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## DOC 2003-05 The University of Dayton Proposal for New Graduate Degree Program M.S. in Financial Mathematics Program Development Plan

University of Dayton. Academic Policies Committee

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**PROPOSAL TO THE ACADEMIC SENATE**

**TITLE:** The University of Dayton Proposal for New Graduate Degree Program Professional M.S. in Financial Mathematics Program Development Plan

**SUBMITTED BY:** Academic Policies

**DATE:** September 12, 2003

**ACTION:** Legislative

**REFERENCE:**

**DESIGNATION, RATIONALE, AND STATEMENT OF PURPOSE:**

The University of Dayton, with guidance and support from the Council of Graduate Schools (CGS)/Sloan Professional Science Master's Initiative, proposes a new professional masters degree program in *Financial Mathematics*. The application of sophisticated financial mathematical tools in finance is fairly recent. Graduate programs in financial mathematics, computational finance, or financial engineering are quite recent. These programs focus in an interdisciplinary way on both statistical and computational methods in financial mathematics. These programs have first been developed at major universities in the major financial districts of New York or Chicago. There is currently a growing regional demand for the application of sophisticated financial mathematical tools in finance. The purpose of the program we propose is to address the growing regional needs for applications of financial mathematics in the banking, insurance, and financial trading industries.

There is opportunity to develop a special educational niche with a select graduate program that utilizes strengths from the Departments of Mathematics and Computer Science, and from the Schools of Business Administration and Engineering. An Alfred P. Sloan Foundation Initiative challenges the academic sciences to develop professional masters degree programs in the sciences and mathematics "that equip people for work outside academia." The University of Dayton answers that challenge with the proposed professional M.S. program in *Financial Mathematics*. The program will deliver two outcomes: (1) students will obtain technical expertise with respect to the methods in financial mathematics, and (2) students will be exposed to professional concepts in business management. The University of Dayton applied through the Council of Graduate Schools to the Sloan Foundation and won an initial grant to perform a feasibility study. The University then followed the feasibility study with a second round proposal to develop a program. The Sloan Foundation supported both the first and second proposals with startup funds for two years.

**PROPOSED CURRICULUM**Admission Requirements

- Completion of a graduate application for admission to a graduate program at the University of Dayton;
- Bachelor's degree in a technical area such as mathematics, physics, computer science, engineering, economics, or finance, and at least a 3.0 GPA on a 4.0 scale;
- Prerequisite mathematics coursework in calculus, differential equations, linear algebra and statistics;
- Programming skills.

Program Requirements

- basic knowledge in methods of applied mathematics or successful completion of introductory course (MTH 511) in methods of applied mathematics;
- basic knowledge in methods of finance or successful completion of MBA 620;
- successful completion of 18 credit hours (6 courses) of required course work at the graduate level;
- successful completion of 9 credit hours (3 courses) of elective course work (does not include MTH 511 or MBA 620) at the graduate level;
- three credit hours devoted to a capstone project requirement in the Mathematics Clinic (MTH 541);
- completion of 5 weekend workshops in topics essential to successful performance in the corporate world. This requirement is referred to as a Business Survival Kit.

Business Survival Kit The Business Survival Kit is an initiative with a decidedly professional focus. It provides an explicit professional

component to the proposed financial mathematics program. To satisfy this requirement, the student will participate in a sequence of 5 weekend workshops. Each workshop addresses topics designed to prepare the student to interact successfully in the corporate or industrial environment. Sample topics include: Writing for Clarity, Group Communication, Business Ethics, Legal Environment of Business, Marketing Management, Operational Management, Investment and Financial Markets, Managerial Accounting, Fundamentals of Economics.

### Table of Courses

<b>Introductory Courses</b>	<b>Elective Courses</b>
Advanced Mathematical Analysis, MTH 511 (3 credit hours) Financial Analysis and Markets, MBA 620 (3 credit hours)	Regression Analysis, MTH 543 (3 credit hours) Partial Differential Equations, MTH 535 (3 credit hours) Ordinary Differential Equations, MTH 531 (3 credit hours) Statistics for Experimenters, MTH 547 (3 credit hours) Methods of Mathematical Physics, MTH 551 (3 credit hours) Methods of Applied Mathematics, MTH 552 (3 credit hours) Linear Algebra, MTH 565 (3 credit hours) Continuous and Discrete Fourier Analysis, MTH 583 (3 credit hours) Difference Equations, MTH 532 (3 credit hours) Deterministic Operations Research, ENM 521 (3 credit hours) Probabilistic Operations Research, ENM 522 (3 credit hours) Data Base Management, CPS 542 (3 credit hours) Investments and Financial Markets, MBA 625
<b>Required Courses</b>	
Introduction to Financial Mathematics, MTH 538 (3 credit hours) Numerical Analysis I, MTH 555 (3 credit hours) Numerical Analysis II, MTH 556 (3 credit hours) Time Series, MTH 544 (3 credit hours) Financial Derivatives and Risk Management, FIN 580 (3 credit hours) Computational Finance and Data Mining, FIN 581 (3 credit hours)	
<b>Mathematics Clinic</b>	
Mathematics Clinic (MTH 541) is the capstone team-oriented project requirement of the program.	

5 Year B.S. + M.S. Program The program focuses on statistical, computational, and analytical methods. The program is designed so that it can be completed in twelve months by students who have good backgrounds in mathematics and some background in economics and finance. In particular, the program will be a viable five year program beyond high school for students with high academic profiles.

Distance Delivery of Select Courses We shall establish internships in the banking, insurance, and financial trading industries to support students seeking a two year program. Distance learning capabilities will be developed to support students seeking internships. These students will be able to take courses by distance delivery.

Post-Baccalaureate Certificate Programs Three Post-Baccalaureate certificate programs in **Computational Finance**, **Financial Statistics**, and **Financial Risk Management** are available for students who do not want to commit to the full M.S. program. Students seeking admission to the Certificate Programs will be required to have at least a 3.00 G.P.A. and appropriate transcripts validating completion of an undergraduate degree. Upon successful completion of five courses focused on a specific set of financial mathematics concepts, and upon successful completion of the Business Survival Kit **or** MTH 541 (team-oriented project requirement), a student will earn a Certificate in that specific area. Successful completion requires that a student have a minimum GPA of 3.0 in the five specified courses. The three Certificate programs and the associated required courses in each certificate are:

<u>Certificate in Computational Finance</u>	<u>Certificate in Statistical Finance</u>	<u>Certificate in Financial Risk Management</u>
Data Base Management, CPS 542 Intro to Financial Mathematics, MTH 538 Numerical Analysis I, MTH 555 Numerical Analysis II, MTH 556 Comp. Finance & Data Mining, FIN 581 Business Survival Kit <b>or</b> Math Clinic	Probabilistic Operations Research, ENM 522 Intro to Financial Mathematics, MTH 538 Regression Analysis, MTH 543 Time Series, MTH 544 Computational Finance & Data Mining, FIN 581 Business Survival Kit <b>or</b> Math Clinic	Investments & Financial Markets, MBA 625 Intro to Financial Mathematics, MTH 538 Partial Differential Equations, MTH 535 Financial Derivatives & Risk Management, FIN580 Comp. Finance & Data Mining, FIN 581 Business Survival Kit <b>or</b> Math Clinic, MTH 541

### **ADMINISTRATIVE ARRANGEMENTS**

The program will be co-directed through the Department of Mathematics. Dr. Paul W. Eloë, Chair of the Department of Mathematics, and Dr. Muhammad N. Islam, Program Director of the M.S. program in Applied Mathematics, will serve as co-directors of the proposed program.

Advisory Board The program has an Advisory Board of eight members from academics and the banking, insurance, and financial trading industries. The members of the Board from the corporate sector provide the real world professional perspectives that are so critical to the success of the program. Dr. Carl Chen, William J. Hoben Professor of Finance, serves on the Advisory Board of the proposed program.

### **EVIDENCE OF NEED**

To assess the demand for the proposed program, we first considered the need from the perspective of **Local/regional**

**employers.** We developed and employed a multifaceted strategy to contact local and regional employers. We have worked with alumni, personal contacts, Career Placement Office, Dayton Area Chamber of Commerce, MBA program, and the Corporate Relations Office at the University. In addition, we retained the services (with funds made available by the Sloan Foundation) of the Center of Business and Economic Research (CBER) at the University of Dayton to initiate contact with regional corporations. We made cold calls from the department to assess the need for the proposed program. As a result, we made contacts with the banking industry, the insurance industry, especially in the area of asset liability management, and the financial trading industry. We have assessed that these three industries represent potential employers; moreover, large corporations with large assets for investment are also potential employers. The post-baccalaureate Certificate Programs developed through our discussions with these potential employers. The five members of the Advisory Board from the corporate sector surfaced through these discussions.

Professional M.S. programs in computational finance are quite recent. Kent State University, in Northeast Ohio, admitted students to an M.S. program in financial engineering for the first time in August 2002. We assess that no other similar program currently exists in the State of Ohio. Ohio State offers an Actuarial Science program; however, the graduate level finance program at Ohio State is strictly academic. The University of Cincinnati has a computational finance component in its applied mathematics graduate program. This program too is academic and theory based. In our feasibility study, we did not find any MBA programs in the area with a concentration in computational finance.

Second, we considered the demand/interest from the perspective of the **Student**. Through the program feasibility assessment, we developed an understanding of the type of student we can recruit. The assessment was based on results from a survey distributed to: undergraduate classes in mathematics, computer science, and finance; graduate classes in mathematics, computer science, engineering; classes in the MBA program; regional and international students via a web page; and current professionals via members of the Advisory Board.

We project there will be a demand by three types of full-time students:

- full-time students on assistantships or internships seeking a two-year program;
- full-time students seeking a twelve-month program (and in particular, students seeking a five-year program beyond high school);
- full-time international students seeking a twelve-month program.

We project there will be a demand by three types of part-time students:

- local professionals seeking the entire M.S. degree program;
- local professionals seeking one or more of the Certificate programs;
- graduate students already enrolled at the University of Dayton who intend to maximize the benefits of graduate study with a Certificate in one or more of the above named areas.

## **PROSPECTIVE ENROLLMENT**

The program, initially, is envisioned as small and selective. We project that we will initially admit three or four full-time students and three part-time students. At the end of five years, we project an enrollment of **7** full-time students and **10** part-time students. The number of students in the Certificate programs will be in addition to those in the degree program.

## **RECRUITING MINORITY STUDENTS**

We will develop an aggressive recruiting strategy for full-time minority students. We will make every effort to recruit, enroll, retain, and graduate minority students in the program. The Graduate School has consistently supported minority students in graduate programs with stipends and tuition remission. It will actively support minority students in this proposed program. We will work closely with Central State University and Wilberforce University, two HBCU's in this region. We will also begin with personal contacts in Departments of Mathematics at Morehouse College, Spelman College and Tougaloo College and develop regional and nationwide marketing plans for minority students. We believe we can market effectively based on our continuing consultation with prospective employers and the indication that graduates will have career opportunities in the banking, insurance, and financial trading industries.

## **PROGRAM FACULTY**

The program faculty are from the Departments of Mathematics, Economics & Finance, Computer Science, and Engineering Management & Systems.

Dr. James Buckley (CPS), data structures and data mining

Dr. Carl Chen (FIN), mutual fund performance, asset pricing anomalies, corporate governance

Dr. Wiebke Diestelkamp (MTH), statistician

Dr. Stephanie Edwards (MTH), applied mathematician, complex analyst

Dr. Paul Eloie (MTH), applied mathematician, functional differential equations

Dr. Peter Hovey (MTH), statistician

Dr. Muhammad Islam (MTH), applied mathematician, transform methods  
 Dr. John Kauflin (MTH), applied mathematician, partial differential equations  
 Dr. Peter Lung (FIN), financial risk management and derivatives  
 Dr. Edward Mykytka (ENM), stochastic optimization methods  
 Dr. Youssef Raffoul (MTH), applied mathematician, functional differential equations  
 Mr. Gerry Shaughnessy (MTH), statistician  
 Dr. Qin Sheng (MTH), computational partial differential equations  
 Dr. Nicholas Tay (FIN), financial risk management and derivatives

### NEED FOR ADDITIONAL STAFF

No additional faculty from the Departments of **Mathematics**, **Computer Science**, or **Engineering Management & Systems** are needed for this program. We will need two additional courses, one course per term, to be delivered by the **Department of Economics & Finance**. We will work with the Department to develop such courses. If faculty for these courses are not immediately available, we will use an adjunct faculty member with expertise in finance to cover these courses. We have researched and determine that adjunct faculty with expertise in finance is available in Dayton. Dr. Carl Chen, William J. Hoben Professor of Finance, enthusiastically endorses the development of the program. He serves on the Advisory Board of the program and he will play a leading role as we develop the long-term solution for expertise in finance. There are no additional needs to deliver the **Business Survival Kit**. Professionals and experts will be retained to direct workshops. Students will pay a registration fee to participate and that fee will be used to compensate the workshop director.

### COST

The Department of Mathematics will seek new resources to implement a professional M.S. program in *Financial Mathematics*. The resources we seek include adjunct faculty in the Department of Mathematics, adjunct faculty with expertise in economics and finance, marketing support (CGS/Sloan startup funds), marketing consultation (CGS/Sloan startup funds), long distance learning development (CGS/Sloan startup funds), and minimal student staffing support (CGS/Sloan startup funds).

CGS/Sloan Startup Funds We have obtained \$47,965 in startup funds that we will use over a two year period.

Internal Funding Support The University including the Office of the Provost, the College of Arts & Sciences, and the Graduate School have committed specific funds to supplement the CGS/Sloan funding for the program.

Marketing Costs Funds from the Sloan Foundation will be used to offset all one-time costs, and initially, support continuing costs in marketing support and marketing consultation. Tuition revenue will be targeted to cover continuing costs related to marketing materials.

Distance Delivery of Select Courses Funds from the Sloan Foundation will be used to offset all one time costs related to developing select courses to be offered by distance delivery. We plan to begin developing these courses this summer.

Curriculum Development Costs Five new courses will be developed. The cost of curriculum development will be absorbed by the Department of Mathematics (College of Arts & Sciences), and the Department of Economics & Finance (School of Business Administration).

Co-Directors for the Proposed Program The program will be co-directed by the Chair of the Department of Mathematics and the Graduate Program Director of the Department of Mathematics. The co-directors will operate in consultation with the program Board of Advisors. Costs will be absorbed by the Department of Mathematics (College of Arts & Sciences).

Assistantships We currently have 5 ½ assistantships for the M.S. in Applied Mathematics program. We propose to use 1 ½ of these assistantships for the new program; that is we will use 4 assistantships for the M.S. program in Applied Mathematics and 1 ½ assistantships for the MS program in Financial Mathematics. During the first year, we have a new ½ assistantship from the College of Arts & Sciences; that is during the first year we will use 4 assistantships for the M.S. program in Applied Mathematics and 2 assistantships for the M.S. program in Financial Mathematics. Beginning with the third year, we have 1 more new full assistantship from the College of Arts & Sciences; that is we will use 4 assistantships for the M.S. program in Applied Mathematics and 3 assistantships for the M.S. program in Financial Mathematics.

External Support With guidance from the Co-Directors, the Board of Advisors, the Graduate School and Corporate Relations, we will continually seek outside support. Opportunities include internships and student support opportunities, such as group project ideas and resources, from local and regional corporations. We will actively pursue grant writing opportunities through federal or private funding agencies. In recent years, the State of Ohio has initiated funding opportunities with the motivation to support the economic environment in Ohio. We anticipate that the program will promote the economic environment in Ohio and hence, we will actively seek grant writing opportunities through state agencies.

Tuition Revenue The program will generate tuition revenue due to part-time students and full-time students pursuing a twelve-month program. A realistic projection is that tuition revenue alone will offset the cost of the program by the fourth year.

## **ADVISORY BOARD**

The Advisory Board of the professional Master of Science program in *Financial Mathematics* serves multiple purposes in the development and maintenance of the new degree program at the University of Dayton. The Board members have served as advisors as we have constructed the curriculum for the new program, providing advice about the proposed program's academic credibility, current pertinence to the financial industry, pertinence to local or regional needs in the financial industry, and relation to mission and vision of the University of Dayton. The Advisory Board members are:

Mr. Thomas Britt, Asset Liability Management, Nationwide Insurance, Columbus, Ohio

Carl Chen, Ph.D., William J. Hoben Professor of Finance, University of Dayton

Paul W. Eloë, Ph.D., Chair, Department of Mathematics, University of Dayton, ex officio

Mr. Jon Gorney, Chief Financial Officer, National City Bank, Louisville, Kentucky

Mr. George Hanley, Chairman, Infinium Capital Management, Chicago, Illinois

F. E. James, Jr., Ph.D., President, James Investment Research, Inc.

Katy E. Marre, Ph.D., Associate Vice President for Graduate Studies And

Research, Graduate School, University of Dayton

Mr. Frank Petrie, Chief Financial Officer, Fifth Third Bank, Dayton, Ohio