Curriculum Development Grant
B424 Parallel and Distributed Programming
Final Report

1. Description of grant-supported activity

The grant has supported the activity the preparation of the new course B424 Parallel and Distributed Programming. The course has been offered for the first time in the department in fall 2002 and has been elective course for both the computer science major students and for the students enrolled in the Master of Science program in Applied Mathematics and Computer Science.

During the preparation of the course I have focused on the preparation of the following course materials:

- the syllabus,
- slides to be used in class and matching handouts for the students,
- a collection of programs to be used as examples for the general models presented in class,
- a web page that makes the information about the course available to the students at all times.

Syllabus
The syllabus has been prepared based on the textbook *Parallel Programming* by B. Wilkinson and M. Allen (1999), as well as on several other books on the subject. I have written the first draft of the syllabus during the summer 2002 and decided on the general structure and main topics to be covered by the course. Although the original syllabus contained more material than what could be covered in a semester, the course has followed it in most part. I have also added one or two items during the semester and modified the order a little bit. I am attaching a copy of the final syllabus to this report.

Slides and handouts
I have prepared an important part of the MS PowerPoint slides to be used in class and handouts to be provided for the students. I have continued to enhance and elaborate the handouts throughout the semester, and the part I have prepared during the semester was very helpful. I have received very positive feedback from the students about the handouts and one student in particular made the remark that I have covered the material better than the 5 books that he has read on the subject.

The handouts have been develop up to 42 pages long and they are also available on the web page. Given my disappointment with the textbook that was also expressed by some of the students, and the fact that even the good books that I have read only cover part of the material that I have included in the course, I am seriously considering writing my own textbook.
Programs written and tested
I have used two libraries for the programming examples and exercises, MPI (Message Passing Interface) and Pthreads (Posix Threads). Each of them represents a different paradigm in parallel computing, which are distributed and shared memory respectively. During the Summer 2002 I have tested both libraries on various platforms, which are my own workstation that has 2 processes, the computers in our laboratories which allow the programs to run on only one CPU, and our Beowulf cluster.

I have prepared 8 different programs using the MPI library, and 3 programs using the Pthreads library. I have considered this part of the course to be very important because the actual programming experience is what gives the students the expertise in the field and the necessary skills to put it in practice later. Thus, working on the programs has taken a big part of my time during the preparation of the course.

Web page
I have also designed the web page associated with the course and provided some essential information about the course using it. The location of the web page is http://www.cs.iusb.edu/~danav/teach/b424dv.html

I have chosen to place the latest version of the handouts on this web page, with any modifications I may have done in class, as well as copies of the programs that I have used as examples. The web page also contains links to useful information on the subject that can be found online and a list of related books available at the Schurz library. I have chosen to post the homework assignments for the students also on the web page.

2. Were you able to complete the project? Describe any difficulty you had.
I was able to successfully complete the project, in the sense that all of the materials were ready in time for class, the programs have been correctly running on the platforms used with the students, and the course in general has been a positive experience.

Among the challenges I could cite the fact that the various platforms did not run the same version of Linux which means that there were small differences between the behavior of the programs on each of them. Some difficulties have been noticed in particular with the Beowulf cluster which is not yet networked, which made the transfer of files with the usual accounts harder. Another challenge was that none of the books contained all of the subjects that I intended to present and I had to use several books and online sources.

3. Did, or will, the project result in a specific product -- a manuscript, composition, syllabus, etc? If so, please describe and indicate state of development.
I am considering developing the collection of handouts that I have provided for the students into a book, which could be another project for summer 2003. The manuscript is currently 42 pages long and needs more elaboration before it can be published as a book.

4. Attached documents: syllabus of the course.
B424 Parallel and Distributed Programming
Syllabus

1. Introduction: 1-2 weeks
   1.1 Classification of parallel computers
   1.2 Sharing resources, synchronization
   1.3 Master-slave model
   1.4 Deadlocks, debugging
   1.5 Evaluating parallel programs

2. Distributed memory models: 9-10 weeks
   2.1 Introduction to MPI
   2.2 Divide and conquer
      • Linear algorithms
      • Communication models
      • Sorting algorithms
      • Computing with possible interruption
   2.3 Pipeline models, interactive peers
   2.4 Operating systems simulations
      • Bag of tasks
      • Client-server
      • Producers and consumers

3. Shared memory models: 2-3 weeks
   3.1 Introduction to pthreads
   3.2 Critical region, semaphores, condition variables
   3.3 Examples of algorithms:
      • Producers and consumers
      • Readers and writers
      • The dining philosophers

Documentation
P. S. Pacheco (1997): Parallel programming with MPI, Morgan Kaufmann.

Web page