THE UNIVERSITY OF BRITISH COLUMBIA

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Sun Microsystems, Inc.
Academic Equipment Grant Proposal

Re: Living Mathematics Project

OVERVIEW: The goal of the Living Mathematics project is to construct a new medium for the communication of Mathematics.

We seek to apply the power of JAVA and and the technology of the world wide web to provide a comprehensive, evolving, easily accessible, highly stimulating and useful collection of tools and resources for teaching, learning, promoting, and doing mathematics with computers. Examples of such resources would include on-line interactive courses and modules, re-usable software components, class libraries, research and computational tools, etc.

The target user group would be mathematicians, scientists, educators (mostly secondary and post-secondary), and students of the mathematical sciences.

In the immediate future, about half a dozen faculty and about four graduate students are working on projects related to our proposal.

A Web site, FTP server, and electronic mailing lists will be available within two months of receipt of the necessary hardware. This will coincide with the first issue of a planned electronic quarterly magazine.

PROJECT DESCRIPTION: The project will consist of several components.

1) A carefully selected and maintained archive of the best WWW, JAVA, and network-computing based tools and resources for teaching, learning, communicating, and doing mathematics with computers. These tools will be freely available to the mathematics and education communities via the Internet. Much of our material will be directly usable in the classroom and lab.

A core goal is to build a collection of resources to enable a number of JAVA-powered interactive hypertexts and "labs" illuminating the core areas of the undergraduate mathematics curriculum. These will be supported by, and contribute to, the development of general tools and resources for presenting visual interactive mathematics.

We have just completed an academic year in which two such courses were offered: An introduction to differential equations for engineering students (UBC Mathematics 256), and an introduction to linear algebra (UBC Mathematics 152). Our experience with these courses over the past term is driving substantial refinements and improvements, and contributing to the

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design and development of materials for introductory courses in differential/integral calculus (UBC Mathematics 100/101) to be offered in Fall 1997/Spring 1998. The current versions of these courses may be found at

* **http://gamba.ugrad.math.ubc.ca/coursedoc/math256/**
* **http://gamba.ugrad.math.ubc.ca/ math152/**
* **http://www.math.ubc.ca/~feldman/java.html**

2) To facilitate the organization and promotion of the archive in component (1), much of the content will be introduced via our second component: A Web-based quarterly electronic magazine communicating developments in such areas as JAVA-based interactive tools for presenting or doing mathematics, Web-based interactive mathematics or science courses, excerpts from interactive technical JAVA-based hypertexts, and authoring tools and materials for such courses and texts. This magazine would also present exemplary class libraries, JAVA beans, source code, and columns featuring student projects (high school and post-secondary).

3) Eventually, we would like to offer workshops for (secondary and post-secondary) educators, designed to give participants skills and knowledge needed to incorporate the resources we are developing and coordinating into their classrooms and labs. The products of their development work would be featured in our Web magazine and made widely available via our archives. In a similar vein, we would promote exemplary student projects, by secondary and post-secondary students, which employ resources and tools from our archive.

4) Support of electronic mailing lists to enable easy exchange of information and ideas about the above among users of the resources.

BENEFITS. Effective communication of mathematics has been notoriously difficult. This is due partly to the nature of the subject, but no doubt results also from the shortcomings of traditional media used to communicate the subject. Since the adoption of the printed page, mathematics has been constrained to represent dynamic, multi-layered, multi-dimensional objects and images in a static, linear, two-dimensional medium. Learning mathematics requires an exceptional ability to visualize, to imagine, and to work with abstractions.

Professional mathematicians have already reaped benefits from the coupling of mathematics and computation — tools such as symbolic algebra systems, efficient and easily accessible numerical computation, and visualization software have led to powerful insights which have changed our understanding of mathematics and of the world.

With the advent of the world-wide web, and especially with the introduction of interactive web-objects via JAVA applets, it is finally possible to represent many mathematical objects dynamically, interactively, and multi-dimensionally. This brings the realm of mathematics closer to the world of concrete experience. The challenge we are addressing is to harness this technology to lower the barriers to "thinking mathematically", at every level.

We anticipate that such developments would make the learning of mathematics easier and less frustrating, hence more enjoyable. The most important benefit would be a more mathematically sophisticated, competent, and confident society.

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Our current JAVA-based classroom demos and labs have already proven to be successful in two courses, and we feel that there are many other departments which could benefit immediately by adopting these tools.

CHOICE OF SUN MICROSYSTEMS AS PREFERRED COMPUTING PLATFORM: Sun was chosen as a preferred operating platform because of its leadership in JAVA. In addition, our department already has an existing base of Sun equipment.

FUTURE DIRECTIONS. There are many possibilities for future development. We list a few.

(*) An infrastructure, consisting of software and Internet-based rendevouz services, to permit collaborative computation within a distributed object framework.

(*) We hope to explore the possibility of obtaining funding from the British Columbia Ministry for Education, Skills, and Training, for the Secondary Education teachers workshops planned in component (3) of this proposal.

(*) Joint projects with PIms (**`http://www.pims.math.ca`**): The Pacific Institute for the mathematical sciences, of which our department is a founding member, is a consortium of five Canadian Universities, dedicated to promoting research activities, exploring the connections between mathematical ideas and their applications, developing links between mathematicians and the private sector, and promoting and communicating mathematical ideas to schools and the public.

(*) In connection with PIms, we would like to enter into agreements with other producers of Internet resources for Mathematicians, such as the American Mathematical Society E-math services, various electronic journals, etc., to mirror their services. This would make our site a natural place for working mathematicians to visit frequently.

EQUIPMENT AND SOFTWARE REQUESTED: We would like to request the following equipment from Sun:

An Internet/JAVA server with ATM network hardware; a Sparc Storage Array; Backup Tape drive. This configuration would be used as a WWW, FTP, and mailing-list server, and also as a boot-server for the Java Terminals.

Two UltraSparc workstations for software and courseware development. These machines would be used by the development team (approximately 10 individuals) to develop JAVA software, WWW pages, and other components of interactive Web-based courses, to layout and produce the WWW magazine.

Ten JAVA terminals for deployment of applications to student labs;

JAVA Workshop development software; Adobe Photoshop/Illustrator software.

Sincerely

Djun M. Kim,
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