The Complete Athlete

The Human Component of the Technical Race

Theodore Costantino

When Mitch Feingold looks at a cyclist, he sees an explosion of forces. The rider moves, his foot comes down, and—where does the energy go? Into the pedal, certainly . . . or does it? Is all that force getting to the pedal as efficiently as it could? Is it being lost somewhere? It is coming in straight, or cocked in from the side, or whooshing in overhead and down into the foot and out to the pedal and down the crank and . . . then what? There's so much to look at, and so much you can't see!

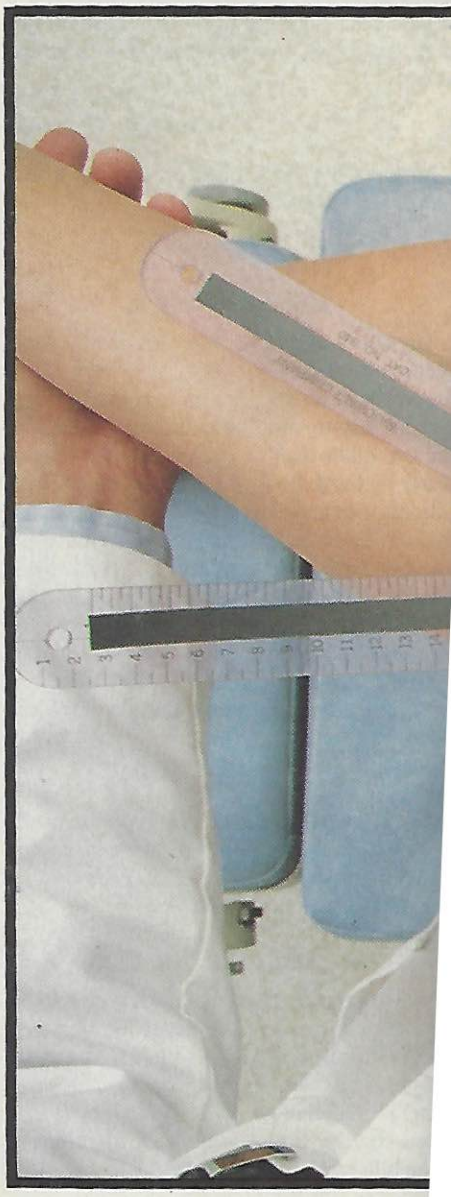
"There are so many variables," Feingold says in wonder. "If you just take the shoe, do you use a stiffer sole, a more flexible sole, do you put the cleat forward, back, angle it in, out; what about the seat height? I mean, all these variables come into play. Not only that, the mechanics change, because if the rider is sitting in the seat, that's one thing. If he gets out of the saddle, that's another. The start is one type of mechanical action, hillclimbing another. We're looking at the jumps, the starts, what happens when the rider is out of his seat. How do you measure these things?"

How indeed.

To find out, Feingold and his co-investigators in the USCF's Elite Athlete Program have brought the full force of modern technology to bear on the question. In laboratories across America, they're using high-speed cameras, strain gauges, digitizing computers, dynamometers, and wind tunnels; they're wiring up the riders, painting their legs with black dots and taping electrodes to their chests, taking cast impressions of their feet and measuring how hard they pull on the handlebars. They—researchers, psychologists, biomechanics professors, technicians—are looking at cyclists harder than ever before, all in hopes of shaving a few thousandths of a second from the rider's time on the track.

Where It All Began

Until the past decade, literature about how riders apply cycling forces has been scarce. Dr. Peter Cavanagh was among the first biomechanical engineers to study how the cyc applies force to the pedal. Cavanagh bolted front fork of a conventional bike to a stand rear wheel rests against a large drum, wh acts as a flywheel. The machine is designe provide the same momentum and drag yo feel while riding on the road. The bicycle p als are equipped with strain gauges that a Cavanagh to monitor precisely the amount



ROCKY THIES

One step in a flexibility evaluation: Dave Grylls is measured for the range of motion around his hip joint.

direction of force that the rider applies during the pedal revolution.

Seven high-caliber cyclists took part in studies that so far have yielded computer printouts of their pedaling style, the amount of force they generate, and their efficiency. For the first time, they are able to see what they were doing with each leg—whether one was doing more work than the other, whether their feet were moving in the same circles, pulling up properly at the bottom of the stroke and applying power smoothly over the top of the stroke.

These measurements have proved valuable. "We noticed that my right heel was ten degrees less elevated on the recovery stroke than my left heel," recalls Brent Emery, a member of last year's gold medal-winning team pursuit squad at the Pan Am Games. Watching Emery ride a bicycle is like watching Steve Garvey hit a baseball. There are no mannerisms in sight; no quirks, no adjustments to the stroke, no moving around or nervous gestures—just calm, concentrated technique at work. Yet the computer saw this ten degree difference—with Emery's feet spinning in 100 rpm circles—and Emery himself saw the printout, revealing that one leg was doing less work than the other.

"It was not a severe thing," says Emery, "but I have made it better. I have improved my pedaling style to be more effective. At one point in my stroke, I am 100 percent effective (as measured on Cavanagh's computer) as far as the power I put out of my legs, the angle at which it's put into the pedal, and how much is used to translate into forward motion."

As impressive as Cavanagh's initial results are, they're just the beginning. Even Dr. Cavanagh's computers can't see and measure all the actions and forces that result from the seemingly simple act of riding a bicycle. Nor can they yet provide the riders with immediate feedback—though a computer monitor that allows the rider to watch the computer's analysis of his pedaling technique even as he rides is in the works. Such a machine might provide the ultimate in technique refinement; the rider could not only spot and correct differences as minor as Emery's ten degree heel elevation discrepancy, but could also experiment with different foot and cleat placements, different seat heights and pedaling styles, and watch the effect of these changes on the monitor.

Basic Tools

In the early seventies, Robert Gregor worked with Cavanagh as a graduate student, helping to perfect the strain gauge pedal so vital to Cavanagh's research.

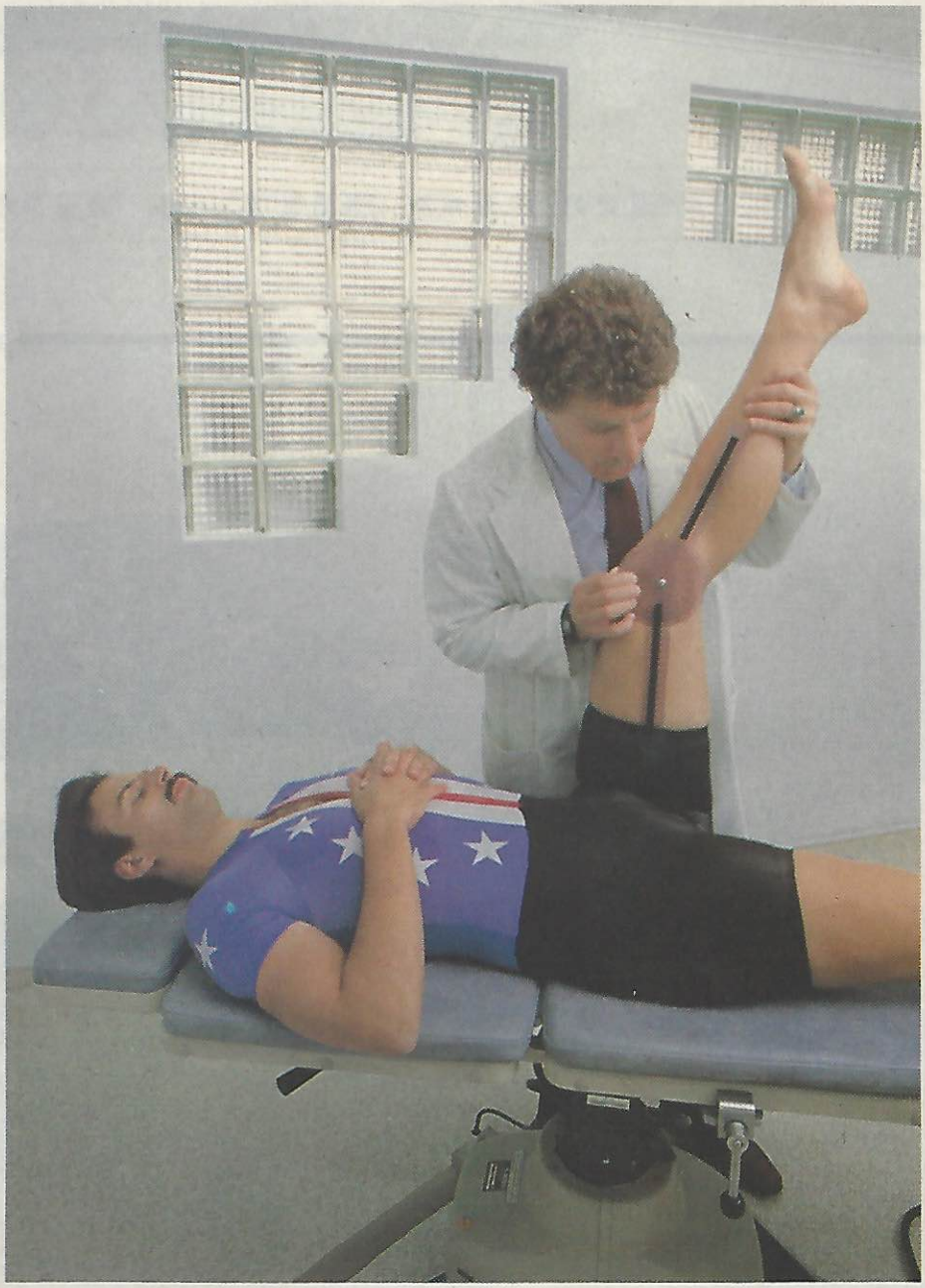
Now, at his home base in the Biomechanics Laboratory at UCLA, Dr. Gregor—whose research tools include high-speed cameras—is helping to interpret the results of Cavanagh's current work. In particular, he is interested in analyzing how the muscles interact during the pedal stroke. He hopes the data will influence future training techniques.

The research process itself is not complicated: Imagine a large, flat surface broken into a grid of half-inch squares. Project a three-dimensional image of yourself riding your bicycle onto the grid. Focus on your legs. Now freeze the image. Mark the centers of your leg joints—a dot at the knee, another at the ankle, one at the heel, and one at your toe. Unfreeze the image for an instant, then stop it again and mark the points. Start, stop, mark.

If you do this enough times, soon you'll have a perfectly modeled image of the motion of your legs during a pedal revolution. And you can mark and look at whatever you want. You can isolate muscle groups just by marking them appropriately on the screen.

If you're Robert Gregor, you feed the information into a computer for analysis. The computer can define the three-dimensional motion of a leg, and working in conjunction with Cavanagh's research, can further refine your understanding of force application, coordination of the motion of different parts of the body, and leg efficiency.

Moreover, by monitoring the activity patterns of the leg muscles (using a technique called electromyography) you can interface your grid studies with your electromyographical research to create a total picture of how the leg muscles produce force, which ones are active, and how they are activated. And when you see all that, you can begin to understand how the muscles work. You can examine how they respond to different training exercises and whether they are affected by different pedaling styles. Eventually, this analysis may help the cyclist to maximize the delivery of power.

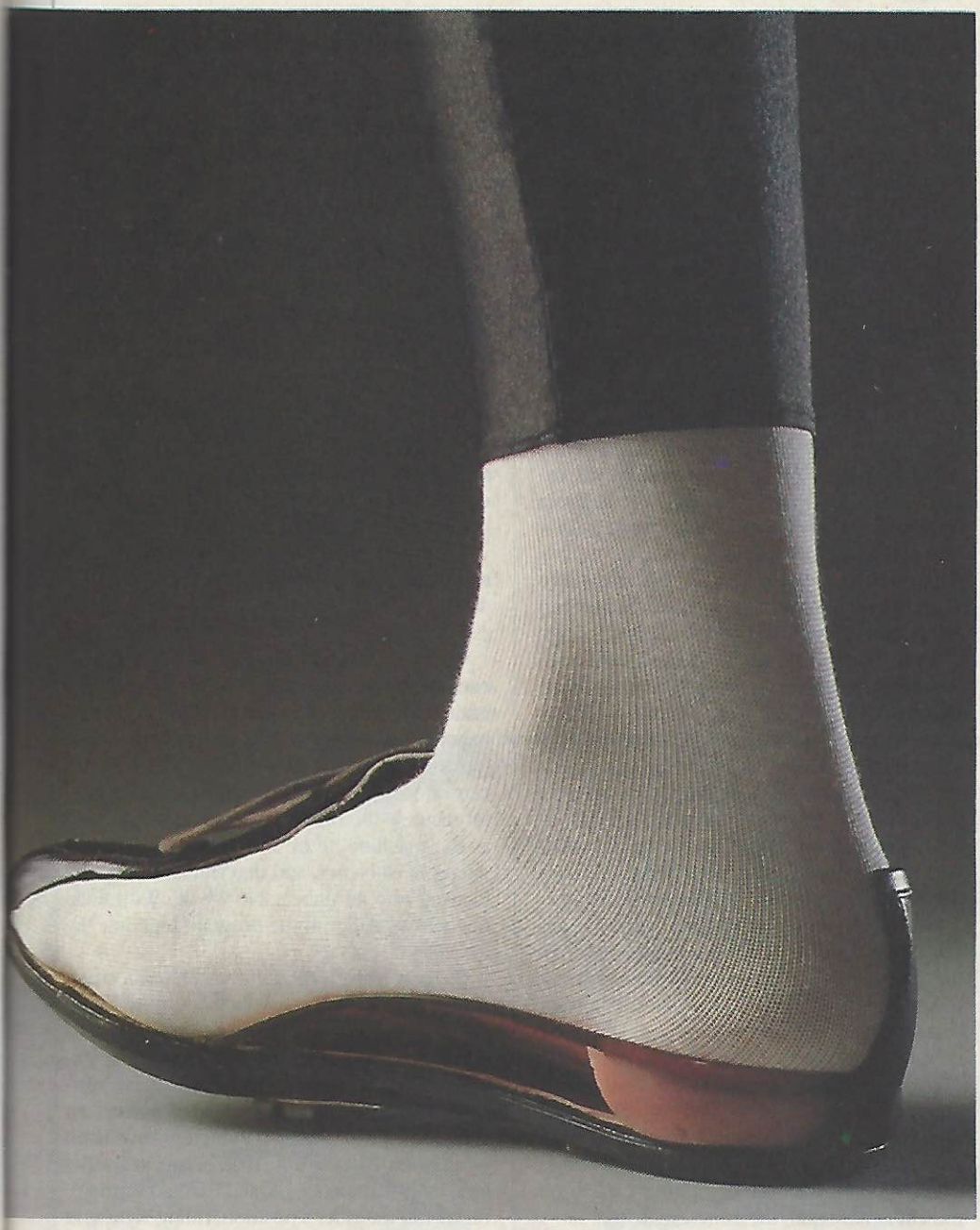


ROCKY THIES

Flexibility and therapeutic stretching are key components of Mitch Feingold's program. Here he measures the flexibility of Grylls' hamstring tendons. The instrument is a goniometer, which reads degrees of motion.

Video Display

The perfection and widespread application of the techniques Gregor is developing lie in the future. But one aspect of the program is



Orthotics—hard plastic shoe inserts—are used in unmodified cycling shoes to control abnormal foot function and increase pedaling efficiency. ROCKY THIES

being used widely now, and with rewarding results.

Originally, Gregor planned to use high-speed cameras to record the motions of the Elite riders during competition. For various technical reasons, the cameras didn't pan out. But the films were a big hit.

"I think the best thing the riders got out of those films was seeing themselves," Gregor said. "They could look at the film and say, 'Look at that fellow from East Germany, look at that Soviet rider, and look at me.' "

Filming has proven to be so beneficial that video taping is now seen as a must for the world-class riders. "From an educational standpoint, for learning techniques, videotaping is excellent for the riders," says Ed Burke, Technical Director of the USCF's Elite Athlete Program.

The riders agree. "I would rather see a video machine at our workouts (than go through more studies)," says Les Barczewski, silver medalist in the 1983 Pam Am sprint competition. "It helps you visualize, so you see exactly what your mistakes are. Like me. I move my head and upper body when I ride. I've been told that a thousand times. When I see myself on video, though, I say 'Holy cow, I move my body quite a bit on the bike. Maybe I can get away from that.' "

John Beckman's experiences with video tapes of the team pursuit at the 7-Eleven/*Bicycling* Grand Prix in Los Angeles and at the Colorado Springs training camp were similarly revealing: "We saw how straight a line we actually *don't* ride! We twitch all over the place. When I ride, I want to know what it looks like from the side, so I can know how it should look from the bike." For example, during the team pursuit, "on the bike it looked like I was really close. But I look at the tape and I've got six inches. So I know I have to reorient myself."

Says Brent Emery, "On a high level, you need video equipment. A coach can tell you everything, but you still have to be able to see it to understand the real fine points."

More Results

One of the techniques used to refine the riders' position on the bike is to reposition their feet on the pedals. To help, Mitchell Feingold, D.P.M., uses orthotics—hard plastic shoe inserts. While these inserts aren't necessarily appropriate for everyone, cyclists with flat feet and knock-knees report favorable results.

"The big difference was when I first put the orthotics into my cycling shoes. It felt like I was pushing with my whole foot for the first time, instead of just at the arch," says Barczewski, who suffers from flat feet and found cycling for long periods of time painful. "They seem to help quite a bit." Barczewski was so enamored of his inserts that he had a separate set made for his street shoes. He wears the orthotics all the time—"probably for the rest of my life."

Other national class riders wearing orthotics include Nelson Vails, Cindy Olavarri, Matt Francis, Roy Knickman, Steve Tilford—and the list goes on.

Although he's happy with the results, Feingold feels that the program is still in its beginning stages. "If a rider feels better and says he's riding better, that's all Eddie B. (Eddie Borysewicz, the U.S. Cycling Coaching Director) has to know. I like to be the scientist and say, 'Well, *why* is this racer feeling better or *why* is he riding better? Let me measure it.' But I'm not going to take Nelson's orthotics away because I can't objectively measure it right now! He feels better with them and he's riding better with them—don't take them away because you can't demonstrate why."

Down the Road

In the future, Feingold would like to study and quantify not only the results from his orthotic program, but also the entire foot/pedal interface: how it affects efficiency, strength, coordination. "Right now, we're asking the questions. Research takes several years. Before 1988, we'll be able to take a guy on his bike and evaluate so many things. We're going to look at high-speed films and the movement patterns, to see if there's a predictable variation based on, let's say, abnormal structure (of a rider's feet or legs). What's a normal pattern? What's an abnormal pattern? What can we do to correct it?"

Feingold's work won't be limited to orthotics and motion patterns, however. "Cycling shoes are where running shoes were 15 years ago," he says flatly. "You need to address two problems in cycling shoes. You need shoes for different types of feet, and you need shoes for different types of events. The most efficient shoe for a sprinter is not going to be a good shoe for a person with the same foot type who's going to do a road race. There are going to be sprint shoes, road shoes, different types of training shoes. That's what we're going to see, and it'll take three to five years to get it going."

For now, then, he is concentrating on the orthotics, and on a flexibility and therapeutic stretching program designed to get the riders to the Olympics without injury.

"Therapeutic stretching is nothing new; it's been around in the literature since the late 1800s," says Feingold. "The goal is to achieve (at least) a minimum range of motion. If you can achieve that, then you'll reduce the likelihood of stress-related injuries, and you'll also be more efficient in your riding (because) you won't have one muscle group fighting another."

The exercises involve working with a partner, who puts opposing pressure on a muscle after you've stretched it; the idea is to stretch the muscles in two ways. But it's more easily done than explained. After repeatedly trying to describe the program, Les Barczewski finally gave up with a laugh. "All I can tell you is after I've done these stretches, I've felt a lot looser and warmed up, which usually doesn't happen after I've done normal stretches."

Says John Beckman, "Mitch is very good at emphasizing proper technique. He's not saying 'The object is to touch your toes,' because it of course is not the object. The object is to bend your leg at the hips, have it at 90 degrees, and make sure your knees are straight."

The non-competitive nature of the exercises—there isn't any feeling of failure if you don't reach as far as the next guy—is especially valuable.

"John Beckman can tie himself in knots, and I'm real tight," says Dave Grylls. "That doesn't necessarily make me a better or worse bike rider. It's just different body makeup."

Is there any way to quantify the results of the program?

"I don't think so," says Feingold. "The idea is to help prevent problems, help (the riders) to be efficient. If they're efficient and functioning better, then that's enough."

A Professional Friend

While the U.S. coaches understand the importance of such programs to keep the riders in top physical shape, they also recognize the need for mental well-being. Thus they hired sports psychology consultant Andy Jacobs, PhD.

"Andy is a good friend to have around," explains John Beckman. "You might call him a professional friend, although his heart is in it more (than that implies)."

Jacobs began working with the riders two years ago and was beseiged with appointments. During his first visit to Colorado Springs, more than two-thirds of the national team members signed up to talk with him. Sessions lasted until 2 A.M.

Although he works with the riders on specifics such as coping with starting line jitters, improving concentration, and dealing with team pressures and interpersonal relationships, Jacobs is also there to serve as a sounding board for whatever is on the rider's mind. And he's not necessarily there to extend sympathy.

"He is somebody to sit and talk to," says Dave Grylls, "who is not a relative or somebody who's always agreeing with you—'Yeah, so and so *is* a jerk.' And he's also not somebody there saying, 'Well, I think you should be doing this.'"

Jacobs' work is especially valued by the team pursuit riders, because he can help them deal with the conflicting emotions of trying to work with riders they compete against in other events—or, in the case of gaining a berth on the Olympics team, the same event.

"Andy's sports psychology program has been a real asset to our team pursuit squad," says Brent Emery, "because you've got eight guys all trying to make the top four, and in between training under stress and living in close quarters together, sometimes we're ready to rip each other's throat out. We were able to get along in spite of everybody's significantly different personalities."

"I think a psychologist for the team is long overdue," says Les Barczewski. "You're with the team for ten weeks at a time and it starts wearing. You don't always have your wife or your girlfriend or whomever to talk your problems through, and your problems start to impede your riding. Andy's helped to relieve that."

An interesting result of Jacobs' work with the team has been the change in their sense of self-worth. Barczewski explains, "In cycling, we've always been at a psychological disadvantage. My peers (and I) were brought up to believe that the Europeans were superior; Americans didn't have a chance of winning anything. But it's reversed now; we're winning in international competition left and right. There seems to have been a psychological breakthrough where the American cyclists have decided that these other guys are not supermen. They're human, and they can be beat. We can beat 'em. Andy has encouraged that and brought it along."

And Andy Jacobs can expect his workload to increase this year: "Sports psychology becomes even more crucial as you get closer to a big event," says Burke. "As the event comes on, success in actual competition becomes 90 percent mental and ten percent ability. So Andy will be helping the riders with goal setting, team unity, and personal problems."

Body and Soul

There is a unifying thread that runs through each of these studies and indeed through the entire Elite Athlete Program. It is the ambitious belief that by asking the right questions, by looking hard at the answers, and through concentrated study of all aspects of a rider's performance—the rider's body and mind, as well as the machine he or she rides—the cyclist's strength, efficiency, and determination will be focused into an unbeatable whole. With luck, that thread will pull the program together before 1988.

By then, a given rider's biomechanical structure will be known. His efficiency, power output, and power delivery will be quantified. His pedaling style and riding position will be examined and evaluated. And all of these variables and more will be compared against an achievable ideal, whose parameters have been established by research that began years before, at Penn State, UCLA, and Colorado Springs. Bit by bit, the rider's position, riding style, and technique will be adjusted until his efficiency is at a peak. His bicycle, shoes, and clothes will be molded into an integrated package designed to enhance his every move. And he'll come to the starting line mentally ready to race.

For now, much of the program is concentrating on the summer of '84, and for that, the athletes are thankful. And ready. "It's going to be an interesting year," says Barczewski. "I'm looking forward to the whole season to be a success, like last year was for the road guys. I just want to see it happen again. I want the Europeans to know that it wasn't their off-year and that the Americans had a good year. I want them to see that the Americans have arrived."○

TECHNOLOGY & THE OLYMPICS