

Case Study.

PING Scores a
Hole in One with
High Performance
Computing



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PING Scores a Hole in One with High Performance Computing

PING®, a manufacturer of high-end golf equipment, is in a fiercely competitive marketplace where the phrase “innovate or die” is a literal truth. In 2005, the company replaced the workstation that had been used to simulate the design of new clubs with a powerful supercomputer running advanced simulation software. The machine paid for itself in a year as the company significantly reduced its need for physical prototyping of newly designed clubs and ramped up its pace of innovation, allowing PING to maintain its leadership in the worldwide premium golf equipment industry.

“Ping!” That is the lovely sound Karsten Solheim’s newly designed putter made as it sent the little white ball unerringly on its way to the cup. The year was 1959 and a new company destined to be one of the leaders in golf equipment was born. The company’s name? Why, PING®, of course.

Solheim, a mechanical engineer who worked in the aerospace and computer industries, was also a golfer with a putting problem. Applying his engineering knowledge, he designed a radically different putter in his garage with numerous innovations that became industry standards.

Part of Solheim’s legacy was the adoption of strict engineering principles and tight manufacturing tolerances that raised the performance and quality bar for the entire golf equipment industry. In fact, at one point in the company’s history, it used its highly developed engineering capabilities to make precision parts for military applications in addition to golf equipment. Today the family-owned Phoenix-based company is totally focused on golf. It has 1,200 employees and sells its products in more than 70 countries. It is also an avid user of high performance computing (HPC).

Innovate or Die

The golf equipment business is more fiercely competitive than anything that happens on the fairways. PING is up

against such giants as Titleist, TaylorMade, Callaway and Nike. As Eric Morales, senior engineer at PING, points out: “Most companies realize about five to 20 percent of their revenues from new products. At PING more than 85 percent of the company’s revenues are generated by new products that have been developed in the last two years. The implication is clear—innovate or die.”

However, one cannot simply increase the capacity of the innovation value stream alone; one must also increase the capacity of the product development value stream. Without the supporting infrastructure, the surge in innovative products will never make it to market in a timely and profitable fashion. HPC has helped PING to excel in both arenas. Before PING’s foray into HPC, designing a new golf club was a cumbersome trial-and-error process. First, an idea would be made into a physical prototype—a process that could take four to five weeks and cost tens of thousands of dollars. Testing the prototype might consume another two to three weeks. If it failed to pass muster, the process was repeated with a new design to the tune of an additional \$20,000 to \$30,000 and six more weeks. When the company began using a high-powered desktop workstation, costs dropped and product development times—a critical factor in this industry—were shortened somewhat, but the results were still far from ideal.

Moving Off the Desktop and On to HPC

The company has always been committed to producing high-end equipment of the utmost quality, durability and performance for the discerning golfer. Given these parameters and the company's emphasis on advanced engineering, innovation and fast time-to-market, PING's transition off the desktop and on to HPC was a seemingly natural evolution. Indeed, as Morales describes it, the decision was almost a no-brainer for PING top management.

"In 2005, we were using desktop workstations to simulate prototypes for the upcoming G5 product line," Morales recalls. "John Solheim, our CEO and chairman of the board, looked over my shoulder at an early prototype and liked what he saw. He asked me to run some variations—in all, seven different scenarios. Well, on the workstation, one simulation took ten hours, so to meet John's request would take 70 hours. So I said to him, 'Come back next Thursday and I'll have some information for you.' And he replied, 'Why so long? Do you need a new computer?' And when I answered yes, John said, 'Tell me what you want and we'll buy it.'"

Morales' investigations led him to a state-of-the-art supercomputer packaged with highly advanced physics simulation software that had been developed at the Lawrence Livermore National Laboratory. He sent the computer vendor the same simulation that took ten hours on the PING workstation. The vendor called him back in 20 minutes—the job was done. Elated, Morales and his team prepared a detailed presentation justifying the purchase of the supercomputer to their CEO. But as soon as Solheim learned how much faster the scenario would run on the new system, he cut short the presentation and said, "OK, go get it."

It quickly became apparent that there was a pre-HPC PING and a post-HPC PING. The supercomputer allowed the PING designers and engineers to run much more detailed and accurate simulations in a fraction of the time required using a workstation. Using finite element analysis techniques, the engineers can simulate a variety of design approaches, quickly discarding flawed designs before moving on to the creation of a physical prototype.

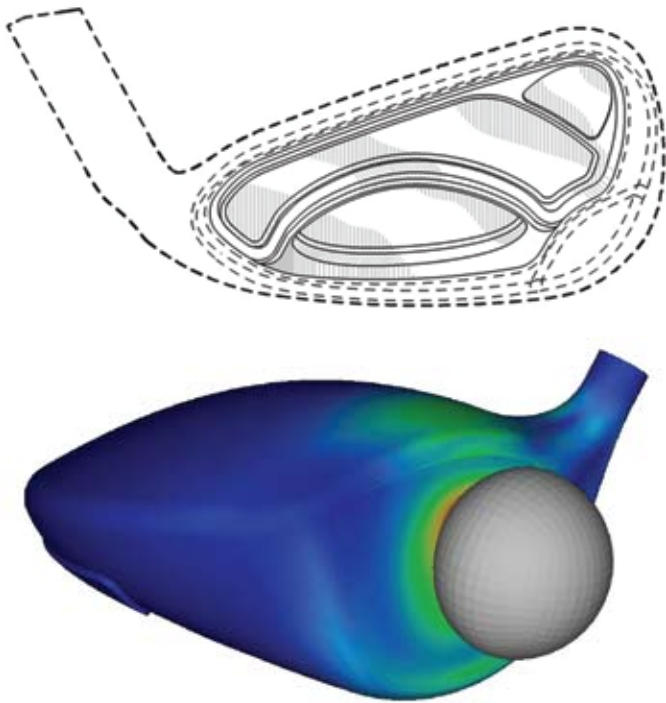
From Concept to Completion

New club designs may be developed on a computer screen, but the initial inspiration may be a sketch on paper or the back of an envelope. Using the supercomputer, the engineers translate these initial ideas into a three-dimensional matrix that simulates how the proposed design will perform in real life. The system can simulate what happens to the club and the golf ball when the two collide, how the components shift during the stroke, and what happens if different materials are used in the club head and shaft. "We can even make materials that don't currently exist—to the machine, it's just a number," says Morales.

"The supercomputer allows us to divide the golf club into high resolution elements and then arrange those elements into detailed segments that can be tested individually under a variety of simulated conditions," he continues. "As we make modifications and improvements, we can simulate moving tiny amounts of metal down to a thousandths of an inch. The idea is to maintain the desired weight, but change the club's center of gravity, spin rates and launch angles without compromising the equipment's structural integrity. Visualization is very important. I load the designer's information into the supercomputer, and then the two of us can see where the potential problems are. The designer makes a few changes, we run a new simulation, and in a week or two we're ready to order the physical prototype."

The HPC system provides a 3-D animated simulation of the design that allows the engineers to see what is happening inside the club as well on the outside. By examining cross-sections of the club during the various phases of its collision with the golf ball, the PING engineers can spot potential problems and correct them in virtual space, rather than producing multiple expensive physical prototypes.

PING does not forget its roots—sound plays an important part in club design. Not just the ping of the putter, but the satisfying "thwock" of a driver making solid contact. The engineers use the supercomputers to design the right frequencies and vibrations into the club so it sounds good even if the customer does not hit the ball quite right. Expect no bad vibrations when you are using PING clubs.



Top: This image illustrates the interior structure of a club head.
Bottom: A simulation of the effects on both a ball and club as a user takes their swing.

Unanticipated Insights

The HPC system's high-resolution visualization capabilities have provided some unexpected insights. For example, in the pre-HPC days the engineers thought the efficiency of the driver's striking face was solely responsible for powering those long drives. But the supercomputer simulation revealed that it is not just the striking surface, but the entire structure working together—what the designers refer to as total structure interaction. With the heightened resolution afforded by the supercomputer, the engineers are able to fine-tune how all parts of the club interact to achieve maximum performance.

Well, in some cases, not quite maximum performance.

Golf, like other sports, has its governing bodies—e.g. the United States Golf Association (USGA) and the venerable Royal and Ancient Golf Club of St. Andrews (R&A). These institutions issue specifications regarding club materials, dimensions—even overall performance—and most golfers, whether pro or amateur, want USGA or R&A approved equipment. When PING designed its current line, the G10, the simulation was accomplished in less than two weeks and the physical prototype passed all tests with flying colors. But the PING engi-

neers were overly successful—the USGA turned thumbs down saying that the club performed too well. “We had to go back and use our supercomputer to design in a lower performance while maintaining the club's high quality and durability so we could sell it to the public,” recalls Morales.

“HPC has also had a profound impact on the company's foundry operations,” Morales continues. “We can simulate the actual casting and fine tune the process. For example, we were having problems with a particular product—the scrap rate was excessive. We simulated the metal pouring into the mold and discovered that one area was cooling faster than the area next to it causing the metal to freeze, leaving gas pockets which created shrinkage porosities within the casting. So we changed the way the metal flowed in and the thickness of the adjacent parts. We eliminated the problem and reduced our scrap rate by 80 percent.”

HPC Competitive Impact: Faster Simulations, Fewer Prototypes, Quicker to Market

Supercomputers are big ticket items. But when Morales analyzed the cost/benefits of adding HPC to the company's infrastructure, the payoffs were immediately apparent. Simulations that formerly took ten hours can now be accomplished in 15 to 20 minutes. Series of tests that previously took months are completed in under a week. PING has accelerated its time to market with new products by an order of magnitude—an important consideration for a company that derives 85 percent of its income from new offerings. And, because they no longer have to go through the expensive and time consuming cycle of building multiple physical prototypes, the engineers can incorporate top quality design into the new clubs from the very first stages of the production cycle.

Says Morales, “This is our new mantra—‘test, then design’—not the other way around. This approach has allowed us to cut our design cycles from 18 to 24 months to eight or nine months. And in that same shortened cycle, we are able to produce five times more products and make them available to the public. All this with the same staff, same factory, same equipment. In fact, the supercomputer paid for itself in its first year of operation

“Our production processes are more streamlined, research and development of new designs has accelerated, and we are tackling problems and gaining insights that were not possible before.”

Eric Morales, Senior Engineer, PING

just by eliminating the need to build multiple physical prototypes and trial-and-error test them.”

He notes that the HPC system has taken a lot of pressure off the company’s researchers, providing them with more time to explore creative approaches to problem solving and devising innovative design concepts. “We

can even revisit old concepts. For example, we found a sketch in our archives of a club design made by our founder, Karsten Solheim, in 1982. It was a good idea, but the materials and processes were not available then to make the product work. But today we can not only create this new product, we can make it better.”

Today the company is in good shape in the rough and tumble golf marketplace. “We have the number one iron in dollars sales, and the number two driver in units and dollar sales,” Morales concludes. “We have two different lines of putters that rank second and third, and our golf bags are also doing very well. There’s no question about it—high performance computing is a strategic asset that has made us one of the top contenders in this very competitive game.”

In Brief

Key Challenges

- Accelerate time-to-market for innovative, high-quality new products
- Shorten the design cycle and eliminate much of the time and expense associated with the trial-and-error process of building and testing physical prototypes

Solutions

- Move from a desktop workstation to a powerful supercomputer running advanced physics simulation software
- Explore and validate designs on the supercomputer before proceeding to the actual design and testing of a physical prototype

Key HPC Benefits

- Runs more accurate and detailed simulations in a fraction of the time required on the workstation
- Evaluates designs using high resolution 3-D simulation to discard flawed designs before moving on to physical prototyping
- Visualizes both the exterior and interior of the club as it collides with the golf ball
- Analyzes vibrations and frequencies to design a club that sounds good when the customer hits the ball
- Provides unexpected insights into equipment design that were not possible before the purchase of the supercomputer
- Fosters innovation and productivity
- Allows the company to compete effectively in its global marketplace

Web Site

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