Success Story

"Consumers see the package goods created by P&G as relatively inexpensive per-use products. What they don't see is the complex technology required to develop and keep the products inexpensive."

—Tom Lange
Associate Director,
Procter & Gamble

Two Moments of Truth

Procter & Gamble uses CAE and SGI® supercomputers to ensure product and production system innovations fit, work, and make financial sense

The Challenge
- To create products that fit, work, and make financial sense
- Pursue a wider range of creative solutions to meet consumer needs

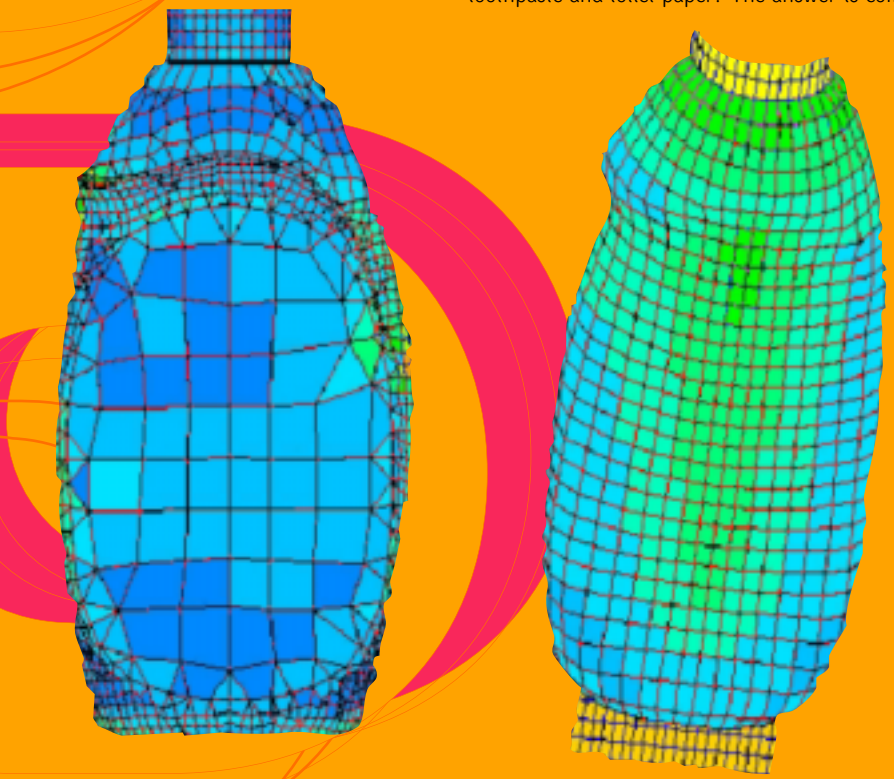
The SGI Solution
- Use of CAE tools and SGI supercomputers to create and test prototypes of products and production machines in a virtual state

The Result
- Millions of dollars in R&D cost savings and months to years in development time savings for products and production systems
- Increased opportunities to innovate product and production system designs

Procter & Gamble (P&G) has been a manufacturing stalwart for 165 years and counting. The package goods giant has annual revenue of $40 billion and spends close to $1.6 billion each year on research and development—the highest in the consumer package goods industry.

P&G products include nearly 300 of the world's most recognized brands, from Ivory® Soap, Pringles®, Charmin®, and Tide® to Downy®, Crest®, Mr. Clean®, Pampers®, and many more. Annually, P&G products find their way into the homes of 5 billion consumers in 160 countries.

So why does P&G need a supercomputer to design and manufacture things as simple and mundane as toothpaste and toilet paper? The answer is complex.



A Technology Company That Thrives on Innovation
Despite its identity as a consumer package goods company, P&G, at its core, is a technology company, one that thrives on innovation. P&G holds over 28,000 patents and is granted a new patent at a rate of more than one a day.

Tom Lange, a 25-year P&G veteran, is responsible for enlisting computer-aided engineering (CAE) technologies that ensure the company's innovations see the light of day. These days, Lange wears multiple hats. Officially, he is the company's associate director for modeling simulation and analysis for corporate engineering. His other titles within P&G include chief technologist for reliability engineering and head of computer-aided engineering.

"Innovation is the lifeblood of our business," says Lange. "When we create new products our mantra is simple—it has to fit, on the body, in the hand, or on the plant floor. It has to work, i.e., do what it's supposed to do. Finally, it has to make financial sense—we have to make it faster, more cost-effectively, and it must add value to the company."

Helping Lange and his design, engineering, and research teams make those innovations happen is a new SGI® Origin® 3800 system with 128 CPUs and 128GB of memory. The SGI supercomputer allows P&G to create and test prototypes of products and the machines that manufacture them in a virtual state—thereby eliminating the need for first-round physical prototypes. The supercomputer also allows P&G teams to study the effects of production-line changes without building the actual equipment. This eliminates costly and time-consuming trial-and-error testing that was once done using physical prototypes.

"We use the SGI supercomputer to help us develop virtual prototypes that now replace the 'initial' physical prototypes of both products and production systems. These virtual prototypes provide a timely and cost-effective means by which P&G can determine the 'fit, work, and financial sense' components used to evaluate a product—before committing to building a physical representation. Virtual prototyping gives us a chance to ask what-if, and then test it in any number of ways to determine next steps, if any, moving forward."

—Tom Lange
Associate Director,
Procter & Gamble

The Origin 3800 system is used by P&G analysts worldwide to assist in modeling and simulation projects. And they continue to use their original Silicon Graphics® Onyx2® system as well.

The Challenge

CAE first appeared as a tool for the defense industry before migrating to aerospace endeavors (military and commercial) and eventually durable consumer goods (automobiles, farm machinery). Says Lange, "The use of CAE is almost ubiquitous in those industries. My job is to bring it to P&G's consumer package goods and the machines used to make them."

The challenge that Lange and P&G face in using CAE to develop consumer package goods is multifaceted. According to Lange, "Consumers see the package goods created by P&G as relatively inexpensive per-use products. What they don't see is the complex technology required to develop and keep the products inexpensive."

There is an inverse relationship that exists in consumer package goods between the consumer per-use cost of a product and the complexity of the technology required to produce it. "A perfect example," Lange points out, "is Charmin bathroom tissue. Charmin has very important product attributes for which consumers are willing to pay, but only within reason. The per-use cost has to be very low for it to be an attractive purchase. However, the machines used to manufacture Charmin cost hundreds of millions of dollars apiece. And in terms of complexity, the number of lines of computer coding required to run each machine and the number of stationary and moving parts required to build and operate the machine make it every bit as complex as some of today's more advanced commercial aircraft."

Considering the number of brands P&G markets, it's easy to see how the cost of introducing innovation to both new and long-standing brands can multiply exponentially. Lange adds, "CAE has been a boon to P&G innovation, but because every product we manufacture is unique unto itself, there is no single recipe for applying CAE to product design and development."

Two Moments of Truth

There are, however, two moments of truth that drive P&G innovation. The first is when the consumer decides to buy a P&G product. If it isn't priced right or has no perceived value for customers, they won't try it. Hence, the costs of materials that go into a product as well as the cost to manufacture the product are paramount in the first moment of truth. CAE has a strong role in evaluating suitable materials for P&G products, to ensure that they work, and in developing manufacturing systems that help keep them affordable. CAE helps to ensure that product containers don't break or crack when dropped, viscous fluids flow easily from their containers, and lids of every type don't leak.

The second moment of truth occurs when consumers open the package and use the product. It has to perform as intended and it has to live up to its promise, whether it's laundry detergent, disposable diapers, or a snack food container. Here, again, CAE plays a role in determining how P&G products function during actual consumer use.

Explore Digitally, Confirm Physically

To develop package goods in a physical-only environment is not only costly, it's also an innovation killer. No company, package goods or otherwise, is interested in introducing something dramatically different to consumers without significant testing. Before CAE, bringing a new product to market was a multiyear exercise in trial and error.

To avoid the cost and time constraints of creating products in the physical world, P&G chooses increasingly to "explore digitally, confirm physically," according to Lange. "We use the SGI supercomputer to help us develop virtual prototypes that now replace the 'initial' physical prototypes of both products and production systems. These virtual prototypes provide a timely and cost-effective means by which P&G can determine the 'fit, work, and financial sense' components used to evaluate a product—before committing to building a physical representation. Virtual prototyping gives us a chance to ask what-if, and then test it in any number of ways to determine next steps, if any, moving forward."

Despite the obvious benefits of virtual prototyping, Lange is quick to add, "P&G will continue to make physical prototypes in the latter stages of product development. They still carry many intrinsic tactical consumer findings that simply cannot be replaced virtually."

Less Risk, More Creativity

Consumers have a faster appetite for change than the manufacturers can satisfy cost-effectively. In the case of P&G, CAE and SGI supercomputers are helping to narrow the gap by enabling the company to pursue a wider range of creative solutions to meet consumer needs without having to invest in costly infrastructures. Lange considers the reduction in costs and the increase in innovative opportunities as the major benefits of using CAE and supercomputing to perform modeling and simulation explorations. "We have documented cases where it has saved P&G millions of dollars and months to years in development time, for both products and the machines that make them."

"We have documented cases where [CAE and SGI supercomputers have] saved P&G millions of dollars and months to years in development time, for both products and the machines that make them."

—Tom Lange
Associate Director,
Procter & Gamble

CAE Tools

Many of the CAE tools used by P&G are readily available commercial applications, including LS-DYNA from Livermore Software Technology Corporation *[www.lstc.com]*, for structural analysis and impact simulation; ABAQUS® from ABAQUS, Inc. *[www.abaqus.com]*, for stress, heat transfer, and other types of analysis in mechanical, structural, and related engineering applications; and FLUENT® from Fluent, Inc. *[www.fluent.com]*, for evaluating the computational fluid dynamics of product designs.

The company is also using applications derived from national laboratory codes. The reason for this is that most consumer package goods are not made out of metal, and, therefore, have a very different set of dynamics than products made of aluminum or steel.

Lange points to products like shampoo, toothpaste, skin lotions, and detergents, which tend to be sticky, goopy, complex, and unusual liquids. "These are all nonlinear materials, and they dominate our environment. We need to know how they perform," he says. "How do they react to heat and cold? Do they flow easily from their containers? How do they affect the surfaces with which they come in contact?"

Consumer package goods also have complex geometries. They are ergonomic by design, and how people interact with them is important to P&G's second moment of truth—does the product perform as intended in the hands of the customer. Modeling and simulation tools are also helping P&G evaluate how the range of human variability affects a product's performance.

Because the consumer package goods industry was not an early adopter of commercial CAE applications, as were defense, heavy industry, and durable goods manufacturers, the available commercial applications tend not to favor this industry. Lange says, "I believe the main reason for this is that the business value of CAE tools to package goods manufacturers is harder to establish, initially. It's easy for software developers to understand that a simple change in automotive design and development costs can save a manufacturer thousands of dollars per vehicle. But when you talk about developing ways to make a 24-cent plastic bottle cap more affordable to manufacturers, you get a very different reaction. They ask you, 'Why do you care?' We care because P&G makes a half-billion of them at a time and a one-cent-per-cap savings is significant."

Moving forward, P&G is looking to work with software developers whose applications will most closely address the physics and geometric complexities inherent in the design and manufacture of consumer package goods.

Investing in Supercomputing

The cost and time savings realized by P&G's investment in CAE tools and use of supercomputers to handle complex modeling and simulation is apparent. CAE has moved from research tool status to production requirement tool. The computational workload handled by the company's SGI supercomputer continues to grow as well. Around-the-clock usage of the supercomputer is standard, with peak utilization sometimes running as high as 80%.

Tide

"In choosing the SGI Origin 3800 system, P&G first established performance benchmarks using a system that belonged to SGI. We then had SGI confirm the benchmarks prior to our decision to purchase. After SGI finished the installation, we again had them confirm the benchmarks on our new system. One of the most important elements of P&G is reliability engineering. It's a discipline we understand very well."

—Tom Lange
Associate Director,
Procter & Gamble

P&G chose to use SGI supercomputers to help advance the company's products and production systems design for a number of reasons. One of the most significant was versatility. The Origin 3800 system, with 128 CPUs and 128GB of memory, allows Lange to choose between solving several large computational problems and numerous smaller problems or a combination of the two—with a single computing system. The versatility of the Origin 3800 system also allows P&G to support the modeling and simulation needs of its numerous brands located throughout the country.

Another key factor in the decision to go with the Origin 3800 system was performance reliability and the relatively simple IT support structure needed to watch over the system. "I want my analysts to be more worried about physics and meeting our business needs than about how to keep a computer working," says Lange. The performance reliability that P&G experienced with the Onyx2 system prior to acquiring the Origin 3800 system factored into the company's decision.

Lange says P&G's selection of the new SGI supercomputer was driven by return on investment. "Development is a zero-sum game. The money spent on improving R&D infrastructure needs to be equal to the savings realized from no longer having to create initial physical prototypes. We try to make infrastructure investment decisions that will sustain our R&D efforts for at least three years, which means we have to anticipate or predict how much we can replace over that time period."

"Because the package goods industry deals with unusual materials and complex geometries that require excessive gridding, we require a tremendous amount of problem-solving memory. Large memory and high speed are essential. The more, the better, especially when it comes to speed. In choosing the SGI Origin 3800 system, P&G first established performance benchmarks using a system that belonged to SGI. We then had SGI confirm the benchmarks prior to our decision to purchase. After SGI finished the installation, we again had them confirm the benchmarks on our new system. One of the most important elements of P&G is reliability engineering. It's a discipline we understand very well."

Collaboration

Within P&G's technical community, collaborations between product designers and the people who build the manufacturing systems are well established. However, one of the interesting things that high-performance computing has provided P&G is the development of a more common language among a smaller subgroup of the technical community—those who normally are responsible for determining the functionality of a product and the equipment and technology that make those products.

"High-performance computing has ended what used to be the distrust of the esoteric," says Lange. "Now when we say, 'We ran your bottle on a virtual test and here's what happened to it, how do you think you can fix that?' designers are suddenly interested. They see more clearly that they can preserve the intent of the package design and still meet the necessary functional requirements of the product. In fact, what I've seen in the packaging community is almost an excitement to help the design community create more exciting designs and, at the same time, preserve the economics of the package."

Summing it Up

P&G has documented proof that a number of product successes have directly resulted from using CAE tools and supercomputers to create them. The use of CAE and supercomputers like the SGI Origin 3800 system have created an entirely new way of doing engineering at P&G. "We now possess complex problem-solving capabilities that were unthinkable 10 years ago," says Lange. "These tools allow us to be more innovative, more creative, and enable us to develop products in less time and at lower costs than ever before. But the real promise they hold for P&G and the package goods industry is the ability to create better products for consumers."

Corporate Office
1600 Amphitheatre Pkwy.
Mountain View, CA 94043
(650) 960-1980
www.sgi.com

North America 1(800) 800-7441
Latin America 1(650) 933-4637
Europe (44) 118.925.75.00
Japan (81) 3.5488.1811
Asia Pacific (65) 771.0290

3413 (06/04/2003)

J14158