

Good Vibrations

Stochastic resonance could bring some balance to all walks of life

One garden's weeds are another's roses. Stochastic resonance, a quirky phenomenon in which adding a little noise to a system improves rather than impedes its performance, is a case in point. Long observed in biology as well as electrical engineering, it is known to increase the ability of some fish to catch their prey, of neurons to synchronize their activity, and of lasers and solid state devices to become more precise.

Now James J. Collins and his colleagues at Boston University and Afferent Corp., of Providence, R.I., are exploiting stochastic resonance in the service of rehabilitative medicine [see their article, "Balancing Act," in this issue]. Noise-based technology may prove useful in overcoming age- and disease-related losses in sensory-motor function. The work they describe here could lead to an electro-mechanical device that enhances the sensation of touch and thereby improves an individual's sense of balance.

Balance is such an integral part of daily life that most people take it for granted—until they take a tumble. Age- and illness-related falls are thought to be caused at least in part by a loss of ability to judge body placement. As we age, we lose sensitivity in cells called proprioceptors that process information about the body's place in space. As the sensitivity of these cells decreases, they provide the brain with less of the information it needs to maintain balance.

Collins's group is in the early stages of developing a device that can restore the senses of touch and balance to people who have lost them through old age or diabetes. When a tiny electric charge is applied to the feet, people are able to "feel" their feet again and regain their sense of balance. Using stochastic resonance—adding just the right amount of electrical



A Chinese acrobatic team in Kimpo, South Korea, 2002

or mechanical noise to neurons to improve their sensitivity—gives people in their 70s the balance of people in their 20s.

Research on stochastic resonance finds some of its roots in work of the University of Illinois's Heinz von Foerster, a cybernetics pioneer who in 1960 first proposed that "order from noise," as he called it, helped self-organizing systems find more stable states. And while the expensive, complex armamentaria of nanotechnology and human genome research are being marshaled against the challenges of chronic illness and old age, it's great to see noise—good old-fashioned noise and classical noise analysis—doing so much good.

"Balancing Act" is the last article in a series called "Aging and Technology" that *IEEE Spectrum* has run over the past year. The series has focused on advances in biomedical engineering that will play important roles in keeping human beings

healthy, fit, and independent well into their seventh or eighth or ninth decades. New drug-delivery technology, replacement body parts, wireless medical monitoring, and the application of reliability theory to human aging were among the topics featured in previous articles.

What you have likely noticed about all these technologies is that you don't have to be old to make use of them. Diabetes, for example, is a problem at any age and can lead to nerve damage in the feet that might be overcome by the same technology that improves balance in older people. And indeed engineers should be making products that are useful to everyone, not just the aged. As we have said before, such universal design means making products that can help us all throughout our lifetimes.