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Antsaklis Knows How Things Work

By Natalie Bakopoulos

Special to The National Herald

Many engineers develop a fascination with how things work at an early age, and this was certainly the case for Panos Antsaklis, the H. Clifford and Evelyn A. Brosey Professor of Electrical Engineering at the University of Notre Dame. The young Antsaklis often disassembled clocks, bicycles, and electrical appliances; he was not only interested in how things work but how they might work better. This attention, not only to analysis but also to synthesis, seems key to a career in engineering research. For Antsaklis, engineering is interesting because of its tremendous impact on our everyday lives. After all, the products of engineering — from electric power, telephones, automobiles, airplanes, satellites, computers, and the Internet — have undeniably changed the way we live. But it's not just the application of research that interests Antsaklis but the process of investigation. A good researcher must have imagination and vision; a good engineer must be able to make the vision a reality. As a research engineer, Antsaklis points out, he must be able to do both; he must have his feet firmly on the ground while still being able to gaze out at the horizon.

At Notre Dame, where he has taught since 1980, he focuses on problems of control and automation and examines ways in which engineering systems can be designed to autonomously perform useful tasks and the theory that needs to be developed to address them. At the heart of such systems with high-degree autonomy — and at the heart of the discipline of systems and control in general — lies the mechanism of feedback, a mechanism prevalent not only in engineered systems but in physical, biological, economic, and social systems as well. Feedback, to put it simply, corrects for uncertainty. Feedback control methods are used to regulate the temperature of our homes and the cruise control in our cars; they allow a plane to run on autopilot. Physiologically, feedback control mechanisms maintain our blood pressure and blood glucose levels. Biomedically, feedback control methods allow for the use of electrical nerve signals to control prosthetic limbs. Because many feedback control systems are hidden, or embedded in computers, Antsaklis notes, the concept is often referred to as stealth technology.

Although such automatic control systems have countless modern-day applications, the first such systems were developed more than 2,000 years ago. The first feedback control device on record was developed in the Third Century B.C., in Alexandria, by the Greek engineer and inventor Ktesibios. His water clock, or clepsydra, incorporated a feedback mechanism that used a floating device as both a sensor and an actuator (a mechanical device for moving or controlling,) which kept the water level approximately constant. This, in turn, ensured constant water flow and, as a result, accurate time keeping. And, generally speaking, it's this same system of precision and systems communication, this same concept of feedback, that lies at the core of Antsaklis' work two millennia later.

GREEK THINKING

Antsaklis was born and raised in Kalamata, a harbor town of 50,000 people situated at the head of the Messinian Bay in the Peloponnese. His father, Ioannis Antsaklis, a surgeon, was not from Kalamata but a small town called Geraki, near Sparti, in Lakonia, and raised in Piraeus. In 1939, while his father was working at the Red Cross hospital in Athens, seemingly destined for an academic career, a friend suggested Dr. Antsaklis relocate to Kalamata to open a clinic and practice surgery. And that he did. Soon after, World War II began, and doctors were in high demand. Ioannis Antsaklis served at the front in Albania. When the occupation and the Greek civil war ended, he had a growing family and decided to remain in Kalamata, a very dear place to Antsaklis, not only because of his family's roots but because of its natural beauty and rich history. He has fond memories of Sunday day trips he took with his family: small, quaint towns of Methoni and Koroni with their medieval fortresses; the town of Pylos on the west coast of the Peloponnese, which is the site of the famous Navarino sea battle during the Greek War of Independence and also the Palace of Nestor; the ancient stadium of Olympia; and Mani, with all its untamed beauty.

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PHOTO: UNIVERSITY OF NOTRE DAME
Dr. Panos Antsaklis, the H. Clifford and Evelyn A. Brosey Professor of Electrical Engineering at the University of Notre Dame, focuses on problems of control and automation and ways in which engineering systems can be designed to exhibit a high degree of autonomy in performing useful tasks.

Many of his memories of Kalamata, of course, involve his parents. His mother, Marina, was involved with philanthropic organizations, such as the orphanage and the Kalogries, the monastery at Ypapanti. A beautiful and intelligent woman, she was well informed about current events. "A great book reader," Antsaklis says of her, "with excellent French, very cosmopolitan. And a great cook!" She instilled in Antsaklis and his brothers the importance of education and often worked with the young boys as they completed their homework. She still lives in Athens and remains the heart of the family. When Antsaklis' father was establishing his practice, Kalamata did not have a traditional hospital, so his father's 40-bed clinic also served as the town's emergency room. His father worked very hard and very late each night, yet he still managed to research new surgical methods, usually to treat a particular patient. And because much of this information was not available in Greek, he also taught himself French, English, and some German in order to read the required medical books and journals. Perhaps this dedication to learning and its immediate relevance was impressed upon Antsaklis at a young age, for his own work combines both theory and application.

His father's dedication and sense of responsibility to the people of Kalamata was not only manifest in his late nights and constant learning. He was a true humanitarian and treated those who could not afford to pay for care, at no charge. And even now, decades later, when Antsaklis visits Kalamata with his family, the children of his father's patients recall his name and relay stories of his father's compassion. Though Antsaklis became an engineer, medicine did interest him. As a young boy, he spent much time at his father's clinic. Before his father began a surgery, the young Antsaklis watched his father scrub his hands "up to the elbows" for what seemed like an endless amount of time. Then, from behind a glass partition, he watched his father perform operations: appendectomies that typically lasted 20 minutes, some done with only local anesthesia, and plenty of bone settings. "I even watched a few Caesarian operations," Antsaklis says. In fact, friends and family assumed that because of this interest, the youngest Antsaklis would naturally become a doctor; his two older brothers were already in medical school. Instead, the intense appeal of mathematics and physics led him toward engineering. At the age of 17, he took the national exams and did very well; if he had enrolled in physics at the University of Athens he would have entered first in rank. Instead, he enrolled in the very competitive and esteemed Mechanical and Electrical Engineering Department at the National Technical University of Athens (Athens Polytechnic,) a rigorous five-year program.

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Antsaklis and his wife, Melinda Reese-Antsaklis, nderneath the Acropolis in front of the Irodio Theater (2008), where they enjoy attending performances.

Antsaklis came to the United States in 1972 for graduate school, sponsored by the Fulbright Foundation, to study control systems at Brown University in Providence, Rhode Island. While at Brown, he met his wife-to-be, Melinda Reese-Antsaklis, who was then a graduate student in Russian literature. After completing his Ph.D., he taught there for one year. He then was visiting professor at Rice University in Houston and lecturer at the Imperial College of the University of London before taking a position, in 1980, at the University of Notre Dame; Melinda also taught there. He has also held teaching and research sabbaticals at Massachusetts Institute of Technology, the Imperial College and the National Technical University of Athens.

IT'S CYBERMAN!

Though he has been in the States for 37 years, Antsaklis has maintained close ties with Greece. For as long as he can remember he and his family have traveled to Greece each summer, visiting Kalamata, where his daughter, Lily, now a sophomore at Heidelberg University in Ohio, still meets with her childhood friends, many of whom are sons and daughters of her father's own former classmates. He also spends some time in Athens, where his mother, Marina, lives, and where he might visit the Benaki Museum and the Temple at Sounion, attend a performance at the Irodio Theater and enjoy an ouzo and the view of the Acropolis from the Dionysus Cafe. His visits to Greece are also professional in nature. He often lectures at Greek universities, and he is the Founding President of the Mediterranean Control Association. And like most academics, Antsaklis both teaches and conducts research. When asked if he finds that one pursuit enhances the other, he replies, "Yes, absolutely!" At Notre Dame he has received numerous teaching awards, such as the Kaneb Teaching Award for Excellence in Undergraduate Teaching. He has also authored several books, including a very well respected graduate textbook on linear systems. He has five graduate students in his laboratory, students from all over the world. Particularly because his own research is interdisciplinary in nature, and because systems and control is a discipline that takes a global point of view, he encourages his students not only to participate in conferences and author scholarly papers, but also to examine the full picture, to attend lectures in other subjects to further broaden their horizons. He said he believes that a leader should be multidimensional so to perceive all the complexities of an issue: societal and ethical in addition to scientific and technical.

Because Antsaklis said he believes not only in depth of knowledge, but in its breadth, it seems fitting that the work that currently excites him most involves the close integration of networked embedded computing systems and the physical and biological worlds working together to achieve certain goals. He says: "This is where software merges with the physical and biological worlds to create systems that we never thought would become a reality, from artificial limbs to novel spacecraft." Such systems have been termed "cyber-physical systems" by the National Science Foundation. A cyber-physical system can be small, such as that used in a pacemaker, or quite substantial, such as an air traffic control system or the national power grid.

Cyber-physical systems can change the way we interact with the physical world. According to a report prepared by the Cyber-Physical Systems Steering Group (2008,) they can make systems safer and more efficient, both economically and energy-wise; they have the potential to transform industry. For example, cyber-physical technology can be applied to create faster-flying, energy-efficient aircrafts and safer, more energy - and economically efficient homes and cars. It can help create highway systems that allow for dense traffic to operate more safely, and it can be used to engineer more capable, finely tuned defense systems.

Antsaklis' parents, Ioannis and Marina, on a family trip to Paris in 1967. His mother still lives in Athens and remains the center of the family. His father, a surgeon, opened a clinic in Kalamata in 1939.

TIME AND TIME AGAIN

Antsaklis notes he is not only interested in improving upon what has already been created but also on identifying what needs doing and finding a way to implement it, so it comes as no surprise that he's a pioneer in this relatively new field. For Antsaklis — much like his father, a talented diagnostician who anticipated and subsequently learned what surgical methods he might need to help a patient — having the vision to see what might be next on the horizon is fundamental to being a cutting-edge scientist. Yet even with all this forward-looking research and technology, Antsaklis said he believes it's imperative to acknowledge those advancements that have undoubtedly stood the test of time. And evidence of one stands right in the center of Athens, in its ancient agora, a place Antsaklis frequently visits when in Athens. The Tower of Winds, or Horologium (from the Greek horologion, or timepiece,) is a combination of a wind vane, sundial and water clock. It is a large, octagonal structure, and on each of its eight sides face points of the compass. These sides are also decorated, in bas-relief, with flying figures of the corresponding wind gods. Atop the tower sat a wind vane in the form of a bronze Triton, which contained a water clock — Ktesibios' invention — to record time when the sundial could not. One of the few standing, never-been buried structures of antiquity, the Tower of Winds, was built around 100–50 B.C. by Andronicus of Cyrrhus for the sheer purpose of measuring time.

Antsaklis' wife, Melinda Reese-Antsaklis, and their daughter, Lily, relax on a beach in Kalamata in 1992.

And isn't time always, as the old adage goes, of the essence? Antsaklis notes that measuring time accurately for long periods was particularly difficult, and the earliest calendars were based on the lunar month and the later ones on the solar year. But, to bring in mathematics, neither the lunar month nor the solar year, rather inconveniently, consist of an integer number of days (the lunar month is approximately 29.50306 days; the solar year, 365.24219 days.) This problematic fact is partially why the Eastern and Western Christian churches celebrate Easter at different times, an extremely complicated matter that Antsaklis, just for fun, has written about in wonderful detail (http://www.nd.edu/~pantsakl/easter.htm.) And it's this quest for knowledge, this desire not only to understand and discover but to elegantly communicate his understandings, that seems to define him and his work.

Natalie Bakopoulos is a lecturer in the Department of English Language and Literature at the University of Michigan. Her first novel, The Green Shore, set in Athens during the military dictatorship of 1967–1974, is due to be published by Simon & Schuster in 2012.

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