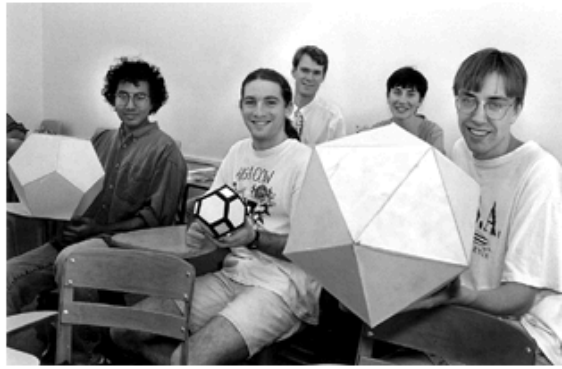
Visiting undergrads gain math research experience with CU faculty

These students in the math department's Research Experience for Undergraduates program studied polytopes this summer. Here with math professors Richard Ehrenborg and Margaret Readdy sitting in the back row are, from left, Mohan Rajagopalan of Oberlin College, Dan Johnston of Washington University and Harold Fox of Cornell. *Adriana Rovers/University Photography*



By Missy Globerman '99

Eleven undergraduate students from around the country and Canada gathered at Cornell this summer for eight weeks to investigate complex theoretical problems about mathematics. These students, composed of mathematics, physics and computer science majors, worked closely with Cornell mathematics faculty and visiting faculty to make new discoveries about fractals, geometry and dynamical systems.

As participants in the Research Experience for Undergraduates program hosted by the Department of Mathematics and sponsored by the National Science Foundation, the students were split into groups of three or four, and each group was assigned a project to work on with one of three mathematics professors and a visiting professor.

Robert Strichartz, Cornell professor of mathematics, said the selection process of these students from the 100 or so who applied was competitive and in a very selective competition. This is the fourth year Cornell has received an NSF grant to get undergraduate students involved in research.

One group studied fractals geometric objects that have irregularities at all scales of measurement. The students graphed and analyzed these structures.

"Fractals are interesting because we could possibly model and more accurately describe things in nature, like waves and the passage of heat," said Michael Levi, a junior at Queens University in Kingston, Ontario.

"By using an experimental approach in studying these graphs of fractals, we learn about their foundations as much as possible and then make generalizations and prove them. However, the study of fractals is very young," Strichartz said.

Another group worked with Richard Ehrenborg, an H.C. Wang Assistant Professor of Mathematics, and Margaret Readdy, visiting associate professor of mathematics, on polytopes, which are regions in space enclosed by points, lines and planes. Examples of polytopes in two dimensions include triangles, squares and pentagons; three dimensional examples include cubes, Egyptian pyramids and octahedra.

"We are looking to see what happens if you have a cube and decide you want to cut off an edge or a vertex," explained Dan Johnston, a sophomore from Washington University. "We've done this analysis in higher dimensions, proved the patterns and seen that the patterns always exist."

As part of a branch of mathematics called combinatorics, this type of research has applications to many areas, including communication networks, statistical design and error-correcting codes for computer problems.

"Even though they are using complicated algebraic methods, these students are boiling down geometrical problems into something you can get your hands on," Ehrenborg said.

The third group, lead by Kevin Pilgrim, an H.C. Wang Assistant Professor of Mathematics, examined dynamical systems. As an interplay between math and physics, these students examined the inputs and outputs of functions and studying the behavior of the numbers.

"We can look at different pictures from the same function and examine the different symmetry on a gridded computer screen," explained Kelly Plummer, a sophomore at the University of Minnesota. Though the notion of dynamical systems arose from trying to understand how the solar system works, the work of these students will be useful as a set of tools for scientists and mathematicians to apply in their work.

"Though their work can be computational and tedious, it is not like watching test tubes in a lab. The students get to participate in discussions with professors about what's going on," Strichartz said. It also is a unique opportunity for undergraduates to get involved with this type of upper level research, he said.

"Working this closely with a professor is something I've never done before," Plummer said.