Report on 2002 GT Math REU

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1 Overview

The Summer 2002 Research Experience for Undergraduates (REU) has twelve students in the program. Ten of these were supported through the VIGRE/GT grant, while another two where supported through other NSF grants. In the previous summer, there were six undergraduates involved in an REU, with funding coming from a mixture of individual NSF grants and the GT Graduate School. The Summer 2002 program was significantly bigger in it's scope and impact than previous REU efforts of the School.

This increase in scale was principally achieved by having the dedicated funding from the VIGRE/GT grant. In addition, the possibility of the funding was advertised to the students and faculty by through a web site. I solicited possible topics from the faculty, and advertised them on a web site. About half of the students wound up taking topics from this list.

The particular goals that we have for this program are:

- Increase the number of students participating in some REU experience during their tenure as an undergraduate.
- Have the REU serve as a significant element of the undergraduate's education, deepening their own intellectual growth and appreciation of research.

- Incorporate, as much as is feasible, these activities into the research programs of the faculty members of the School.

The REU moved the School towards these goals. As mentioned, the REU was significantly bigger, in fact double, previous REU efforts at the School. All twelve students were working on projects that, if completed, would have made a notable contribution to knowledge in that field. And everyone left the program with a deeper understanding of the nature of research. Many of them also left the program with a impressive gain in their knowledge and sophistication at absorbing and creating mathematics.

One group of students, Ryan Hynd, Jeffrey Elms, and Roberto Lopez, in collaboration with Professor McCuan, did complete enough work that they will present findings at an American Mathematical Society sectional meeting in Salt Lake City. Two of the students, Ryan Hynd and Roberto Lopez, will travel to the meeting. Ryan Hynd will present a paper entitled "Delaunay's rolling curves and rotating drops" in a Special Session on Soap Films.

The weaknesses of the program came from two sources. The students expressed some frustration with the fact that the goals of the project were worth striving for, they could not complete the projects in question. (One student was close to completing a project as classes began.) This is a reflection of three aspects of the projects this past summer. They were genuinely at the research level, many of the students simply did not have all of the background required to begin work on the project immediately, and the time scale of research in mathematics is significantly longer than the six to ten weeks of a summer REU.

Two of the students wound up feeling isolated from a research environment.

2 The Participants

A more detailed list of the participants are as follows.

Professor	Student	Topic
Peter Mucha	Michael Abraham	Small World Networks
John McCuan	Roberto Lopez	Electrostatics
John McCuan	Jeffery Elms (ECE)	Electrostatics
John Pelesko	Ryan Hynd	Electromagnetics
Joe Landsberg	Erika Norenberg	Morse Theory
Joe Landsberg	Joe Montgomery	Algebraic Varieties
Johan Belinfante	David Eger	Artificial Intelligence
Xingxing Yu	Jeremy Barrett	Graph Theory
Margaret Symington	Andy Wand	Contact Topology
Anthony Yezzi (ECE)	Ganesh Sundaramoorthi	Image Processing
Prasad Tetali	Boris Kerzhner	Expander Graphs
Prasad Tetali	David Skoog	Expander Graph

More extensive reports of the undergraduate's research appears on the Georgia Tech Undergraduate web pages

`http://www.math.gatech.edu/~lacey/ump/reu/gtreulist.htm`

Of these twelve, I would like to highlight these students.

Andy Wand. Andy graduated from GT in the Spring 2002 semester, and was given an ambitious topic in Contact topology by Professor Symington. Andy quickly began absorbing topics and techniques in the field, and along the way made frequent contact with several graduate students and faculty at the University of California Berkeley. In fact Professor Kirby met Andy Wand at a conference, and was impressed enough that he got Andy admitted and supported at Berkeley, beginning in the Fall 2002 semester.

ACE Lab Group: Jeff Elms, Ryan Hynd, and Roberto Lopez. The ACE Lab was home to three students, Jeff Elms, Ryan Hynd, and Roberto Lopez. These students were working on sophisticated experiments involving soap films and electrostatics. And the mathematics to model these experiments involved significant aspects of the Calculus of Variations and numerical methods. These three worked long hours in the lab, the entire summer. They confronted the variety of intellectual issues raised by their work, and made as a group significant advances in their mathematical sophistication. The abstract of their paper "Delaunay's rolling curves and rotating drops" to be presented at the AMS meeting is:

In 1841, Delaunay described the meridian curves of all constant mean curvature surfaces of revolution. Each is the path traced out by the focal point of a conic

section as the conic section rolls along the axis of symmetry. In 1863, Plateau examined the shape of a neutrally buoyant liquid drop driven to rotate about its axis of symmetry. The mean curvature of these surfaces is a quadratic function of radial distance. The shape and stability of Plateau's rotating drops have been examined by many authors. We discuss an extension of Delaunay's rolling curve interpretation to this important class of surfaces of prescribed mean curvature.

Ganesh Sundaramoorthi. Ganesh is a double major in Computer Engineering and Mathematics. His project concerned a sophisticated approach to automating the identification of objects in a digital photograph. The work was carried out in the Computer Vision Labarotory on campus, under the direction of Professor Anthony Yezzi. The automation is to be done through the evolution of a curve according to an energy that controls intrinsic properties, especially self–crossing, and an energy that arises as from properties of the image. His summer's work concentrated mainly on the first energy, and involved a mixture of theory, and numerical simulations. He came to a deeper appreciation of the subtle interaction between the theory and implimentation in this problem.

3 Plans for Next Summer's Program

Much of the REU program worked well. We will modify the procedures a little, in order to address some of the concerns that came up from this past summer.

As before early in the Spring 2003 semester, possible topics for REUs will be solicited from faculty and postdocs. These topics can be quite brief. They will be advertised on a central web site, in order to inform the Professors and students of the upcoming program.

To address the students' concerns about completing the work, I will take two steps. The first is to inform faculty sponsors of the issues concerning completion of work. And the second, is inform the students about the opportunities that there are to continue the work into the next semester. These avenues are to take M 4080, a two-hour senior project course. The second is to apply for President's scholarships, which provide approximately $1,000 to the student to continue their work. Deadlines for application will fall at the end of the Summer.

A deadline for application will be listed as March 31, with notification of awards by April 15. It will state that funding decisions will continue until funds run out.

The grant includes travel funds to report findings. It looks as though only a couple of this past summer's participants will take advantage of this. With earlier identification of the participants, we might be able to send a small number to a relevant conference. The aims here are to help them get up to speed a little faster, and possibly combat the isolation. The CBMS conferences could be especially attractive. This will be done on a case by case basis, where their would be special reasons to think that isolation would be a problem.

Finally, I will work to have more groups of students. The ACE Lab worked quite well, and Kerzhner and Skoog worked well together, covering different aspects of a single topic. This part may also work to address isolation issues.