The **Democratization** of Engineering Analysis

To compete successfully in today's business climate, Procter & Gamble makes analysis tools available to rank-and-file engineers as well as to analysts and advanced simulation experts.

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Early practitioners of techniques such as finite element analysis (FEA) and computational fluid dynamics (CFD) typically were confined to industries in which the risks to human life or mission success were such that the expense could be justified. It is, therefore, no surprise that the first commercial FEA packages came from and were used by industries that could afford access to expensive computational resources — and for which a failed component could have catastrophic results.

As these techniques spread to other industries, computer-aided engineering (CAE) remained the bailiwick of the expert analyst, requiring advanced degrees and long apprenticeships to cope with the difficulties of the technique and to ensure accurate results.

The rapid and unrelenting improvements in hardware, the personal computer and low-cost cluster computing — and technology such as the ANSYS Workbench platform — has truly democratized CAE analysis. A common desktop PC has more than 10 times more computing horsepower than a high-end workstation from just 10 years ago costing 10 times that price. No longer is engineering analysis a luxury that costs many thousands of dollars requiring the services of highly trained experts.
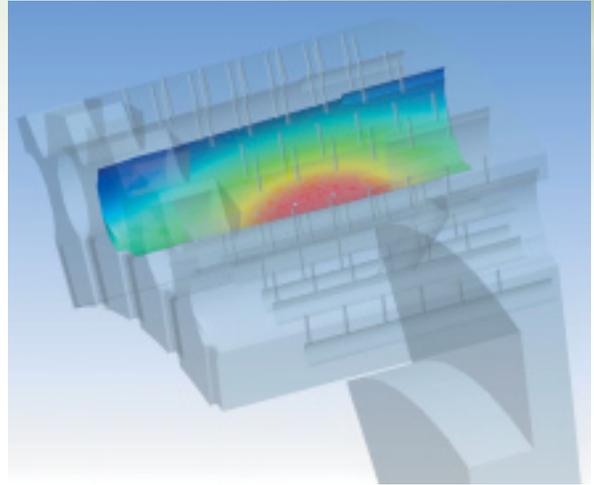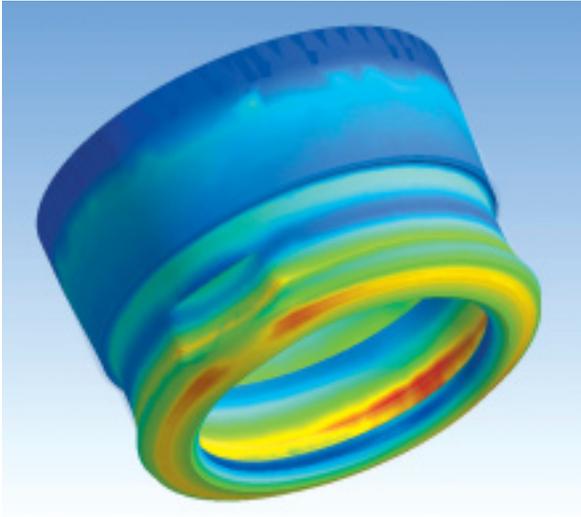
Simulation on the ANSYS Workbench platform was used to determine stresses (left) and thermal distribution (right) in these components of high-speed equipment used in Procter & Gamble Company production operations.

The Procter & Gamble Company (P&G) is best known for its brands. Three billion times a day, P&G brands touch the lives of people around the world. The company has one of the strongest portfolios of trusted, quality leadership brands, including Pampers, Tide, Ariel, Always, Whisper, Pantene, Mach, Bounty, Dawn, Pringles, Folgers, Charmin, Downy, Lenor, Iams, Crest, Oral-B, Actonel, Duracell, Olay, Head & Shoulders, Wella, Gillette and Braun. Chances are that you have used one of these brands recently, if not today.

P&G also is well known for advertising these brands. According to *Advertising Age* magazine, P&G was the largest advertiser in the United States in 2005, spending more than $4.6 billion. Advertising, packaging, display and name recognition are aimed at what P&G refers to as the first "moment of truth," when a customer decides to purchase a product they have never used before. But, as any manufacturer knows, you won't have a customer for long if your product doesn't deliver as promised. If you fail the consumer the first time, you will not be rewarded with repeat business. P&G calls this the second moment of truth, when a customer uses the product and judges whether you have delivered on your advertised promise. This is where the science behind the brands comes into play.

All manufacturers face similar tensions — rapid innovation, keeping down costs and improved time to market. P&G is a leading proponent of CAE technologies in its drive for improved innovation. In fact, in a 2003 conference call with Wall Street analysts, P&G Chief Executive Officer A.G. Lafley stated, "We are significantly expanding capabilities in computational modeling and computer-aided engineering, so we can do an increasing percentage of product and process design through virtual simulation."

In the consumer packaged goods business, this would not have been realistic or feasible just 10 years ago. High-end CAE analysis was then the domain of experts, most likely employed in the defense, aerospace or automotive business. The expert also was armed with complicated, high-end analysis software and an expensive UNIX® workstation. Today, the ubiquity of inexpensive, fast and powerful desktop PC workstations has made the use of CAE analysis available to the rank-and-file engineer in ways unimaginable in the past.

When P&G creates new products, there are three goals — it has to fit, do what it is supposed to do and, most important, make financial sense. The company wants to make the first prototypes virtually and make the physical item only when confident it will work. In the consumer packaged goods business, companies make billions of items and sell them for a relatively small amount. Analysis allows P&G to optimize those products and processes to save a penny or two here and there. The focus is in making lots of high-quality products very quickly.

Just as the needs of individual projects vary, so do schemes for utilizing CAE. P&G has developed a three-tier approach for CAE. Tier 1 consists of a small cadre of experts. They face new-to-the-world kinds of problems that require a great deal of preparation and development. Here a highly trained, advanced-degree individual will stretch the bounds of a high-end commercial code or require specialized codes from national laboratories to solve the problem.

The second-tier analysts use very high-end analysis tools, but the problems are such that the tools can be automated to some extent. A common example at P&G is the analysis of bottles. P&G sells billions of packages each year. Design optimization is critical to maintaining competitiveness and profitability. The sheer numbers of projects annually require a different level of expertise to achieve effective results. P&G has chosen to automate a number of these analyses in a product called the Virtual Packaging System (VPS). VPS is a collection of common analysis tasks that

have been developed over the years and automated to a large degree by internally written code. This allows a journeyman analyst to feed various geometries to the system and view the results in short order. The time to complete an analysis is reduced substantially. "This system frees analysts to focus on the physical parameters of the design problem rather than on setting up analytical solutions," said David Henning, manager of packaging analysis at P&G. Typically, there are three times as many analysts in this category as there are experts.

A third tier is that of the rank-and-file engineer engaged in project work. Occasionally, this individual is faced with the need for an analysis to determine the suitability of a structure for a particular load or other such question. In the past, a call would go to the expert practitioner who may (or may not) have the time or resources to assist. For these types of analyses, P&G uses the ANSYS DesignSpace product as the software of choice. ANSYS DesignSpace was selected after a careful investigation of solutions available in the marketplace.

In making the decision on which software to use, the comparison requirements were ease of use, accuracy, full associativity with a number of 3-D computer-aided design (CAD) systems, and widespread training and support. In the end, ANSYS DesignSpace software was selected.

The solution allows for escalation of the problem to ANSYS Mechanical or ANSYS Multiphysics software if a particular analysis requires nonlinear materials, large deformation or advanced contact. The ANSYS Workbench platform also contains tools for convergence studies that serve to ensure an accurate solution.

The ANSYS Workbench environment is available to thousands of engineers and scientists within the P&G organization. Training is available to those who wish to utilize the tools. P&G also finds that more and more new hires are already trained in CAE tools. These software products allow the engineer to rapidly screen numerous designs before having to commit to a physical prototype. The overarching goal is to make sure the first physical prototype has the best chance for success that the engineer can provide.

This translates to fewer, more meaningful tests, decreased innovation cycle times, and, most important, reduced time to market. This is where analysis makes money: in improving the decisions that are made every day and getting a better product to the market faster. ■
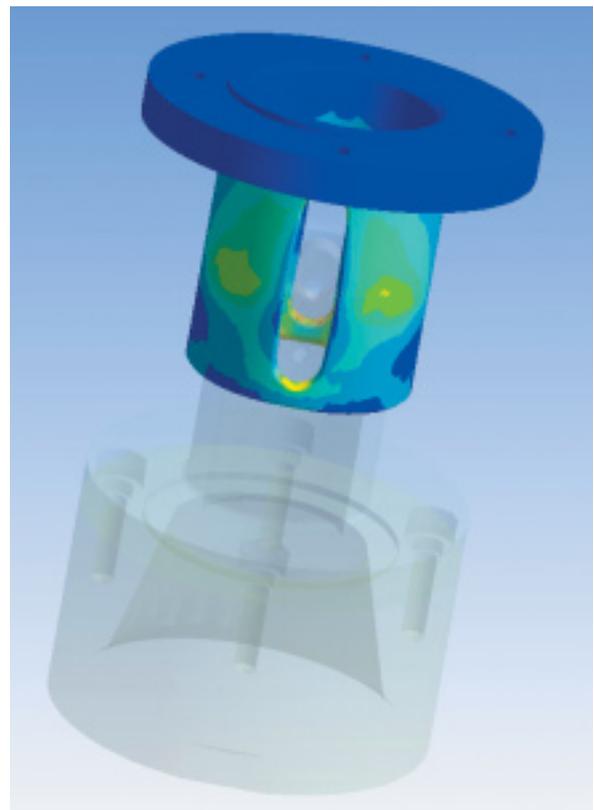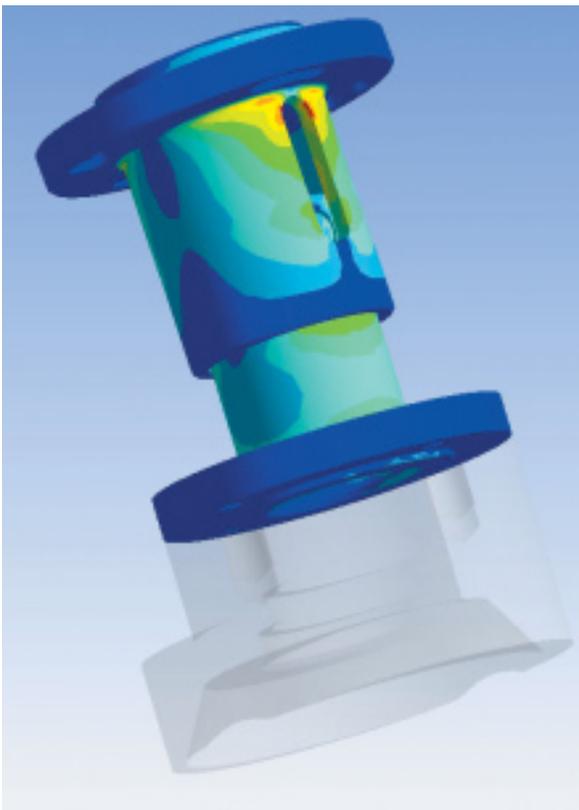
Proctor & Gamble rank-and-file engineers routinely use ANSYS DesignSpace software in product development projects. Sample plots here show loads on the slotted concentric shafts of a converting machine assembly, enabling engineers to quickly evaluate the design early in development.