Multivariable Calculus Projects and Poster Session
Professor Donnay, Math 201, Fall 2005

Assignment: Take any topic in which you are interested and make connections between it and what you have learned in Multivariable Calculus.

Poster session: Tuesday December 6th at 7:00 PM, Thomas Great Hall
Pizza party from 6-7 pm with the math department and math majors.

- You will be working in 2 person teams of your own choosing.
- The finished project will consist of two parts. A "poster" displaying your results and a two page paper in which you describe in more detail your work.
- A one page project proposal will be due at the beginning of class on Monday November 21. Your proposal should say who is in your team and provide a description of what you want to investigate and how you plan to present your results. The standard presentation is a "poster" displaying your work but alternative forms of presentation are acceptable if a poster is not suited to your project. Thomas Great Hall has wireless internet access, so you could show materials on a computer using PowerPoint or the internet.
- The regular lab sessions will be finished by Thanksgiving (if not earlier) so you can use the final lab periods to work on your project. If you need more access to the computer lab, please let me know and I will make arrangements.
- **The project must be connected in some way to the material that was covered in our course**, but you are free to be creative and imaginative in choosing the topic. Here are some ideas:

1. Math surfaces: Find some beautiful math surfaces (either from the web or math books) and make your own pictures of these surfaces using Mathematica. Minimal surfaces would be one interesting class of surfaces. Here are some sites:
   http://www.susqu.edu/facstaff/b/brakke/ - then look for Triply Periodic Minimal Surfaces.
   http://www.msri.org/publications/sgp/SGP/indexc.html
   http://www.cs.berkeley.edu/ sequin/ - Art and Geometry.
2. Spirograph curves: explore further the epicycloids and hypocycloids that you made in lab with True-Basic. Try various radii for the circles and look for patterns. There are other famous math curves (evolutes, tractrix, etc) that you could learn about and draw.
3. Make a web site for Multi-variable calculus with links to sites that have interesting related material.
4. Write a short story involving multi-variable calculus or a song and dance.
5. Examine contour maps and gradients. There are lots of map materials available on the web (EPA, US Geological Survey). The use of global positioning systems (GPS) is leading to tremendously accurate maps. Examine level sets of various properties (rainfall, temperature, etc). Calculate directional derivatives, gradients, draw flow lines, calculate average value of functions all based on these maps.
6. Maps of the world and the different projections used to draw them. The problem of how to represent a three dimensional sphere on a two dimensional paper is tricky and has been approached in many different ways. One standard method is the Mercantor projection. This topic relates to different coordinate systems: note that spherical coordinates are closely related to longitude and latitude. Mathematica has a map feature that draws different projections of the earth.
7. Architecture shapes - a variation on math shapes.

8. Three dimensional drawings - the understanding of perspective.

9. Sculpture. Create your own three dimensional math shapes. Perhaps make clay models of some famous math shapes. (See the MaCalester College web site http://www.macalester.edu/ mathcs/ - they have done snow sculptures involving math shapes).

10. Design a tour of the beautiful and interesting math shapes that can be seen on the Bryn Mawr campus (the roof of the gym, various dormitories, the Shiply School "monoliths", etc.).

11. Create some "props", using items easily available in your dormitory or eating hall, that could be used for demonstrations in Multi-variable calculus.

12. Learn about the mathematical billiards which is Professor Donnay's area of math research. See the billiard game on this web site at
http://serendip.brynmawr.edu/chaos. Ask him for more details.

13. History of mathematics. Learn about some famous mathematicians and their contribution to multi-variable calculus. For example, see writing project .p. 1162, Stewart, 5th edition.

The Stewart textbook has Projects in many for many of the sections that you could do. Also some of the homework problems requiring the computer could become projects or the Problems Plus at the end of each chapter. Check out S 11.1 - Parametric Equations, 11.3 - Polar Coordinates, 13.7 Families of Surfaces Laboratory Project, 16.8 #37 and the projects in that section, 14.4 - Kepler's Laws, 17.6 - parametric surfaces,

You could go back to the Graphing Calculator and study some of the interesting shapes that are shown in the demo.

Here are some web sites. You can easily finding many more using a search engine and some mathematical key words (minimal surfaces, mathematical surfaces, etc):

- The Geometry Center. Look for their graphics archive and their link to other graphics sites
http://www.geom.umn.edu/
- The Mathematical Sciences Research Institute (MSRI) and their project on scientific computation in graphics: http://www.msri.org/publications/sgp/SGP/
- The American Mathematical Society has a page on students projects: http://www.ams.org/new-in-math/student-resources.html
- The Math Forum http://mathforum.org/. Among other things, you might look for links to geometry and differential geometry.
- Association for Women in Mathematics (AWM) and their Education link: http://www.awm-math.org/education.html
- The Mathematical Association of America (MAA); http://www.maa.org