

FACULTY & STAFF

RESEARCHER HAS "WIGGLE" ROOM

GORDON G. PARKER
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Scientific challenges are the sum and substance of Professor Gordon Parker's work. But while he's busy solving one problem, his mind is working overtime as he dreams up new problems to address. "It's wild and it's fun," Parker says of his work.

A native of the Detroit area, Parker earned a BS in Systems and Electrical Engineering from Oakland University. He then continued his education and earned a MS in Aerospace Engineering from the University of Michigan. Then, after a three-year stint with General Dynamics Space Systems in San Diego, Parker earned a PhD in Mechanical Engineering from SUNY at Buffalo, New York.

He also spent four years at the weapons research facility at Sandia National Laboratories in Albuquerque, New Mexico. During his first two years at the nuclear weapons facility, he worked on his dissertation research through a Department of Energy fellowship. After his PhD was complete, he continued one year as a postdoctoral fellow and one year as a senior member of the technical staff. Meanwhile, he also taught at the University of New Mexico. Parker joined the faculty of Michigan Tech's ME-EM Department in 1996.

Parker's main research focuses on control systems: getting a machine, system, or plant "to do what you want it to do." To illustrate control systems, he points out two that we use in everyday life: the cruise control system and hydraulic braking system used in modern automobiles. "Control systems are all over the place," he says. Much of his work involves eliminating what he calls "wiggles"—the not-so-technical term for vibrations and oscillations.

At Sandia, he worked on a variety of projects, including satellite control systems and robotic systems for cleaning up hazardous nuclear waste created during the Cold War. "Nobody wanted to be anywhere near this stuff," Parker says of the waste. Therefore, long robotic arms were used to remove material from underground, million gallon tanks, eliminating human contact altogether. However, there was the question of how to effectively stabilize the robotic arm, which tended to vibrate as it was swung around with a load on its end. Parker designed control systems that eliminated this "wobble."

Parker's solution impressed the right people and has led to more work to research for the Navy. Flashing forward to the weeks leading up to the Gulf War, U.S. armed forces scrambled to find a nation close to Iraq from which they could launch their attacks. However, these nations were uncooperative causing the U.S. to rapidly become frustrated in its efforts. To avoid such frustrations in the future, the U.S. Navy developed the Sea Basing initiative—which involves using offshore facilities as a staging area, as opposed to relying on other nations.

This is one component of the U.S. Navy's guiding vision called *Sea Power 21* and is comprised of three fundamental components: the Sea Shield, Sea Strike, and Sea Basing initiatives. One logistical scenario involves large ships outfitted with numerous cranes that pull material

off of a cargo ship, bring it over the deck, and deposit it on a smaller vessel (called a "lighter"), a roaming transport for men and material. "It's an offshore base with all the functionality of a land base," Parker says. "This is a big push, especially for

An example of the Sea Basing Initiative for the U.S. Navy.



expeditionary activities where the Navy is in a supportive position."

However, there are two problems with the setup. One is the same tendency that the robotic arms that were used to remove waste had demonstrated: the crane's payload oscillates when moved by the operator. The second problem is that even a mildly heavy sea can affect the crane. "Realistically one can do this only on a glassy sea," Parker notes of this particular operation. "We want to be able to do it in high seas when the ship is rolling and heaving."

Having already developed a system to handle the former problem, Parker set his sights on designing a system to offset the motion created by the waves. His control scheme is "a crane system that will cancel out the ship's motion." Parker's solution

has been successfully tested on land and during an at-sea demonstration last fall. Meanwhile, he continues to work with the Navy to further enhance the crane-ship system.

Parker also recently completed a project for the Air Force Office of Scientific Research on the Optimal Design of Smart Structures. Picture an airplane wing with flaps and spoilers. Now picture the wing with no moving parts—a structure that can be formed and deformed by actuators, hydraulic cylinders, and other more exotic methods internal to the wing. Rather than using rudders and flaps to control a plane's direction, a wing can be deformed and twisted to perform a particular function. "These are referred to as smart structures," says Parker. He continues, "Active structures may be a better term. You can actually morph wings on an aircraft—generate its maneuverability—without using control surfaces, like flaps. Instead you literally twist the wing. That's a big push, too, with NASA and the Air Force."

He is also involved with computer code that ties in with smart structures. This optimization code, a parallel genetic algorithm, can run on hundreds of computers simultaneously, integrate with off-shelf codes, and assist in producing "whatever kind of complex, smart structure one can imagine." But that's not enough for the restless Parker—there are three other areas of research that he would like to do more work in.

He wants to work with robotic systems in factories to solve that same vibration

and swinging problem present with the hazardous waste and crane-ship projects. "Mathematically, there are ways to move it properly to get high speed without the wiggle," he says. "It's fun, and it's cool-looking. To see it happening, one would say, 'no way.'"

Finally, he and a colleague, Professor L. Brad King, are joining forces with Professor Hanspeter Schaub at Virginia Tech University to develop new propulsion and control methods for formation-flying spacecraft. Parker explains, "Take two spheres, introduce an electric charge, and make them either attract or repel one another. A combination of natural gravitational forces can be used, along with charging the spacecraft, to maintain or change a certain formation. The application here is earth-imaging—spy satellites, for the most part. This allows a tight formation of spacecraft at geosynchronous orbit—the orbit where an object can remain fixed over part of the earth full time-- and do some extremely high-fidelity imaging. In a nutshell, one could have hemisphere imaging with a resolution of a meter. The exactness of the image is related to how well these spacecraft can remain in a certain location—and talking to each other—to form a large satellite dish. Basically, they're all taking pictures at the same time and communicating that to a central spacecraft that combines all the data into a composite image."

"It's cool," the enthusiastic Parker continues. "The control problems and the dynamics associated with it are huge, but it's fun." When asked whether he enjoys research or teaching more, he answers, "They're tied. They're both a lot of fun. What I don't like—I don't want to be in the position where I'm just managing graduate students. That's no fun. I like doing stuff—coding, testing, and technical work."

He sums up the support that he gets from the ME-EM Department in one word: "Fantastic."



"PARKER'S MAIN RESEARCH FOCUSES ON CONTROL SYSTEMS."