if something does go wrong—such as a container bulging out when dropped—simulation can provide a solution in just a couple of weeks to get a project back on track.

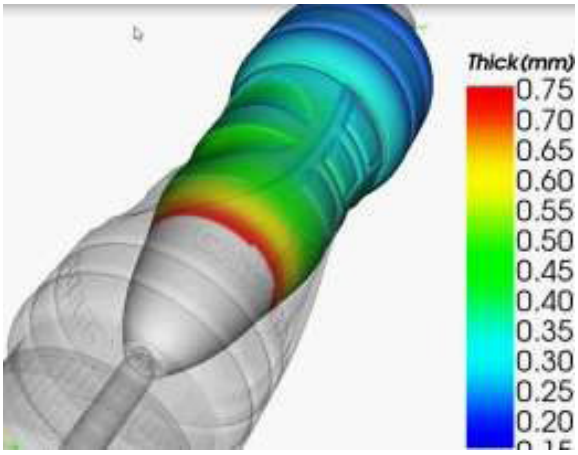
Abaqus has also helped make the Amcor R&D team more effective. Having well-documented performance reports generated in Abaqus means never needing to start a project from scratch. Each new product design leverages what worked before.

PUSHING THE LIMITS AND DRIVING INNOVATION

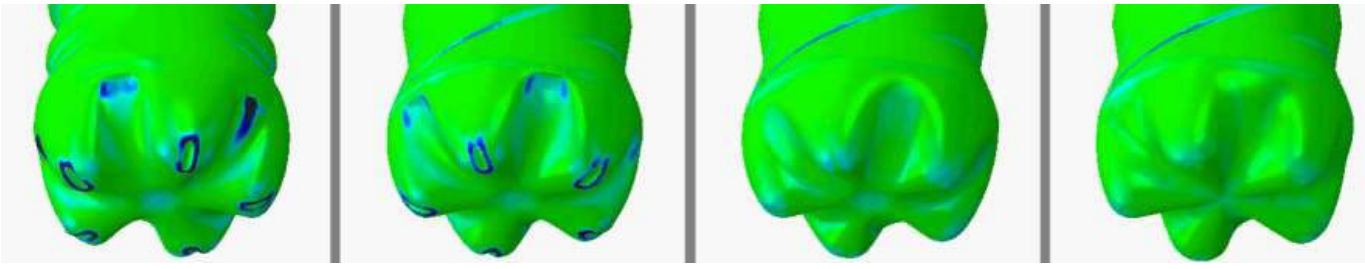
With two young children of his own, Huang is understandably concerned about preserving the environment for future generations. That's one of the reasons he'll continue to push for lighter, stronger products that use less material. In the case of the PowerStrap base design concept driving 20-30% weight saving across hot-fill products, the development leaned heavily on a concept-to-product simulation process using Abaqus as well as SIMULIA's Isight optimization software for virtual DOE. Says Huang, "Simulation was a critical component in this development from literally paper sketches to millions of bottles. As a result, we were able to bring the concept to market in less than three years, compared with typical six to eight years previously. Our new concepts are maturing even faster."



Abaqus can also be used to simulate the manufacturing process. Here, the effects of inadequate mold insulation are easily visualized—on the left is a tool with no insulation, while the right shows one that's been fully insulated.



Ever wondered what the inside of a blow mold or injection mold look like during filling? With Abaqus, you can visualize exactly what's going on.



This creasing simulation illustrates how Abaqus makes it easy to test multiple design iterations without the need for expensive prototypes and tooling.

Recyclability and reusability are front-and-center in Amcor's R&D strategy. "In exploring new polymer materials made from renewable sources, their properties are plugged into simulation to predict performance and cost position in a realistic context," says Huang. "As one of many examples, in overcoming the environmental cracking of re-usable carbonized containers, simulation was leveraged to reduce the stress level and increase the reuse cycle."

"Obviously, we would need a great deal of support from society to meet our pledge," he says. "As we launch products with our goal of 100% recyclable and reusable in mind, there remain plenty of challenges to be tackled with our customers and suppliers in the areas of longevity and reusability. Simulation is a valuable tool for this."

In the meantime, Huang will continue to strive for the perfect container. "We're sometimes fighting for fractions of a gram nowadays," he says. "That said, we're very proud of the amount of plastic we've removed from the environment. It's one of the biggest contributions to responsible packaging we've made over the years. Our goal is to realize an end-to-end virtual product design, development and manufacturing process to bring the highest value to our customers. Abaqus will continue to be a key part of future success stories."

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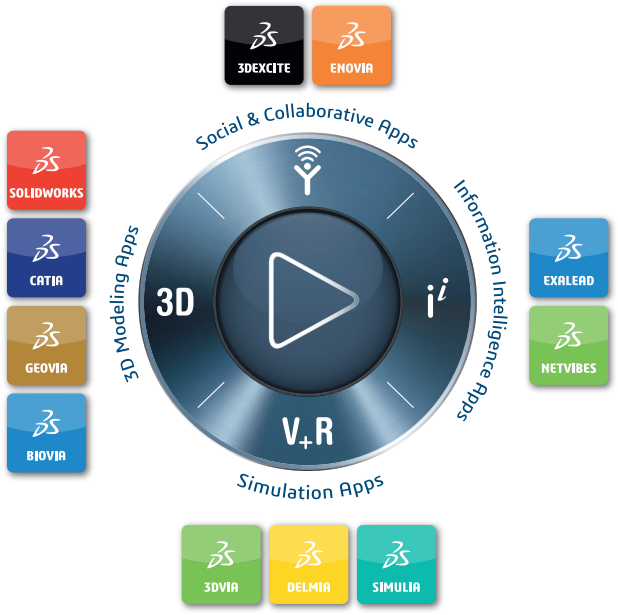

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