

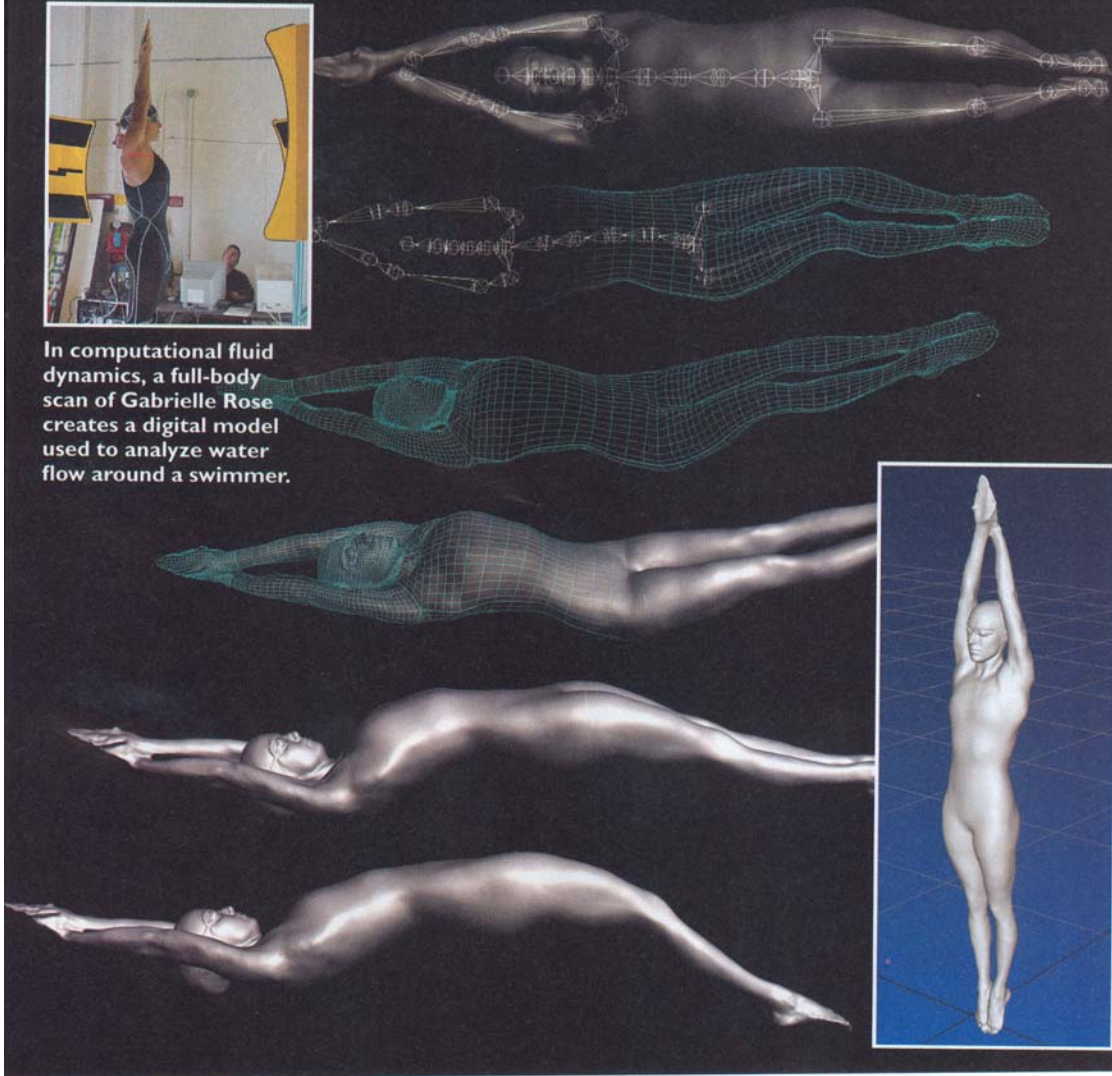
SPECIAL ADVERTISING SECTION

Stroke Science

Talent + tech = gold for the U.S. swim team, which is wiring its way to success in Athens and beyond



In computational fluid dynamics, a full-body scan of Gabrielle Rose creates a digital model used to analyze water flow around a swimmer.



BY Jordan Hyman

It all started four years ago in Barry Bixler's imagination. The aerospace engineer wondered about ways to bring his world underwater, and he asked USA Swimming to support his study of a swimmer's arm motions. "I was curious how the propulsive drag would change depending on how you held your arm, your angle of attack, how you accelerated or didn't accelerate it," says Bixler, a self-described swim dad who analyzes airflow through jet engines for Honeywell. "It was a typical nerdy idea from me."

But there's nothing typical about an aerospace engineer helping people swim faster, and Bixler's ideas represent swimming's technological frontier. In a sport where technique is king, his efforts with computational fluid dynamics (CFD)—an engineering tool used to design cars, boats, planes and more—have spawned the deepest study yet of the swimming motion.

Remarkable technologies help Olympians in many sports enhance performance, but even before CFD, swimmers were at the forefront with their custom-designed altitude tents, lactic acid tests, respiratory strength-training devices, flumes that act as personalized aquatic treadmills, underwater imagery and stroke-analyzing software. When you put all that science with

years solely on video taken both above and under the water. CFD expands the possibilities. In 2000, Bixler's research with arm models—funded by USA Swimming and a grant from the International Olympic Committee—found that when you accelerate your arm as it passes through the water, you decrease drag. So swimmers who tire midrace and slow their arm speed midstroke are hurting their times, while efficient competitors who pull their arms through the water at a consistent acceleration throughout a race will have better results.

Intrigued by Bixler's discoveries, swimwear giant Speedo brought him in to improve the Fastskin suit worn by 80% of medal winners at the 2000 Games. First, U.S. swimmers Ed Moses and Gabrielle Rose went to Hollywood to have their entire bodies scanned by CyberFX, a special effects company that has worked on *The Matrix* and *Spider-Man*. Bixler used the scans to create CFD computerized models and mannequins that had a typical swimmer's body structure. At New Zealand's University of Otago water flume, Bixler's team conducted 8,000 tests with 2,000 combinations of fabrics and seam orientations. Moses and Rose replaced the mannequins for final testing.

"From CFD analysis we can tell water velocity, direction of the water as it flows along the swimmer's surface and where water leaves the surface," says Bixler, who co-wrote the soon-to-be-released *Swimming (Handbook of Sports Medicine and Science)*. "We took a lesson from the sharks. As water moves over a shark, it speeds up and slows down as it does over a human. Their skin is different in different locations. So we went, 'Duh, we don't have to use the same fabric for the whole suit.'"

The result is Fastskin II, with different fabrics on different parts of the body to optimize flow. Elite U.S. swimmers like Michael Phelps and Amanda Beard will wear it in Athens, as will international stars including Australia's Michael Klim and Inge de Bruijn of the Netherlands. FSII is gender- and stroke-specific—backstrokers' zippers are on their chests—and Bixler says the suit reduces drag 3% to 4% versus the original Fastskin. That could mean the difference between gold and fourth. Bixler has also used CFD to improve bulging goggles and show eight-time gold medalist Jenny Thompson how much drag she causes by not tucking her goggle straps under her cap.

USA Swimming has even bigger plans for CFD. Scientists at George Washington University are analyzing body scans of Rose



Phelps dived into his Olympic quest in a Speedo Fastskin II at last week's trials.

USA Swimming's stable of highly fit, motivated athletes, the advantage is undeniable. After a 33-medal haul in Sydney, America's strongest Olympic team is fusing tech and talent as it goes for even more in Athens and beyond.

GO WITH THE FLOW

They might look easy on TV, but freestyle, breaststroke and butterfly are complex rhythms of moving parts. To find the beat, the world's best swimmers and their coaches have relied for

and three-time backstroke gold medalist Lenny Krayzelburg to build on what Bixler's research revealed about stroke technique and efficiency. "CFD will take our understanding of swimming rapidly to a higher level," says John Walker, USA Swimming's assistant director of national team technical support. "The body moving through water interacting with flow patterns is hard to quantify. But this technology will allow us to see things we had hints about but couldn't measure."

That's where Rutgers professor Tim Wei comes in. Last October Wei flew to Colorado Springs to work in USA Swimming's flume. Wei always thought it would be cool to chart water flow around whales, but he settled for swimmers. He had 1996 100-meter backstroke gold medalist Beth Botsford swim in the flume and filmed the workout to see how the flume's tiny, champagne-like air bubbles moved around the swimmer. The technique mimics digital particle image velocimetry (DPIV), a lab test in which lasers illuminate silver-coated glass spheres placed in water to track flow.

Call it the science of the stroke. Wei's group experiments, the GW group calculates, all to make the world's fastest swim team even faster. The researchers are excited about what they're seeing, and they think swimmers and coaches could apply the results in time for the 2008 Games in Beijing. "We're going to break it down and try to understand the fluid dynamics mechanisms going on under the water," says Russell Mark, USA Swimming's biomechanics coordinator. "What makes a swimmer swim faster?"

TALE OF THE TAPE

Video training software from Swiss company Dartfish is providing still more helpful insight. USA Track & Field, Gymnastics and several other national governing bodies plus athletes in more than 20 countries worldwide use the technology, and USA Swimming's version—called Dartswim—lets not only national teamers but all of USA Swimming's 300,000 members record, organize and analyze digital video on their computers.

In Salt Lake City, Dartfish's SimulCam let NBC show two skiers on the downhill course at the same time. Golfers use it to dissect their swings. And Dartfish's StroMotion showed players sequentially gliding through the air in the NBA slam dunk contest on TNT. But only since June could club swimmers in middle America log on to dartswim.com to download clips of Olympic medalists. Software ranges from \$29.95 into the thousands, so swimmers of all levels can compare their strokes to other swimmers', break down a race into second-by-second frames or do side-by-side analysis of their own sessions. Four hundred USA Swimming-affiliated clubs have purchased a version of Dartswim. "The coach can tell you to do it a hundred times and it feels like you're doing it, but you're really not," says Jason Lezak, who won the 100-meter free at last week's Olympic trials. "When you actually see it and compare what it used to look like to what it looks like now, it helps you improve."

Lezak is one of 23 national teamers—including 2000 butterfly gold medalist Tom Malchow and 100- and 200-meter



Dartswim digital video lets athletes break down their every motion and compare their strokes to an Olympian's on the 'Net.

breaststroke world record-holder Brendan Hansen—signed with Dartswim so others could view their clips, but they help themselves too. National team coaches can tape in the Colorado Springs flume, where they adjust water velocity, water and air temperature and chamber humidity. And if they can't attend international meets or national team training camps, they download fresh clips of their swimmers, then call in with advice.

An area of concern for Walker, though, is the high number of foreign downloads at dartswim.com. "This site is open to anyone," he says. "We had to consider loss of competitive advantage, but at some level, especially since we're supporting and promoting it internally and developing it to fit our club structure, we felt the benefit to our pipeline was just too great."

DIFFERENT STROKES

Along that pipeline, USA Swimming's support staff advises athletes on everything from nutrition to mental preparation. USA Swimming physiology coordinator Deb Whitney helps swimmers improve conditioning by monitoring lactic acid thresholds. At U.S. trials she pricked earlobes for blood samples after races to make sure athletes were clearing lactic acid from their bodies, thereby ensuring proper warmdown.

Swimmers also go out on their own to seek advantages. British breaststroker James Gibson uses the PowerLung, a dual-action respiratory training system that looks like an asthma inhaler and works muscles for breathing. Companies like Endless Pools produce flumes for the home—aquatic treadmills with currents that adjust to specific training needs.

Moses, a 2000 silver medalist, spends nights sleeping at altitude. He had a company called Colorado Altitude Training seal off his bedroom and install generators that reproduce air. He can play video games on his Xbox at 10,000 feet against buddies near sea level in the next room. "It helps you build blood cells so you can carry more oxygen," Moses says. "It really helps me with recovery and pushing my training sessions to the edge."

The boundaries for technology keep expanding. In Athens the U.S. will bank on again dominating the sport, but when the Games are over, the games will continue in labs and flumes. In the marriage of swimming and science, the race never ends. ■