# The Light of Research

## From Air Traffic to Neuroergonomics: A Trailblazer in 'Human Factors'

### Raja Parasuraman

It seems fitting that Professor of Psychology Raja Parasuraman should have chosen to devote his academic career to exploring brain function, because his own mental proclivities are so diverse: He can describe in detail his current research on how technology affects workers' attention spans, expound on the value of the music of Bob Dylan and Jimi Hendrix and list the exploits of Latin American revolutionary Che Guevara — and make the switch between topics almost seamlessly.

Such intellectual nimbleness, however, once earned him a rebuke from a professor. When Parasuraman earned his Ph.D. at England's Aston University in 1976, one of his instructors asked him whether he wanted to study psychophysiology (the study of the interactions between mental and physiological processes) or ergonomics (a science that seeks to adapt working conditions to suit workers). Parasuraman told him, "Both."

"You should focus on one area, because if you try to do both you're bound to fail," the professor said, to which the New Delhi, India, native replied, "I'll take that risk."

The risk has paid off. Parasuraman has parlayed his intellectual prowess, curiosity and willingness to take chances into a remarkable academic career. To colleagues in the academic world, he's known as a trailblazing founder of a new scientific field, neuroergonomics. His students recognize him for that as well, but also for being a model teacher and mentor.

The new scientific field came into existence in 1998 when Parasuraman — who has a bachelor's degree in electrical engineering and a doctorate in psychology — set up a Web site soliciting opinions from other scientists who studied ergonomics. He asked them about the possible creation of a cross-disciplinary field of study — one that would combine neuroscience with the principles of ergonomics, which analyzes the human factors of workplace performance (e.g., juggling tasks or the physical abilities of younger and older workers).

Ergonomics applies psychology and physiology to the design of safe and effective technology and products that fit with human mental and physical capabilities — for example, making sure that computers and other technology in airplane cockpits are designed to be usable by pilots and are compatible with their abilities. Neuroscientists study the brain and nervous system, typically with a view to understanding disorders.

Comments for and against the idea flooded his e-mail inbox. Pleased with the response, he began compiling articles for *Theoretical Issues in Ergonomics Science*, a journal devoted to neuroergonomics that he launched in January 2003.

Parasuraman says that by combining neuroscience and ergonomics, human interaction with technology can be enhanced with the aid of our increased knowledge of the brain. Also, new technologies such as brain-based computers for the disabled could be designed.

"I thought that since we now know so much about brain functions and imaging, it's only natural to apply that knowledge — not just to determining whether someone will be afflicted with disorders such as Alzheimer's disease or schizophrenia, but also how normal individuals react under stress at work and deal with new technology," says Parasuraman, mentioning two questions that he studies. Along with Research Associate Professor Pam Greenwood, he co-directs Catholic University's Cognitive Science Laboratory, which he established in 1985 and which currently is staffed by 20 graduate students.

"Raja is so good at human factors that it makes me jealous," says James Becker, a psychiatry, neurology and psychology professor at the University of Pittsburgh who collaborates with Parasuraman in studying the effects of aging in regard to Alzheimer's disease and ergonomics. "His contributions are going to become more and more important as he finds new ways to understand the relationship between the brain and the workplace, optimizing workplace performance."

Since the early 1990s the Cognitive Science Laboratory's staff has studied

automation in the airline industry — whether computerized cockpits lead to greater complacency and dependency on technology and, therefore, more pilot errors.

In 1996 this work made Parasuraman the logical choice for a related assignment: an appointment to a panel of the National Research Council, an independent agency that advises the federal government. The panel was charged with studying the concept of "Free Flight," a satellite-based system of air traffic management that is poised to revamp air traffic control as we know it.

Free Flight was invented by the airline industry to make air traffic control more efficient. Despite September 11 and the sluggish economy, air traffic is expected to nearly double in the next 10 years. To accommodate this increase, Free Flight will give pilots the responsibilities of choosing the most direct route to a destination and maneuvering out of another jet's flight path — duties once solely the domain of air traffic controllers.

Controllers will still play an important role, Parasuraman explains. They will serve in a managerial capacity, analyzing weather patterns and monitoring traffic flow in the skies. But controllers will dictate an airplane's flight only during an equipment failure, in bad weather, if a plane is near an airline terminal or if a flight situation seems dangerous.

This is similar to the military concepts of tactical and strategic control: A colonel leading a platoon of soldiers to take a hill is a tactical controller, and a general calling the shots from headquarters a hundred miles away is the strategic controller. Under Free Flight, air traffic controllers will be the generals.

For his research at Catholic University, Parasuraman brought in air traffic controllers from local airports and placed them in situations similar to the crises they might face on the job. A Cognitive Science Laboratory-developed simulator presented a radar display of airplanes in flight, approaching an airport and preparing to land. The simulator recorded the controllers' attention spans and perceptions by measuring their eye movements as they performed tasks in a real-time simulation of air traffic control.

During periods of light traffic flow, the controllers identified potential crises quickly; but as traffic density increased, they missed conflicts or responded to them too late. Parasuraman then added a computerized "conflict probe" that predicted an airplane's future course up to 10 minutes ahead of schedule. The controllers' detection accuracy increased dramatically.


"Raja is one of the smartest people I know and his work is widely used by NASA," says Anthony Masalonis. Now a systems engineer with Mitre Corp., an aviation research firm, Masalonis worked with Parasuraman on Free Flight experiments from 1996 to 2000 as a CUA doctoral student.

Considered an international expert on air safety, Parasuraman has appeared on the Learning Channel, CNN and other media outlets. During his 20-year CUA tenure, he has brought to the university about $9 million in grants from agencies such as NASA, the U.S. Army and Air Force, NIH and the Alzheimer's Foundation.

For his students, Parasuraman is a dynamic, nurturing mentor, with a laid-back manner and a quick smile. He'll critique a student's paper, then invite him or her out to dinner. There have been times when he brought leftovers from home to feed his CSL researchers working late at night.

"Raja is so brilliant, so accomplished, but yet he's still humble," says Erica Rovira, 25, a doctoral student who is studying human factors in air traffic control.

"Dr. Parasuraman is always encouraging us to be independent and to go out and get grants," says Camilla Knott, 29, another doctoral student who is studying visual and spatial attention in the elderly. "He really prepares us for the real world."