

# **An Advanced Mathematics Classroom/Laboratory**

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## **Creation**

In November of 1994, I along with two colleagues submitted an NSF ILI grant application for equipment and software to be used in a Macintosh computer classroom/laboratory. The laboratory was designed for advanced mathematics courses, not introductory or remedial classes. The grant proposal stated that implementation would begin the following spring. However, it required over two years before the room was ready for classes in the spring of 1996.



## **Layout**

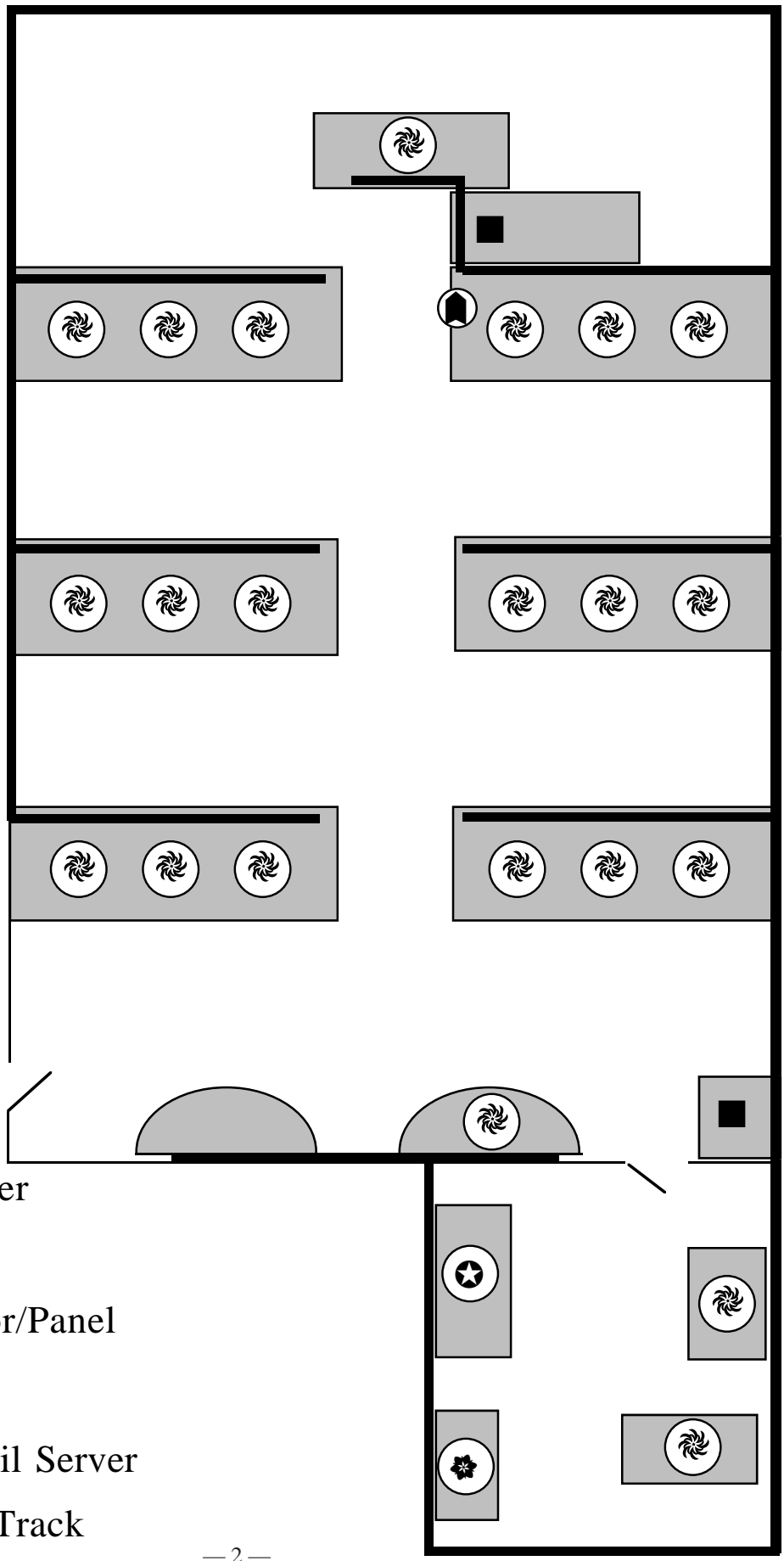
The laboratory layout is designed so that an instructor can teach from the front. There is enough room between the rows so that a person can easily move about the room. In addition, each cluster of three computers can serve as a group work area. The layout of the room is shown on the next page.







# Laboratory Diagram

Room dimension:

20' x 30'

Scale: 4'/1"



-  Computer
-  Printer
-  Projector/Panel
-  Server
-  Web/Mail Server
-  Wiring Track

## Evaluation

We have conducted surveys in classes using the laboratory both at the beginning and at the end of a course. The portion shown below has been used both times with fill-in questions added on the survey used at the end of the term. We believe that students should change their view of mathematics through use of the laboratory. We also hope that they begin studying differently. The fill-in portion provides a little support for these hopes, but the basic portion has provided little information about how students study, either at the beginning or end of the course.

### Mathematics Computer Survey

Course Number: \_\_\_\_\_

Major:      Biology                            Mathematics        
              Computer Science                 Physics              
              Economics                          Other \_\_\_\_\_  
              Education                     

Class Standing:     Freshman       Sophomore       Junior       Senior  
                          Graduate      Other \_\_\_\_\_

Indicate with a check which of the following methods you have used in the *past year* to learn mathematics:

_____ <input type="checkbox"/> reading	_____ <input type="checkbox"/> working through examples
_____ <input type="checkbox"/> lectures	_____ <input type="checkbox"/> learning by trial and error
_____ <input type="checkbox"/> homework	_____ <input type="checkbox"/> visualizing concepts through graphing
_____ <input type="checkbox"/> using computers	_____ <input type="checkbox"/> finding patterns
_____ <input type="checkbox"/> research projects	_____ <input type="checkbox"/> memorizing theorems
_____ <input type="checkbox"/> studying by yourself	_____ <input type="checkbox"/> memorizing proofs
_____ <input type="checkbox"/> studying with others	_____ <input type="checkbox"/> constructing proofs
_____ <input type="checkbox"/> being tutored	_____ <input type="checkbox"/> Other _____
_____ <input type="checkbox"/> memorizing formulas	

Please rank the value of each method you checked above on a scale of 1 to 9, where 1 means *least* valuable and 9 means *most* valuable.

How would you rate your computer literacy?

Beginning                       Intermediate                       Advanced

## Setting Up Workgroups

Basic management of the laboratory is accomplished via At Ease for Workgroups. This has two main components. First it provides a simple interface for the students which hides the desktop and allows access only to specific programs. Second, it permits the establishment of workgroups with particular sets of applications and members. To set up a class, it is only necessary to copy a standard, empty workgroup and then import the users. The class roster comes from a standard mainframe text file with data separated by spaces. For example, the following are the first five students to register for Math 624, numerical analysis:

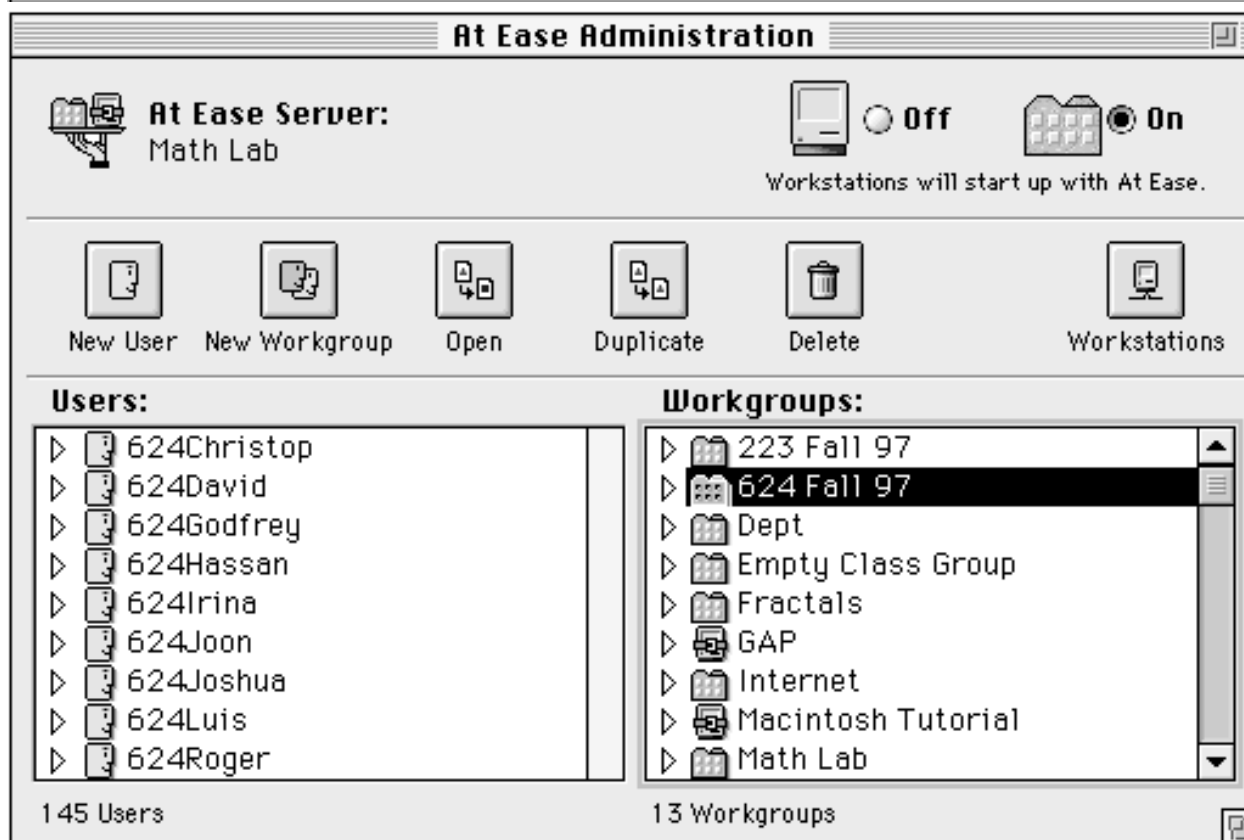
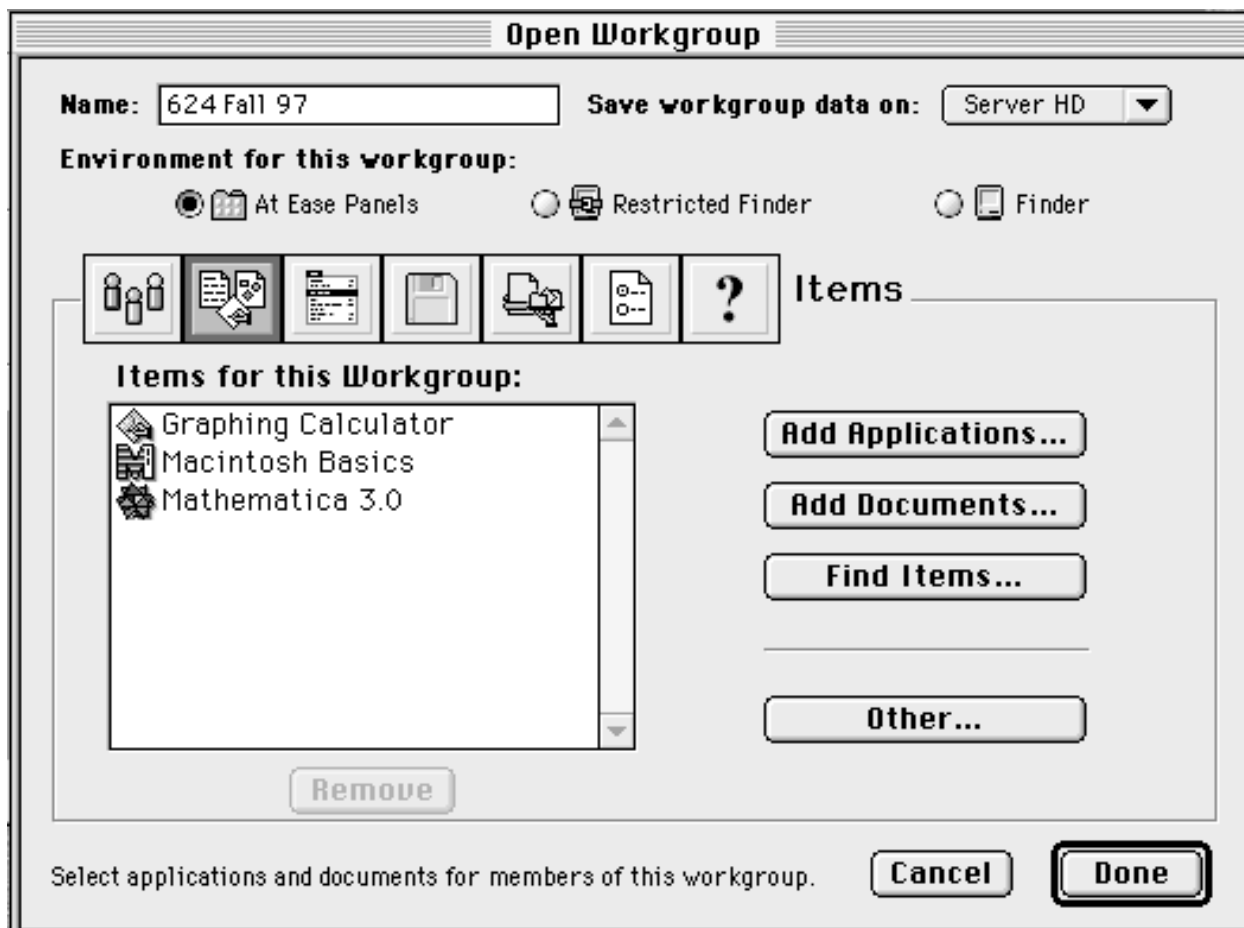
GROSSMAN	SARAH	063-89-9881	◇	D 1 6 130	◇	04/15/1997	D8ARE
OSTROWSKY	ANDREW	130-67-5195	◇	D 1 8 034	◇	04/15/1997	AF7RE
LEWIS	JOSHUA	131-86-3459	◇	E 1 7 100	074◇	04/18/1997	S05RE
SANCHEZVILARO	CARLOS	138-45-2840	◇	D 1 7 130	◇	04/28/1997	S05RE
HOQUE	HASSAN	075-32-6672	◇	D 1 7 074	◇	05/05/1997	S36RE

When imported into the database Panorama, the student list is easily converted via macros to a tab delimited file. The following is a sample from the same course, now it is in alphabetical by first name.

624Andrew	130	624 Fall 97
624Carlos	138	624 Fall 97
624Christop	112	624 Fall 97
624David	059	624 Fall 97
624Godfrey	134	624 Fall 97

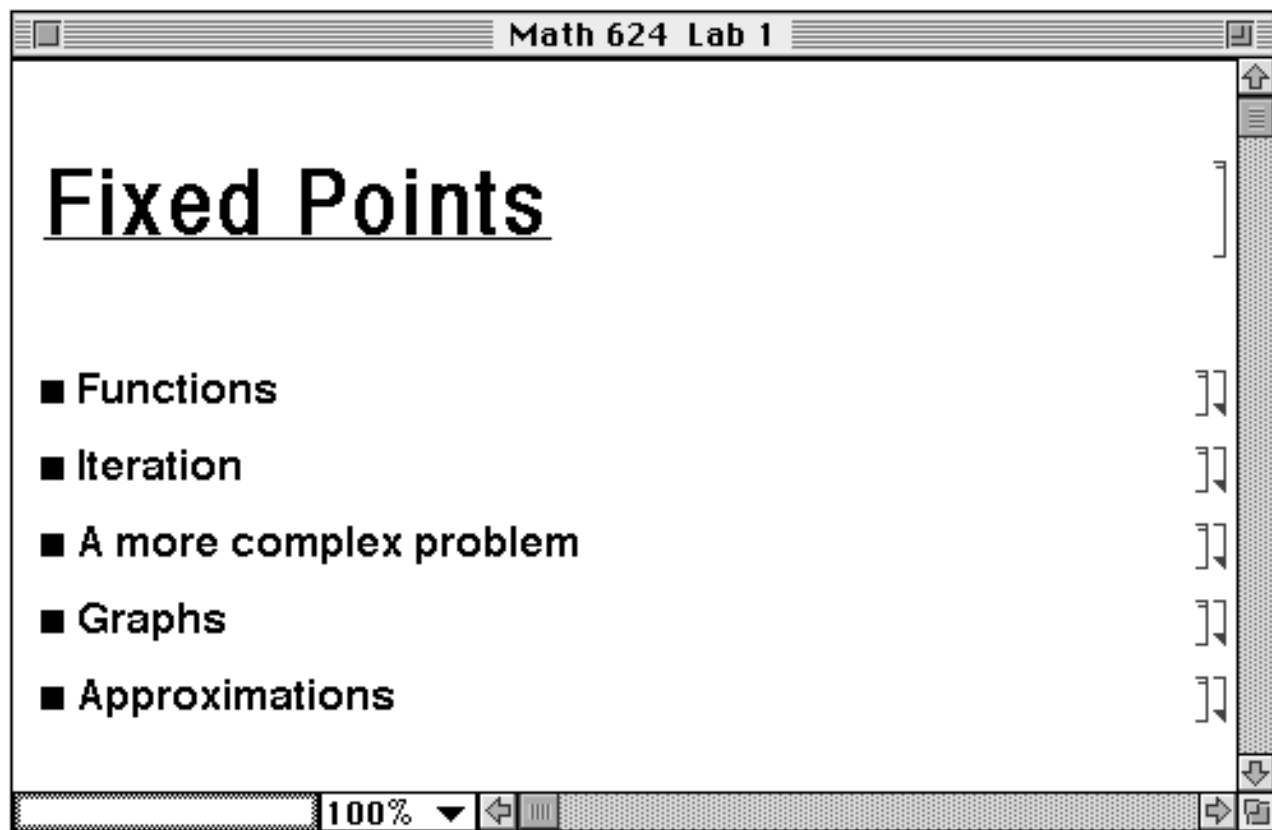
The first column contains the user name, second the password taken from the student ID number, and third is the name of the workgroup the students will be placed in. At Ease imports this list and the class is set up. At the end of the term, all of the student members of the workgroup can be deleted using a single menu command.

The next page shows two At Ease windows. The first is the setup of the workgroup with the applications available to the students. The second shows the students entered in as users. They were placed in the workgroup “624 Fall 97” in the same operation.



Courses are conducted with Mathematica. This powerful program presents several challenges. It requires students to be careful with notation. Faculty often must rethink what they want to accomplish since simply solving problems with the power of Mathematica is often not instructive. I meet with an instructor before the first use of the computers, often several times. Points discussed include: student preparedness, time spent in a non-traditional setting, the level of the first session, exploration verses simple solving of problems.

The following shows a Mathematica notebook with five sections. This is used in the first meeting of our senior level numerical analysis course, Math 624.



The next page contains a screen dump of the beginning of the first section on functions. It is designed for students with no computer experience. This means that it must attempt to catch common errors which produce erroneous results that students often overlook at first.

We have established a newsletter to report on activities in the laboratory. The first page of the first issue of this newsletter follows the Mathematica notebook illustration.

## ■ Functions

Suppose you want Mathematica to evaluate the cosine function at various points. Mathematica uses `Cos` to denote this function, not `cos`. Mathematica is case sensitive and treats `cos` as a simple sequence of letters. We will use the following cell to define `f` as the cosine function. { Notice the use of **square brackets**, the **underscore** and **colon**. }

```
f[x_]:=Cos[x]
```

Tell Mathematica about this function by **evaluating** the above line. Do this by moving the cursor until it is an “I-beam” in the line, click the mouse button so a flashing vertical line appears somewhere in the line and then press the enter key { **not return**. }

What happened? The bracket to the right of the cell was outlined briefly while Mathematica built the function and the notation “*In[1]*” was placed before the line to indicate that it is the first input for this session. However, Mathematica does not display the function as an output.

Just to check that Mathematica really knows what `f[x]` means evaluate the next line.

```
f[x]
```

Did you get `Cos[x]`? If so, then you can use `f` to compute the cosine of an angle. Move the cursor just below this cell, defined by the bracket at the right, when it turns into a horizontal I-beam, click the mouse and a horizontal line will appear. Type `f[2]` and press enter. `f[2]` should appear in a new cell in magenta type and the result should appear in blue type.

Mathematica has given the exact value, `cos 2`. To obtain an approximation of this number use the function `N`. Try `N[f[2]]`.

Now try `N[f[2],10]`. Is it clear what is happening?

Mathematica will tell you about any of its functions if you use a question mark. Try typing `?N` and pressing enter in a cell you make just below this one.

This shows that the function `N` can be used in two ways. It also suggests that `f` is not the function we want.

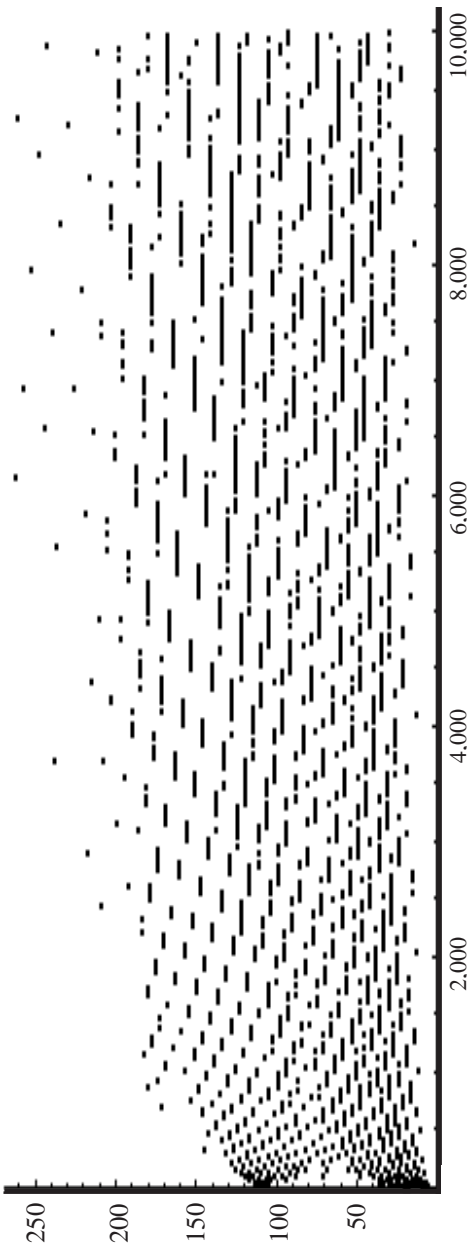
Define a function `g(x)` which gives an approximate value of the cosine of `x` below and check to see if `g(2)` is the same as the value obtained above.

If you didn't get `-0.416147`, check to see if you have used the proper format. You can check to see what Mathematica thinks `g[x]` is. If Mathematica prints `g[x]` in the Out line, then you have not defined `g` as a function. { Neither `F(x_)` nor `F[x]` can be used to define a function `F`. }

# EXPLORATIONS

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Spring 1997



A distribution obtained in exploring the  $3x + 1$  problem.  
[See Bob Cowen's article.]

## The Dorance Blanche Weill Advanced Mathematics Computer Laboratory Now in Full Operation

Larry Mansfield

Spring 1997 saw the department's computer lab approach its full potential. Marty Hoffman maintained a regular schedule of hours in the lab and two students, Thomas Lam and George Xenakis, covered a few evening hours each week. Three classes met regularly in the lab: Eugene Don's *Mathematical Applications of Computer Programming*, Bob Cowen's *Mathematics from an Algorithmic Standpoint*, and Yungping Jiang's *Numerical Analysis II*. Two other classes usually met in a classroom but used the lab for special assignments: Ken Swick's *Differential Equations with Numerical Methods* and Ken Kramer's *Theory of Numbers*. In addition, Bob Cowen conducted a weekly faculty course on the use of *Mathematica*. (See Bob's article elsewhere.) Every department member has an account in the lab which can be easily accessed from the lab or from one of the computers located in Kiely 507.

The lab actually began operation last spring with two classes. The printers arrived during the term but the software for management proved inadequate. By the time this term began, Apple's networking software was in place. The *Network Assistant* program allows an instructor to project any

student's screen for all to see with a simple click of the mouse. It can also blank out all screens when the students' attention might be distracted by the computer. The accompanying program, *At Ease*, provides a simple interface for the students. They see only the applications necessary for the class. Files they create are stored on the server so that students do not need to sit at the same computer in each class session.

When classes begin in the fall, we should have at least two new computers in place. These will go on the tables at the back of the lab and will be set up with group work in mind.

*Mathematica* provides a rich environment for experimentation and exploration in mathematics. With all the routine calculations immediately available, students can be asked many new challenging questions. *Mathematica* contains powerful graphic and symbolic capabilities. The lab presents a challenge to instructors to design course components that take advantage of this new dimension. As you plan your advanced courses, think about how these new capabilities might be employed and consider bringing your class to the lab.

The Dorance Blanche Weill Advanced Mathematics Computer Laboratory  
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