

A Well-Kept Secret: The Kettering University Experience

By *Brian J. McCartin, Joseph J. Salacuse, and David Green, Jr.*

In January 1998, the GMI Engineering & Management Institute, in Flint, Michigan, an institute with a long history in applied mathematics, became Kettering University. Despite its traditional strengths in applied mathematics and in cooperative education, the university's educational offerings remain little known in the industrial and applied mathematics community at large. At both national and international conferences, Kettering faculty members frequently find themselves answering questions like these: What is Kettering? Does it have a program in applied mathematics?

People are often surprised to learn that the Kettering program is fully cooperative: Each student must have a co-op job throughout his or her undergraduate career. The co-op program includes 550 different companies (80 of which are Fortune 500 companies) in 42 states and six foreign countries.

Origins in Local Industry

In 1919, Major Albert Sobey, an engineer with the Army's Military Intelligence Division assigned to the National Bureau of Standards, was recruited by the Industrial Fellowship League of Flint to fill the post of educational director. On his arrival in Flint, Sobey created a night school at which employees of local industries could enhance their career opportunities by increasing their knowledge and skill levels. By 1924, more than 600 workers had enrolled in the school, and four-year cooperative programs in engineering and management were created to meet this increased demand.

Two years later, the General Motors Corporation agreed to underwrite the school and to extend its services to all units of the corporation. For the next 56 years, General Motors was the sole client of the school, which became known as the General Motors Institute. In 1945, the state's Board of Regents approved the awarding of undergraduate degrees, and the program added a fifth-year thesis to its requirements. In 1982, the relationship with GM ended; the school began operating as a private independent undergraduate cooperative educational institution and later became known as the GMI Engineering & Management Institute. (See [3] for a history of the institution.)

Since the separation, approximately 550 companies at more than 750 locations have sponsored co-op students at the school, which is now known as Kettering University. Current degree programs include bachelor's degrees in applied mathematics (since 1990), applied physics, computer engineering, electrical engineering, environmental chemistry, industrial engineering, management, manufacturing systems engineering, and mechanical engineering. In addition, two master's degrees in engineering and management are offered. These programs, which were developed with guidance from the Corporate Advisory Board, now serve more than 2500 undergraduate and 500 graduate students.

Kettering continues to emerge on the international scene as a major player in co-op education. For example, the U.S. Department of Education has named Kettering the lead institution and grant recipient for a consortium of engineering colleges that will link up with similar consortia in Western Europe. (Members of some of these consortia met in Zaragoza, Spain, in March 1997 to address automotive trends in Asia, Europe, and the U.S.) Kettering students can also minor in international studies and/or register for a study term abroad.

The Academic Program

The appropriate role for applications in the undergraduate mathematics curriculum has been under discussion in the U.S. for close to 20 years [2]. The study of industrial mathematics [1, 4] is of much more recent vintage; however, much of this study has been focused on graduate curricula. A detailed look at Kettering's strictly undergraduate program in applied mathematics can contribute to these discussions.

The undergraduate programs at Kettering require five years for completion; each program consists of alternating 12-week study and work terms until the final year, which includes one study and three work terms. Each freshman class has two sections: A-section students begin their Kettering careers at school while B-section students report directly to their employers. Consequently, Kettering students do not get a summer break and roughly one-fourth of the Kettering faculty



Kettering's campus in Flint, Michigan.

Area	Credits
Applied Math Core	44
Applied Math Concentration	32
Computer Science	7
Basic Science	20
Technical Electives	16
Humanities/Social Studies	22
Communication/Management	12
Free Electives	12
Thesis	4
Total	169

Table 1. *Kettering's Applied Mathematics Program.*

have their “summer months” each term. The program in applied mathematics requires 169 credits (see Table 1). All requirements save the thesis are completed during the nine academic terms. The thesis must be work-related and is completed during the student’s last three (work) terms.

The applied mathematics core is composed of traditional course work, such as differential equations, linear algebra, probability, and numerical analysis. A student who chooses an applied mathematics major then selects a concentration in either applied and computational mathematics or applied statistics. Depending on this choice, the student completes advanced course work in applied mathematics, e.g., partial differential equations or mathematical statistics, respectively.

The culmination of this training in applied mathematics is a senior-level capstone course in mathematical modeling. The new Applied Mathematics Laboratory, which opened in July 1997, is expected to enhance the completion of this coursework.

As part of the applied mathematics concentration, a student must take several connected courses in a single application area (the applications sequence), such as fluid dynamics or industrial engineering, in addition to fulfilling the basic science requirement. This additional requirement reflects one of the cornerstones of our curricular philosophy: To be useful in an industrial setting, an applied mathematician must master at least one application area.

The learning traits acquired in the mastery of one application area are easily transferrable to other application areas that can arise in the course of an industrial career. Of course, an applied mathematics major can utilize available electives to study any area in even greater depth, which often results in the student’s minoring in that field or selecting a second applications sequence.

Many of the 17 full-time applied mathematics faculty have extensive industrial experience, and 12 are very active in research and consulting. Their areas of expertise span the full spectrum of industrial and applied mathematics: delay differential equations, dynamical systems, elastohydrodynamics, electromagnetics, graph theory, thermo-fluid dynamics, molecular dynamics, queueing theory, stochastic processes, and warranty/risk analysis. Students are sometimes involved in faculty research projects and are well qualified on graduation to proceed directly to graduate studies.

Work Experience

Co-op education is the central mission of Kettering. Students complete at least five satisfactory work terms at authorized locations. Two additional work terms are then designated for each student’s thesis project (more on this later), bringing the general minimum number of work terms to seven. However, the vast majority of students complete 11 work terms, i.e., they typically have more than 2 1/2 years of full-time work experience when they graduate! (Ideally, Kettering students remain with the same employer throughout their five-year programs—and beyond.)

The bonds that develop give both student and employer the confidence to proceed with progressively more responsible and developmental assignments. Kettering’s corporate relations staff develops and maintains relationships with employers and continuously recruits new employers who will meet the geographic needs and academic/career interests of our students. In addition, members of the applied mathematics faculty have played a very active roll in obtaining co-op positions for majors in applied mathematics. Approximately 95% of all applied mathematics majors have co-op positions when they enter their sophomore year.

Kettering students co-op at some very large, well-known organizations, such as AAA, Allstate, Blue Cross/Blue Shield, EDS, Ford, GM, and Watson Wyatt, as well as at smaller, more specialized companies, such as Cybernet Systems Corporation, Actuarial Systems Corporation, and AP Parts International. The main concern of the faculty is that each student receive a quality co-op experience with all its attendant benefits, such as a broadening of the student’s knowledge and interest in applied mathematics, enhanced career opportunities, and income that can offset the cost of a college education. Approximately 90% of Kettering graduates receive offers of full-time employment from their co-op sponsors on graduation, and Kettering students typically earn between \$35,000 and \$70,000 over the course of their cooperative work experience.

Thesis Project

The thesis project, a special requirement of each Kettering baccalaureate degree program, is intended to facilitate the student’s transition to professional status. During this capstone phase of the program, students demonstrate the ability to apply acquired technical knowledge to a major realistic problem posed by their employers. The thesis project is a final blending of the institute’s academic portion of the program with the employer’s work-experience component. The project is co-advised by an industrial adviser and a faculty adviser. Each student must identify the important parameters of the assigned problem, plan a solution strategy, conduct research, experimentation, and design, as appropriate, and prepare a major report interpreting the results, which is reviewed for approval by both advisers as a requirement for graduation.

Two Profiles

Perhaps the best way to illustrate the way the Kettering program works is to share the experiences of two recent graduates. Isaac Merchant graduated from Kettering in 1995 with a BS in applied mathematics, with a concentration in applied

statistics. As a student, Merchant became increasingly interested in statistics in general, and in the actuarial profession in particular. He subsequently obtained a co-op position at Allstate Insurance in the Chicago area. While a co-op student, he worked in a number of different areas, which gave him a broad understanding of the actuarial profession, and then allowed him to make an informed decision on pursuing a career as an actuary.

On graduation, Merchant was offered, and accepted, a job in the actuarial field with Allstate. In his own words: “Co-op experience is excellent. It is the only way of knowing if you really like your selected profession. The program at Kettering is ideal since it allows you to start as a freshman and work your way up.”

Michael Fisackerly, a 1998 graduate, majored in applied mathematics, with a concentration in applied and computational mathematics. Fisackerly enrolled at Kettering as salutatorian of Davison High School, one of Michigan’s finest secondary schools, with a GPA of 3.985 and a score of 800 on the SAT Achievement Test in mathematics. He did not slow down at all when he arrived at Kettering. He completed an application sequence in mechanical engineering, also pursued minors in both applied physics and applied optics, co-authored several papers with a faculty member, and was named a Goldwater Scholar.

Fisackerly had a co-op position with EDS in Troy, Michigan, where he worked in a variety of areas, including computer networking and remote systems management. His career goal is to go on for a PhD (at the University of Maryland) and to work in applied and computational mathematics.

Advisory Board

An essential feature of the applied mathematics program is its Industrial Advisory Board, which has been in place since the inception of the program. The board consists of nine members, each of whom either directly uses mathematics or supervises people who use mathematics in an industrial setting. The board has been extremely helpful in guiding the development of the Kettering program: Board members have suggested strategies for identifying potential corporate partners in selected application and geographical areas and have made curricular recommendations, such as the introduction of a financial application sequence that is currently under development.

David P. Mamuscia, Director in Actuary at Blue Cross and Blue Shield of Michigan, is currently advisory board chair and has long been a very strong advocate of the program. “Kettering’s program is invaluable in preparing candidates for Blue Cross and Blue Shield of Michigan’s actuarial positions,” Mamuscia says. When the co-op students have completed their Kettering degrees, they will have approximately 2 1/2 years of experience in a real job with our company. This allows us to offer employment to a tried and true employee, whom we know will be successful. Taking the guesswork out of employee selection saves us innumerable time and money in the long run. Kettering’s program is something other firms should consider.”

As the academic community struggles to find the appropriate role for industrial and applied mathematics in its undergraduate curricula, Kettering’s program might provide some insight into the range of possibilities.

References

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Brian McCartin (bmccarti@kettering.edu) is a professor of applied mathematics, Joseph Salacuse (jsalacus@kettering.edu) is a professor of mathematics and the discipline chair of applied mathematics, and David Green (dgreen@kettering.edu) is a professor of mathematics and the head of the Science and Mathematics Department at Kettering University.