

## Report on ACS Technology Grant for

# A New Perspective on Geometry: A web-based series of independent study courses in geometry

Alan S. McRae

Washington and Lee University

### Background

The role of geometry in the education of our math majors has sadly fallen by the wayside. This is unfortunate as geometry is beautiful, practical, and its development over the centuries up to the present day has required major efforts by some of the greatest mathematicians. Below I quote from the famous mathematician H. Busemann as he discusses the decline of geometry in the curriculum:

*... do we have the right to completely disrupt historical continuity whenever a subject moves out of the focus of contemporary interest? Do we really expect or agree that our present mathematical efforts will be altogether junked (at least from courses) as soon as the interests change? This disregard for historical continuity obviously leads to dangerous absurdities if taken seriously and must be fought."*

The focus of most undergraduate math curricula is on algebra and analysis, which is to be expected as these two subjects introduce powerful tools that are used throughout all of mathematics. Few departments have the faculty resources to offer a wide spectrum of courses in geometry, and typically can only offer a course in classical geometry (primarily aimed at majors with an interest in secondary education) and/or differential geometry.

### Description

The purpose of this project, a portion of which is completed, is to make publicly available a comprehensive series of web sites for discovery-based, interactive courses on geometry. The courses would be modular in design to facilitate ease of use by faculty worldwide. They will be offered here at W&L as part of our independent study program in modern geometry, allowing the student to choose those branches of geometry of greatest interest to her. Among its aims are: to exercise the student in the visualization of mathematical concepts, to present a unified view of classical and modern geometry, to develop and exercise problem-solving abilities, and to give the student a sense of the unity of mathematics by relating geometry to other fields, both in and outside of pure mathematics.

Ideas and definitions at each step in the learning process will be both motivated and illustrated, sometimes via interactive and dynamic geometric tools. The theory will then proceed to develop through problems, reading assignments, and projects. Some of these problems will take the form of missing steps in interactive exercises written in HTML and Java. The students will then add their own contributions to the web course

as appropriate (a beautiful new solution, an interesting find in an old journal, a surprising application, etc.).

### **Timeline**

The first course (on finite geometry) is now complete, and can be accessed at [http://home.wlu.edu/~mcraea/Finite\\_Geometry/MainPage/main\\_page.htm](http://home.wlu.edu/~mcraea/Finite_Geometry/MainPage/main_page.htm).

The second course (on geometric probability) will be completed during the summer of 2003. When the course is ready for public access, it will be available at [http://home.wlu.edu/~mcraea/GeometricProbabilityFolder/MainPage/main\\_page.htm](http://home.wlu.edu/~mcraea/GeometricProbabilityFolder/MainPage/main_page.htm).

### **Learning Outcomes**

Geometry allows the student to see the beauty and unity of mathematics, the 'big picture' if you will. Instead of a course with unmotivated general definitions, few examples, and little or no ties to other courses, my web courses in geometry are about those examples that are central in mathematics and have inspired generations of mathematicians. The student of geometry acquires a greater appreciation for mathematics as a creative act. And they would get to share their work with the world by contributing to the web page.

In addition there is further educational value to a student who helps me build and add to the web courses. She has the opportunity to learn enough about a field of mathematics not only to know what some of the unanswered questions are, but also to start thinking about them. In addition to her intellectual pursuits (reading, problem solving, questioning, generalizing), she may think about how best to relate what she has learned to others within the context of a web environment.

### **Curriculum**

Web courses for the topics listed below are ultimately to be written. The first course is complete, and attention needs to be given to the next three, as very few books suitable for undergraduate study are available for these subjects. I would ultimately like to build a web course in space-time geometry in support of a course on time machines that I teach every few years here at W&L. Faculty outside of W&L could use these web materials either within their own courses or as independent study courses.

1. Finite Geometry
2. Integral Geometry and Geometric Probability
3. Convex Geometry
4. Minkowski Geometry
5. Space-Time Geometry

### **Assessment**

I am currently using the web course on finite geometry for a course I am teaching at Washington and Lee University. Course evaluations will be completed on-line using the Flashlight program. Future use of the site will be assessed similarly, and by peer review (published articles on the project, conference talks, etc.).

## **Dissemination**

This project has resulted in one publication, *A New Perspective on Geometry: independent study courses in geometry available on the web*, Visit-Me-2002 Conference Proceedings, July 2002, University of Vienna. Additionally, my students will have the chance to be a part of a project that could be viewed and used by thousands. All web courses for this project are to be publicly available using W&L's servers.