Hardwear and Footware

"These boots are made for walkin'"— Nancy Sinatra

What do you tell people when they ask you what you do? My strategy is to start with vague answers and prepare for the inevitable penetrating question. "I teach engineering," I say. Easy. "What *kind* of engineering?" they invariably ask. "Aerospace engineering," also easy. "That's really neat," they say, "I've always been interested in airplanes." Then it comes: "What exactly do you do on airplanes?" Anticipating this question, I've already begun to prepare an answer that I think would make sense to the friendly inquisitor. "I work on guidance and control," hoping that "guidance" will sound impressive even if "control" elicits a blank stare. The conversation usually ends here with a polite "Oh."

Once, when I just finished my Ph.D., an engineer asked me what my specialty was. "Control engineering," I said confidently, knowing I was speaking to a fellow technologist. "Toilets!" was his reply. "Uh, what do you mean?" I queried. "You work on toilets. They're control systems." I was embarrassed that my chosen field of specialization could evoke such an image. How could Riccati ever live down such a scatological association?

Today, we control engineers proclaim without hesitation that the flush toilet is one of the great inventions of the human race. In fact, distinguished IEEE Control Systems Society speakers unabashedly demonstrate to high school workshop attendees the benefits (and dangers) of using feedback to regulate the water level in the common household toilet. What technological innovation could possibly be more impressive to those future scientists and engineers?

For a long time, I've wondered how we might explain our profession to the public without evoking the impression that toilets are our major contribution to civilization. Now I think I've found the ultimate approach: shoes. Smart shoes. Everyone can relate to shoes, and shoes are the future of embedded processing for a very simple reason: the shoe is the ideal place to put a computer.

OK, I admit that using a shoe to house electronics can suggest a lot of bad Maxwell Smart jokes. But let's not forget that Agent Smart's smart shoe was the original cell phone, decades ahead of its time and ages before a thriving, billion-dollar industry gave us nonstop talking.

Lately, some pretty impressive shoe-based control innovations have surfaced. First, there's Adidas' feedback-controlled running shoe, where "a microprocessor in the heel dials in the perfect ride." The firmness of the sole changes with the terrain. No more tradeoffs between soft and hard soles when I run from dirt to rocks to road. If they come in extra wide widths, I'll be an early adopter.

In the more serious category, there's the "landmine sensing shoe," in which sensors detect bits of metal and warn the wearer through beeps. One could, in theory at least, walk through a minefield in safety. In some parts of the world, unfortunately, this innovation is a lot more than a luxury.

To avoid running wires up and down our legs, I expect smart shoes will exploit the next big wave in technology, namely, wireless. The "bluefoot" networking protocol will provide automatic foot-to-foot links, wherever we happen to be.

What else could control engineers put in a shoe? We can think of the shoe as the "brain," and whatever sensors we wish to carry around can report to the "brain." Pretty soon, our feet will be doing more thinking than our real brain. What a thought.

So, remember, when someone asks you what you do, proudly say, "I work on smart shoes." Oh yes, and don't forget to charge your shoes while you're sleeping.

Dennis S. Bernstein
Editor-in-Chief
IEEE Control Systems Magazine