Tenure Professional Summary, Fall 1999 - Summer 2004
Trinity University Mathematics
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This professional summary begins with an overview highlighting my teaching, research, and service contributions. This overview is followed by a chronological analysis that more completely discusses my educational experiences, my research pursuits, and my service to the department, the university, and my profession. I have attempted to present an honest and objective introspective of my career. Some facts about my time at Trinity are below.

- I have taught 10 different courses to 423 students. I also designed a new course in mathematical optimization.
- I received 4 teaching awards.
- I have 10 articles published or accepted for publication, (co-)authored 3 contributed works, and have 3 articles submitted.
- I won 1 international research award.
- I have published or submitted research articles with 11 undergraduates and have directed 12 undergraduate research/senior projects.
- My research received over 66 citations (including 26 self citations).
- I contributed to 7 external grant proposals of which 4 were awarded, 2 were declined, and 1 is pending.
- I gave 18 invited talks and 18 colloquia.
- I served on two university committees and serve as the vice president of the Health Applications Section of the Institute of Operations Research and Management Science.
- I refereed 21 articles and grants for 12 journals and funding sources.
- I was awarded one national service honor.

Each academic institution has its own unique character, and I have come to appreciate and understand Trinity and its students. I clearly remember my first semester when I was upset by a first-year student who told me that I graded too harshly. Later that semester a student wept in my office because she earned an A- instead of an A. I doubted my ability to reach Trinity students and considered leaving. I was fortunate to have one of the best classes I have had at Trinity in my second semester, a Calculus II class in which there was a special chemistry among the students. I'll never forget the day that I presented the traditional example of a mathematical object having finite volume and infinite surface area. One of the students mentioned that this was a perfect example of how mathematical models differ from their real-world counterparts. Another student said that peculiarities like this are what made her dislike mathematics and that "math-world was all messed up." To my surprise, several students began to argue that it was the real-world that was messed and not math-world. A good natured discussion followed, and I thought, this is why I came to Trinity. I have enjoyed teaching at Trinity ever since.

As mentioned above, I have taught 10 different courses across our mathematics curriculum, with my favorites being Calculus I, Linear Algebra, and Mathematical Modeling (my least favorite was Numerical Calculus). Students have reacted favorably to my classes, with the aggregate mean and median responses on the student questionnaires being 5.44 and 6.0, respectively. Table 1 lists the annual and cumulative responses over my probationary period. The lowest mean (5.23) and median (5) are in response to question 5, which states "I am learning a great deal in this course." Since the majority of Calculus I and several Calculus II students are repeating this material from high school, I understand why many feel like they are not learning the same amount as when the topics are first introduced. Written responses are mostly positive, although they are largely useless as directives to improve the classroom experience (the exception being MATH 2326 in the spring of 2001, which is addressed later). Many of the student comments are inspiring, which is comforting because it informs me that much of what I do in the classroom works. The most common complaint is that my courses are difficult. Challenging students is part of my job, and I believe in setting lofty goals. I do not think this is a negative comment, and as Alex Kolliopolous (a past Trinity student) once told me after I mentioned that students thought my homework was difficult, "Yes. But they'll thank you for it later." The average grade earned in my classes was 2.45 (C+). Grade trends and an overall histogram are found in Table 2 and Figure 1.

Year		Q1	Q2	Q3	Q4	Q5	Q6	Q7
1999-2000	Mean	5.28	5.09	5.65	5.29	4.95	5.08	5.2
	Median	5	5	6	6	5	5	6
2000-2001	Mean	5.58	5.17	5.64	5.41	5.3	5.27	5.57
	Median	6	5	6	6	5	5	6
2002-2003	Mean	5.53	5.38	5.6	5.46	5.18	5.37	5.55
	Median	6	6	6	6	5	6	6
2003-2004	Mean	5.75	5.63	5.87	5.6	5.44	5.53	5.7
	Median	6	6	6	6	6	6	6
Overall	Mean	5.54	5.32	5.69	5.45	5.23	5.32	5.51
	Median	6	6	6	6	5	6	6

Table 1: Annual and cumulative student responses. Highest possible score is 6.

Year	A	A-	B+	B	B-	C+	C	C-	D+	D	F	Avg. Grade
1999-2000	13	8	9	11	7	2	20	2	1	6	13	2.37
2000-2001	10	11	13	21	7	7	18	6	0	6	7	2.58
2002-2003	13	14	12	21	3	6	14	6	3	12	15	2.37
2003-2004	7	7	14	23	10	5	18	8	0	4	10	2.46
Overall	43	40	48	76	27	20	70	22	4	28	45	2.45

Table 2: Grade distribution trends.

The department reformed its entire curriculum during my first few years at Trinity. Our majors' curriculum was simultaneously simplified and strengthened. In my opinion, the two primary branches of mathematics are analysis and algebra, and students armed with these fundamentals are capable of entering the other areas of mathematics. Our majors are now required to have a course in analysis and algebra, whereas they previously needed only analysis. Moreover, students now select 6 upper divisional courses, allowing them to mold their coursework to their interests. The lower divisional courses were reformed as part of an InterMath initiative that Dr. Lawson and I directed. Working with the Department of Engineering Sciences, we reformed Calculus I-III, Differential Equations, and Advanced Calculus for Engineers (which is now a course in partial differential equations), and we introduced a new course in probability and statistics. The reordering of topics allows us to dovetail the mathematics and engineering curricula. The point of mentioning the curricular reform is that I am not only familiar with the mathematics curriculum, but that I have a vested interest in its success. I have had to think about how the mathematical curriculum affects students in and out of our discipline. The department has much to offer, and I hope the updated curriculum helps us foster a life-long appreciation of mathematics.

Each of the classes I have taught at Trinity could have been better, and I constantly experiment in the classroom. As examples, I used the Moore style of teaching in MATH 2326 (this method is described later), I designed a progressive testing method for MATH 3323, and I continue to

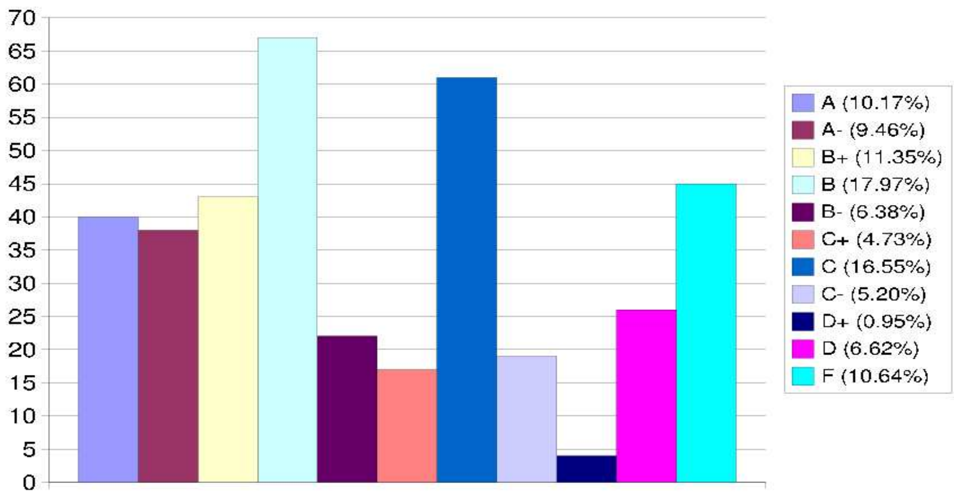

Figure 1: Cumulative grade histogram

experiment with group work. In addition to the attempt to improve the learning environment, adjusting the topics and presentations within a course helps keep the material fresh. Also, in my 3rd semester I added 'Dress-Up' days in which students received points for dressing in semi-formal attire. This allowed me to highlight the lectures where I presented the most significant results of the course. For example, The Fundamental Theorem of Calculus is highlighted in Calculus I. I wear my academic regalia for these lectures, and they have become one of my educational signatures. Lastly, I arranged for our Mathematical Modeling students to swap and review semester-long projects with graduate students in Helsinki. This exchange allowed our students to compare their work to that of foreign graduate students (our reports were better). My strongest educational quality is that I candidly and energetically express my awe of mathematics. My weakest educational characteristic is that I have little patience for lazy students. Instructing a student on the intricacies of a topic when he or she only desires an answer is frustrating. I refuse to misconstrue mathematics as a collection of solution techniques, as the discipline is far greater than a toolbox for the other sciences. I will continue to experiment with teaching methods and will strive to be more patient with lazy students.

I have worked with several students outside the classroom. As an example, I started to work with a small group of students on Friday afternoons in my second year, and while the membership has changed, the group continues today. Three of these students received National Cancer Institute Summer Undergraduate Research Fellowships (NCI-SURF grant) last summer. I have also directed several senior projects, two of which have developed into publishable papers. Maybe my single most important transformation over the last 5 years is my understanding of undergraduate research. I was educated in large state schools, and the hands-on approach of a liberal arts education was foreign to me. Initially, I naively believed that I could direct students to small projects related to my graduate work, but this thought quickly dissipated. It was not that these projects were overly difficult, but rather that the students lacked a basic understanding of mathematical optimization (my area of expertise is optimization, which resides in the larger field of Operations Research (OR)). It is true that optimization builds from the analysis and algebra that our students take, but even with this foundation they are too far from the topics of my dissertation. However, the nature of my research has changed in an attempt to include undergraduates, and I now investigate applied problems that can capture a student's interest. The idea is to 'hook' a student with an application, abstract the mathematical underpinnings, and then prove results about the real-world phenomenon with the mathematical abstraction. This research scheme works well because undergraduates see the totality of the project –i.e. they understand how the mathematical abstraction is useful. The difficulty is getting students to detach themselves from the real-world phenomena and conduct a mathematical investigation for its own sake. Students often want to isolate their questions to those that directly relate to the real-world situation, and my job is to show them that we can mathematically investigate the abstraction without the hindrance of practicality. Since it is impossible to predict the future impact of a mathematical result, limiting our investigation restricts our understanding. This perspective on research is not original, and several great minds would agree with this strategy.

> The tool which serves as intermediary between theory and practice, between thought and observation, is mathematics; it is mathematics which builds the linking bridges and gives the ever more reliable forms. – David Hilbert
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> One can understand nature only when one has learned the language and the signs in which it speaks to us; but this language is mathematics and these signs are mathematical figures. – Galileo
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> I assert that, in any particular natural science, one encounters genuine scientific substance only to the extent that mathematics is present. – Immanuel Kant
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> We do not master a scientific theory until we have shelled and completely prised free its mathematical kernel. – David Hilbert
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> More than any other science, mathematics develops through a sequence of successive abstractions. A desire to avoid mistakes forces mathematicians to find and isolate the essence of the problems and entities considered. – Elie Cartan

I have enjoyed the applied nature of my research, and I plan to continue along this path. While some of the mathematics is not overly intricate, the simple and elegant proofs often provide keen insights. The fact that this kind of mathematics does not require advanced concepts naturally positions itself within Trinity. First, as mentioned above it is easier to attract students, and second, my teaching responsibilities do not allow me to spend consecutive days or weeks concentrating on difficult mathematical constructs. There is sadness in knowing that I'm not at the cutting-edge of mathematical savvy, but to be honest, only a few of the most gifted mathematicians of every generation propel the discipline to new heights. I recognized long ago that I could be an active and respected research mathematician, but that I lacked the intellectual gift of the great minds of our field. My current research activities attract bright students into mathematics and allow me to be productive.

My service contributions have largely been to the department and to my profession, but I have served the university on the Faculty Development Committee and on the Safety, Security and Health Committee. I have also advised first year students twice, a responsibility that I enjoy. I believe that a younger faculty's impact is more significant if they focus their energy on improving their department and on positioning themselves within their profession. I knew little of Trinity's unique character when I arrived, but I did understand mathematics and the workings of my professional societies. My continued research allowed me to present several (invited) talks at national conferences, and the networking of this environment was beneficial. At the national level, I have served as Treasurer and Vice Chair of the Health Applications Section (HAS) of the Institute for Operations Research and Management Sciences (INFORMS), and next year I will be the HAS Chair. I also accepted a nomination to to be the Treasurer of the INFORMS Optimization Society (IOS) from 2005 through 2008 (elections are held in October). INFORMS has over 12,000 members spread across numerous academic disciplines. The HAS and IOS have a combined sub-membership of over 800, and my service to these groups brings significant exposure to Trinity's mathematics department. Thanks to this increased visibility, I obtained two editorships, which further expanded the department's exposure. My service in these offices not only allows me to aid the societies, but it also permits me to responsibly influence the discipline. I enjoy this role and believe it is far more significant than serving on a university committee whose task I only partially understand within Trinity. However, I now have a clearer view of Trinity's organization and character and am ready to become more involved.

The sections that follow present a thorough chronological exposition of my teaching, research, and service. My goal with a chronological presentation is that a reader will observe how I have developed as a faculty member and how the projects that I have been involved with have evolved. Some discussions about my research and teaching include technical references, and it is not intended that this terminology hinder a clear exposition. Rather, technical terms are included to benefit departmental readers. In closing, I appreciate the fact that I can sustain myself by teaching and studying mathematics. As Simeon-Denis Poisson so poignantly stated, “Life is only good for two things, doing mathematics and teaching it.”

The first four months at Trinity were filled with the challenges of acclimating to a new environment. While my first semester brought several successes, there were many aspects of my job that I needed to improve.

Teaching

I taught Calculus I (MATH 1311) and Numerical Calculus (MATH 2324), and I would grade my teaching performance with a B. I was accustomed to being one of the best teachers in a department, but dealing with a new student population was difficult. The older students that I taught in Denver were more active and mature than my Trinity students, and I struggled to engage students at Trinity. I needed to alter my lecture style to better suit Trinity students. My homework assignments were effective, but a few students commented on how "harsh" the writing component was graded. However, the benefits of requiring students to pay attention to what they write easily outweigh any student perception to the contrary. Students made several positive comments about my availability and my internet resources. My self imposed grade of a B was supported by the student questionnaires, with the median scores ranging from 5 to 6 (the mean of the medians was 5.02 and the mean of means was 4.9).

After two weeks in MATH 2324, the immense difference between my expectations and those of the students was evident. Prior to teaching the course, I was informed that the students in this class would have had Calculus I and Principles of Algorithm Design I, and I designed a course that highlighted how mathematics could be used to perform simple numerical analysis. Weekly programming assignments were designed to demonstrate the difference between theory and practice. This seemed like a good mixture for a course that was cross listed with computer science. However, the vast discrepancies in what the students knew about both mathematics and programming made me rethink the goals of the course. I was adept at dealing with varied student populations after teaching in an urban university and in a rural Mississippi high school, but this group ranged from one student who lacked a high school understanding of mathematics to another who worked as a professional programmer and had a working knowledge of Calculus. Overall, the class' mathematical skills were weak and their computing skills were varied. Because I felt compelled to teach a substantial amount of programming syntax, I only had time to support the mathematics with rudimentary geometry instead of rigorous proofs. In the end, most students learned how to make a digital computer perform basic numerical analysis, but my original goal of rigorously developing numerical analysis was not achieved. Student comments were as varied as the students themselves, with one saying that "this is the most valuable class of the semester" and another saying "I didn't get anything out of it, not at all what I expected."

Research

Early in the semester I received notification that the paper *Uniform Bounds on the Limiting and Marginal Derivatives of the Analytic Center Solution over a Set of Normalized Weights*, co-authored with R. Caron, was accepted by *Operations Research Letters*. Another research paper, *Marginal and Parametric Analysis of the Central Optimal Solution*, was completed in October and submitted to *Information Systems & Operational Research* (the paper was later accepted). Three new results were established my first semester. Two of these results were the basis of a paper on optimizing radiotherapy treatments. Surveying the literature for this article was demanding because I had to familiarize myself with a new research field. This research was timely as indicated by the following quote from the January, 1999 SIAM Review article *Optimizing the Delivery of Radiation Therapy to Cancer Patients*:

> It is our hope that the community of optimization experts will be able to offer further insights that will improve our ability to solve these difficult problems.

The third result was the cornerstone theorem of *The Asymptotic Optimal Partition and Extensions of The Nonsubstitution Theorem*, which was later accepted by *Linear Algebra and Its Applications.*

I presented three invited talks, one at the yearly meeting of The Canadian Operations Research Society and one in a SIAM short course. In November, I gave an invited talk at the national INFORMS meeting, and the audience included several distinguished researchers. Having such an audience was both flattering and intimidating. In January, I gave an invited tutorial on sensitivity analysis and chaired an invited session at the INFORMS Computing Society conference. Invitations to present tutorials are usually reserved for more senior researchers, and the invitation to give a tutorial surprised me. The organizers of the International Mathematical Programming Symposium invited me to talk on interior point methods, and I was asked to present a paper at the European Operations Research Society's conference in Budapest. I also authored an NSF-REU grant that was not awarded and a summer stipend proposal that was. I supported mathematical research at Trinity by initiating a research group between the departments of Mathematics and Engineering Sciences. We used the first semester to introduce our individual research interests. Lastly, I organized three departmental colloquia.

Service

The mathematics web presence was lacking when I arrived at Trinity, and I accepted the responsibility to update the departmental web pages. I designed a new look-and-feel that was consistent and easy to use. The web page was reviewed by both Dr. Cooper and Dr. Ponomarenko before it was posted. Our technical report series went online, and since then all new technical reports have been submitted in portable document format (PDF). This allows the outside world to immediately access the department's research. I worked with two seniors, Son Quach and Cory Wetzel, on problems related to optimizing radiotherapy treatments. Combined, I directed three senior projects, Son's computer science and mathematics projects and Cory's mathematics project. I was pleased with their progress, but there was much to do the following year. I supported the Trinity Mathematics Modeling Group by attending all but a few meetings. I also refereed a paper for the *Journal of Optimization Theory and Applications*. The results were flawed, and I developed a few counterexamples and returned the paper.

Review of 2000

In my second year, I was productive with my research, became more comfortable as a faculty member, and increased my confidence as an educator.

Teaching

I taught two sections of Calculus II and one section of Complex Analysis in the spring of 2000. In many ways the positive teaching experiences of this semester are what allowed me to realistically consider a career at Trinity. In the Calculus II courses, I found that I had developed a student following from my first semester, and that these students were comfortable with my educational style. These students acted as leaders and helped the remaining members of the class become familiar with my emphasis on well written homework. The rest of the class followed suit, and I was rewarded with motivated, attentive students. I experimented with group assignments, where the group membership rotated throughout the semester so that everybody worked with students of different abilities. This was a success in the afternoon class; they met outside of class, worked collectively on problems, became friends, etc.... However, the 8:30 class resisted this requirement, and I was concerned about their progress. In retrospect, I'm confident that the class being taught at 8:30 had an effect on their ability to keep mathematics with them throughout the day (their sleep deprived class participation made mathematics some vague memory as the day proceeded). My perception was that the student groups for this class essentially operated as individuals that merely stapled a collection of problems together. In any event, the comments about homework in both classes were good, and my anxiety about the students' frustration was not warranted.

Two new ideas were implemented in the spring semester. First, I added a 'Dress Up' day where students were awarded points for attending class in semi-formal attire. The idea is to highlight the lectures that cover the most important concepts of a course, and the hope is that making these lectures special will help students learn these results. Students were enthusiastic about this, and from all indications 'Dress Up' day was a success. Second, I conducted four help sessions for Calculus II on Saturday afternoons, during which students worked problems against the clock for extra points. The attendance at these sessions varied, but in general, the students who attended had a good time and performed well on tests.

Complex Analysis was a joy to teach. The class had 5 students (2 physics majors and 3 math majors). I taught this course like a typical graduate course, meaning that in addition to the homework problems the students were required to learn many proofs. The physics students, who had had no formal training for such a course, enjoyed mathematics at this level and were easily the best students. In contrast, the mathematics students had had a preparation course but struggled with the rigor of the material. Of these three students, one received a B-, one a C-, and one an F. After talking with several of our faculty, it was clear that we had attracted students who did not enjoy mathematics, and in my opinion, some of our majors were overwhelmed by the material of their upper divisional coursework. While I was not sure what to do about this, it was clear that we needed to do a better job of recruiting majors.

The teaching evaluations from the spring semester were much improved over my first semester, with most of the scores being between 5.5 and 6. So, the majority of students thought that the courses were a success. As already mentioned, my anxiety level was high because of the group homework, but my worries increased because I distributed the student questionnaires during a class in which I returned the lowest test scores of the semester. I was confident that the evaluation scores would be low. However, the students did not vent their frustration by assigning low scores on their evaluations, and from all indications they enjoyed having me as an instructor.

I taught two sections of Linear Algebra and one section of Math Modeling in the fall. Linear algebra is one of my favorite classes to teach. The tests for this course were divided into four sections, with each section being more difficult than the previous one. Students who did not receive 70% of the points in a section were not allowed to earn points from subsequent sections. The first section contained definitions and theorem statements and guaranteed at least a C once completed. The second and third sections contained standard homework problems, the difference being the level of difficulty. Earning 70% on these sections guaranteed a score of B (80) and A (90), respectively. The fourth section contained two challenging questions (see the course syllabus for grading examples). Testing in this manner increased my control over what the students studied, and in this class definitions and theorem statements are important. I was frustrated by students in later courses who did not know the fundamentals of linear algebra, and I was able to require students to learn this material by posing appropriate questions in the first sections. While the amount of information retained is always questionable, this technique fostered an understanding of the basic elements of the course. There were two 'Dress Up' days in linear algebra. The first was the day that we covered the fact that a linear transformation can be represented by matrix multiplication, and the second was the lecture that we concluded a lengthy list of equivalent statements about the invertibility of matrices.

My initial apprehension about teaching the modeling course turned into enthusiasm as I developed the course materials. I decided to use the Generalized Algebraic Modeling System (GAMS) and teach the topics through optimization. The students turned in 6 bi-weekly reports that described and analyzed a model. Additionally, there was one problem concerned with portfolio optimization that the students worked on throughout the semester, and the reports for this problem were exchanged with reports from MBA students in Helsinki. While at a conference, I mentioned to Dr. Erling Anderson that I was going to use GAMS in a modeling course, and he told me that he was teaching a similar course in Helsinki. We both thought it would be helpful for our students to see how others would approach a problem. My students were nervous about swapping the reports, but the poor quality of the work from the MBA students reassured the class that they were doing well. I liked the exchange because it encouraged our students to develop a sophisticated model. Our reports were clearly superior to those of the Helsinki graduate students.

The educational portion of my job went well outside of the classroom. I was an Alpha Lambda Delta favorite professor and attended their annual dinner. I directed the senior projects of Cory Wetzel and Son Quach (both Mathematics and Computer Science). Son traveled with me to Cancun and presented his results at the INFORMS Computer Science conference. This was a pivotal trip for Son because he met Dr. Morton from the University of Texas' Operations Research department, where Son is now pursuing a Ph.D. Both Son and Cory presented their results at the local MAA conference in Austin. It was fun to see them get nervous before the talk, and afterwords see how their confidence and self-esteem grew knowing that their presentations had gone well. Son's report is now published in the NCUR proceedings. Finally, I was invited to attend a teaching conference at West Point where they showcased their integrated mathematics-engineering curriculum. I attended this conference with Dr. Lawson and Dr. Collins (Engineering), and we returned with several ideas about strengthening our curriculum.

The previous year I tried to organize a small research group among the engineering and mathematics departments. Unfortunately, I discovered that I was the only member that was regularly working on new research material. While I found these research meetings helpful, I was not convinced that the others did, and I decided that the organizational effort was not worth the benefit. Instead, I organized a small research group of talented students. We called this group the APplied Optimization Group (APOG), and I had 5 students (two math majors, two computer science majors, and one biology major). We met Wednesdays from 4:00 to 6:00 and started to develop the background material necessary to work on Sleuth (discussed below). The students learned mathematics that they would have otherwise not seen, and they were enthusiastic about the project. Advising this group was personally beneficial because it forced me to regularly think about research level mathematics (albeit most of this thought was concerned with how to describe and present difficult topics to undergraduates).

Research

My research production was good. The paper *Uniform Bounds on Limiting and Marginal Derivatives of the Analytic Center Solution over a Set of Normalized Weights*, co-authored with R. Caron, appeared in *OR Letters*, and the paper *Marginal and Parametric Analysis of the Central Optimal Solution* received favorable first round reviews (and later appeared in *Information Systems & Operational Research*). I completed a work titled *Designing Radiotherapy Plans with Elastic Constraints* *and Interior Point Methods*. This paper was nominated for the William Pierskalla award, which is given to the best paper on OR and health care. I gave an invited talk at the INFORMS conference on this work and discovered that I had won the award. Surprise does not adequately describe what I felt when I discovered that I was the winner. There were several reasons for my shock, but the main reason was that one of the competing papers was based on a Stanford dissertation that won the Dantzig Prize the previous day (this and the Von Neumann Prize are the highest honors in Operations Research). To win against such competition felt great. My graduate adviser was in tears after the announcement, and his sentiment was touching. Additionally, my dissertation received the University of Colorado's nomination for the Council of Graduate Schools (CGS) national dissertation award. While I was flattered to receive this honor, I spent two weeks preparing a condensed version of my dissertation, and this time could have been better spent on research. I was still waiting for referee's comments on the paper *Analytic Centers and Repelling Inequalities*, and such lengthy delays in the review process were frustrating. Lastly, the short article I wrote for the *Encyclopedia of Optimization* appeared.

My research found itself useful in two software packages. First, $\mathcal{R}$adiatherapy optim$\mathcal{A}$l $\mathcal{D}$esign ($\mathcal{RAD}$) offered an entirely new approach for planning radiotherapy treatments. The software had many capabilities that were not previously available, the most important being a mathematically sound analysis of the optimal solution. Second, a sensitivity analysis package, called Sleuth, was prototyped over the summer. The advances in sensitivity analysis had not yet influenced professional software, and because much of my graduate work was in this field, I was the right person to implement the new capabilities. My goal was to have a release for the academic community by the end of the summer, but this goal was not fulfilled. I gave two talks about Sleuth and made several contacts with leading software developers who gave me access to their code. As an applied mathematician, I have always felt that part of my job was to port my mathematical work to applications that improve the real-world. Both of these projects meet this criterion.

I traveled extensively to promote my research and gave 7 talks, 1 tutorial, and organized/chaired 3 invited sessions. I felt fortunate to be at an institution that supported this important component of research. I made many research contacts that would have otherwise been impossible, and I found that many colleagues respected what I was studying. As such, my work was gaining citations. I was also invited to author a book on optimization and sensitivity analysis, and while I was happy to be considered, I decided to forego this project because of its time commitment.

In the beginning of the fall semester, I found myself involved with 3 grant proposals. I was a CO-PI on our latest NSF-REU proposal, a project that Dr. Chapman headed. I was grateful for his leadership and had significantly less responsibility than in the previous year's proposal. I completed an NSF-RUI grant in which I asked for 3 years of support for undergraduate research here at Trinity. Lastly, Dr. Lawson and I wrote a successful $5,000 grant that was used for a mathematics and engineering retreat. We discovered this funding source at the InterMath conference at West Point.

Service

I continued serving the mathematics department in several ways. First, I organized the departmental colloquia, and while this series was not financially supported, I was able to attract good researchers. Second, I was the web coordinator for the department. Third, Dr. Lawson and I co-advised the Trinity Mathematical Modeling Group (TM^{2}G). I often scheduled (and continue to schedule) evening help sessions around these meetings, and students were thankful for the added help. Fourth, I was on the ad-hoc technology committee that was charged with addressing the department's technological needs. We questioned the faculty and completed a proposal for the establishment of a new mathematics laboratory. Fifth, I maintained our technical report series and added a student sub-series for senior projects. I served my professional community by refereeing articles for *Technometrics*, *Journal of Optimization Theory and Applications*, *European Journal of Operations Research*, *Operations Research Letters*, and *Optimization Methods and Software*.

Review of 2001

My academic responsibilities this year were divided between Trinity University and The University of Mississippi (Ole Miss). I was fortunate to have a visiting research position at Ole Miss, and I tried to take full advantage of the research opportunities that this position afforded. While I was thankful for the time to focus on my research, being at The Hearin Center in the Business School was not what I had expected because my colleagues were not as mathematical as I had anticipated. I returned to Trinity twice and on both occasions was pleased to be among mathematicians. So, while my first semester at Ole Miss gave me time to focus on my research, my appreciation for Trinity's mathematics department increased.

Teaching

In the spring of 2001, I taught two sections of Differential Equations and one section of Introduction to Abstract Mathematics. The Differential Equations courses were largely populated by sophomore engineering students, the majority of whom I had taught the previous three semesters. This was my first time to teach Differential Equations with Linear Algebra as a prerequisite, and there was no doubt that the course we offered at Trinity was superior to the one that I had previously taught in Denver (where Linear Algebra was not required). Our course included topics in modeling, solving (both exact and numerical), and analyzing ordinary differential equations. I used MATLAB as a numeric solver and had three or four demonstrations on how this software could be used to solve and analyze ordinary differential equations. Since the engineering students were already familiar with MATLAB, this was a reasonable software package to use. The only drawback to MATLAB was that it used numerical procedures instead of algebraic procedures, which meant that MATLAB returned an approximate solution instead of an exact solution. However, realistic models are most often solved through numerical techniques, so again, the use of MATLAB was appropriate. For the most part, students enjoyed the class and felt as though they had a good learning experience. However, I did not observe the high level of enthusiasm that was exhibited the prior semester by the same group of students. The student evaluations for this course were good, with median scores of either 5 or 6 and mean scores from 4.9 to 5.7.

Teaching the Introduction to Abstract Mathematics course was one of the most difficult and challenging teaching responsibilities that I have had. First, this course is pivotal for our mathematics majors because it provides a basis for subsequent coursework. Second, the course objective is to develop mathematical maturity, which is not easily measured. I could not say that we had met the goals of the course because we had covered a list of topics, but rather I had to quantify each student's ability to reasonably argue and present mathematical proofs. I chose to use a modified Moore's Method to teach this course, meaning that the students were given only a few definitions and theorems from which they had to prove a host of results. In the Moore style, much of the course was devoted to student presentations, which gave me a passive role in the classroom. Students were judged on quality and participation. As I had expected, the students were timid at the beginning of the semester and did not want to critique each other. I expected this to dissipate as the semester continued, but I was not satisfied with student participation. Mathematics students seem most comfortable in, and almost unilaterally expect, a lecture type course. Moore's Method of teaching contrasts the lecture style, and this method 1) covers far less material, 2) challenges the students in every class, and 3) is designed to develop the maturity that is the main goal of the course. There were two ways in which this course differed from a traditional Moore's course. First, I lectured about once every four weeks, compared to none in a Moore's course. Second, instead of making every student responsible for every problem each day, I allowed students to select and request problems. After having a Moore's Topology course myself, I thought that this would relieve some of the stress imposed by the fear of not knowing which student would be asked to present a solution. This adjustment to Moore's Method failed, and instead of having all the students engaged in each class, students were essentially non-participants unless they were presenting a solution. Most students were only interested in what was being presented because they had to later submit a solution, not because they already had a solution that they wanted to verify. The classes essentially reverted to lectures given by the students. In many courses this would be an acceptable format, but the sought after maturity was not readily gained because students simply watched others present solutions. Unless a student had struggled with a problem and realized its difficulties, he or she was not an active participant trying to discover the truth, but rather he or she was a scribe jotting down mathematical symbols. I now understand why it is essential to make each student responsible for each solution in every class, and I will make this the case next time I teach the course.

I ended the Introduction to Abstract Mathematics course with an oral exam, which worked well. Although students feared this exam, each of them left the exam feeling like it was better than a written exam. This was good and bad, for if a student did poorly and left feeling good, they were surprised at their low grade. Students left with a positive feeling because I was able to help them when they were having difficulty, and so the students felt as though they had completed the problems. However, I was grading them on how much they could do, and they received little or no credit if I had to provide a substantial amount of help. I had clearly stated that this was how the grading would be done, and I'm not sure how to overcome the false sense of security felt by some. The best thing about the oral exam was that I could quickly find the student's maturity level because I could tailor the difficulty of the exam to the student, so the oral exam provided me with a clear picture of whether or not a student was ready to continue with their upper divisional coursework. The downside to the oral exam was scheduling the exams, and I am not sure that this would have been possible with a larger class.

I do think that the Introduction to Abstract Mathematics course was a success. The better students got substantially more out of the course than the weaker students, but this is almost always the case. I required the students to use LaTeX for their written assignments, and I am convinced that this skill is beneficial. Some students commented that they did not enjoy or appreciate this requirement, with their complaint being that this was a mathematics course not an English course. This is a recurring complaint when students are asked to learn something in which they do not see an immediate benefit, but I refuse to yield to this complaint. Learning to write and express one's ideas is critical in any discipline, and this course is directed at developing these skills in mathematics. Learning LaTeX is part of learning how to present one's ideas in an aesthetically pleasing manner.

I was involved with students outside of class in several ways. I continued to work with a group of five students on Sleuth. We met every Friday for about 3 hours and worked on the mathematics that supported this software package. I'm still surprised that these students were interested in studying mathematics outside of class. In March, we traveled to the MAA conference where they gave two talks (Trinity students gave a total of 4 talks). This was the second consecutive year that Trinity made a strong showing at the local MAA conference. I also directed Erhan Kartalepe's senior project. Compared to the wonderful experiences I had with Cory and Sun the previous year, this was abysmal. Erhan was completely disenchanted with mathematics and was looking for a project that was void of rigor. At the end of the first semester we had developed the background needed to approach his problem, and he got upset because I had asked him to prove some preliminary results. One day he began pounding on my desk saying that he was a bachelor of **science** major, and that he did not have to know any mathematical theory. I calmed him down, and we had a nice long talk about what mathematics is and is not. His emotional eruption was the consequence of his struggles in analysis. Unfortunately, Erhan stopped working on his project until he was warned by the instructor of the seminar that he would fail the course unless he made significant progress. This shock worked well, and Erhan worked diligently over the final weeks of the semester. His final report was a significant improvement, and his presentation was impressive. He demonstrated that he understood the problem and how it should be addressed (although his mathematical rigor was still lacking). He was fortunate to finish the course. This was my first experience with a student that was unhappy with his major, and I was sad for Erhan. I'm glad that he persevered and completed the degree.

There were two pleasurable experiences that followed from the Modeling course that I taught in the Fall of 2000. First, Nathen Coelen enjoyed the course so much that he selected me to be a Blue Key Honor Society Favorite Professor. Second, Nadine Nitisusanta attended the alumni picnic where she told me that she had shown her professors at Boston University (where she went to graduate school) the semester project for the Modeling course. They were impressed with the difficulty of the problem and with the solution that Nadine's group developed.

I worked with three students over the summer on our NSF-REU grant. This took more time than I had anticipated, but the experience was rewarding. The ability and training of the three students varied greatly, and I was concerned about providing each of them with a research experience. Fortunately, our problem led to three different questions, each with an appropriate level of difficulty. One of these results was impressive, and we later wrote a paper about this result that appeared in *OR Letters*.

Research

Thanks to the visiting research position at Ole Miss, my research productivity increased. I completed three new research papers, was working on a fourth, and developed some results that were the basis for two more papers. The three completed papers were 1) *An Extension of the Fundamental Theorem of Linear Programming*, co-authored with my REU students, 2) *Partitioning Multiple Objective Solutions with Applications in Radiotherapy Treatment Design*, and 3) *The Asymptotic Optimal Partition and Extensions of The Nonsubstitution Theorem*, co-authored with J. Hasfura and J. Stuart. The results for each of these papers were developed at Trinity, and I was able to finish these articles with the increased research time at Ole Miss. The paper in preparation extended some of my dissertation work on the sensitivity analysis of the central path. The other results were related to the Navy problems that I worked on at Ole Miss.

Two papers were accepted for publication. The article *Marginal and Parametric Analysis of the Central Optimal Solution* appeared in INFOR, vol. 39, num. 4 (2001), and the article *Analytic Centers and Repelling Inequalities* was accepted by the *European Journal of Operations Research*.

Dr. Lawson and I prepared an InterMath grant to work with the engineers on curricular reform. Our first InterMath grant was successful, and we had a clear picture of how we wanted to improve the mathematics curriculum that serviced the engineering students. The new proposal's objective was to see that this vision materialized. The NSF-REU grant was awarded in February, and as mentioned above, working with these students over the summer was a rewarding experience. I was informed in May that my NSF-RUI grant was not awarded. The reviews of the proposal were mixed and ranged from excellent to good. The biggest criticism was that I did not distinguish my work from that of two others. This was my fault and was something that I could have easily done, but I was unaware that the differences were not evident. All four referees said that the educational part of the grant was excellent. This was my first NSF grant where I was the only PI, and I learned much about preparing a proposal. Subsequent proposals benefited from this experience.

I was an invited speaker at the annual INFORMS and CORS conferences. I additionally organized a session at the INFORMS conference on optimization and health care. I gave colloquia at The Hearin Center, The Ole Miss Mathematics Department, The Trinity Economics Department, The Software Engineering Department at McMaster University, and The Trinity Physics Department.

Service

Dr. Lawson and I co-advised TM^{2}G, and for the seventh consecutive year we had a meritorious team. I was asked to help with this group when I first arrived at Trinity, and I was nervous because I did not feel qualified. However, over my first two years at Trinity I came to enjoy our weekly meetings and appreciate the COMAP contest (this is a yearly international competition in mathematical modeling). This change occurred because I was more familiar with the students and because I recognized that I had something to contribute (teaching the modeling course helped).

I continued to organize our departmental colloquia (even while at Ole Miss), maintain our web site, and manage our technical series. This series had introduced several of our faculty to fellow researchers at nearby schools, and several of us had been asked to give talks in their respective colloquia. So, not only were we enriched by the research talks, but we were also becoming active participants in the local research community. Both the web site and the technical reports were maintained by Holly Rosson while I was at Ole Miss.

Finally, Dr. Cooper acquired several used machines for our computer lab, and I spent a few days installing the Linux operating system and a free-ware version of LaTeX for Windows. Unfortunately, a software auditor was unaware that LaTeX was free-ware and removed it from the lab computers at the end of the Spring semester. Since the REU students needed LaTeX during the summer, I spent another couple of days reinstalling the software. I was not enthusiastic about administering these machines, but Dr. Cooper and I were the only faculty willing to maintain the lab.

As part of an InterMath grant, Dr. Lawson and I organized a retreat at The YO Ranch in Kerrville for the Engineering Sciences and Mathematics departments. This retreat was a success and fostered a strong relationship between the departments. Both departments agreed that the curricular reform would help both the engineering and mathematics majors. We ended the spring semester with a joint meeting at the Holt Center. Dr. Lawson and I completed a proposal for a second grant to implement these changes.

Professionally, I was the web master for the HAS, and except for initially designing the web site, this responsibility was simple. I refereed papers for *Optimization Methods and Software*, *OR Letters*, *European Journal of Operations Research*, *Technometrics*, and *Journal of Optimization Theory and Applications*. I also developed a web site for those working in OR and radiation oncology. I launched the web site in early December, and eight papers were announced in the first month. While at Ole Miss, I organized a research group between the Mathematics Department and The Hearin Center. I was also an organizer for the 15$^{\text{th}}$ Cumberland Conference in Combinatorics and Graph Theory, where I organized a track in combinatorial optimization. I secured two Von Neumann winners, Fred Glover and Peter Hammer, as plenary speakers.

Closing Remarks

As mentioned earlier, I was fortunate and grateful for the leave granted to me by Trinity, and having a year to focus on my research allowed me to complete several projects. I spent the majority of my first semester at Ole Miss writing papers on research that I had already completed at Trinity, and removing these projects from my research queue was liberating. There were several reasons that I accepted the visiting job at Ole Miss, one of which was to prove to myself that I could handle a research job. I seem to thrive on challenging myself, and I wanted to know whether or not I could satisfy the expectations of a school with a Ph.D. program. I am now confident that I could handle this research pressure.

Review of 2002

The spring semester of 2002 was the second semester of a leave of absence, during which I was a Visiting Research Professor in the Hearin Center for Enterprise Science at Ole Miss. The time at Ole Miss was superb, as I had no teaching responsibilities and was allowed to focus on my research. The rest of my time was directed towards a Navy problem that I surprisingly found interesting. I doubt that any graduate student understands how free they are until they leave graduate school, and being two years removed from this freedom, I appreciated the time to read, write, and think. I was able to complete six research articles, one of which had appeared and two others had been accepted (the other three were in review).

I grew personally at Ole Miss as well. Most of my funding was provided through Naval grants, and I spent a day or two per week working with Navy personnel. My respect and gratitude for the men and women in the US Military grew immensely, and I found the sailors to be quality individuals. I was on the Millington Naval base Friday, September 14, 2001, just three days after the attack on the World Trade Center, and the somber focus and sense of duty exhibited by the sailors was one of the most honorable things I have witnessed. I am grateful to have had the chance to work on a problem that might improve a sailor's career, and I wish that I could have done more.

Teaching

I taught two sections of Calculus I (MATH 1311) and one section of Differential Equations (MATH 3336) in the fall. As usual, each class had its own personality and challenged me in a different way. The 8:30 class was as strong as I have had, and for an early morning class, the students were on time, prepared, and engaged. The challenge with this class was the temptation to give them more work than my other Calculus class. They enjoyed being on top of their work, and I am sure they would have perceived any extra material as unfair. The 9:30 class was almost the opposite of the earlier class. The students were perpetually sleepy and appeared as though calculus was a weight they could not bear. There were several students in this class with inadequate preparation, and even after talking with several of them before the drop date, most decided to finish the course. Many of these students made significant progress during the semester, and I am confident that they could do well in the course with an improved background. I find it taxing to work with these students, as I often feel like I want them to excel more than they do. Assigning Ds and Fs at the end of the semester to students that I had invested several weeks of personal attention was difficult. There were excellent students in this class, but they were lost within the larger class. The students in the first course were vocal and regularly visited my office to discuss homework. In contrast, only a few of the students in the second course were enthusiastic, and none of them attended office hours.

I altered the way I handled calculus homework, and this was the first time that I used a grader. In the past, I had assigned many representative problems from each section that I would review during class, and I would collect an additional set of challenging problems from each chapter. My goal with the second set of questions was to get students to recognize that mathematics was about the theory and logic that supports the solution techniques. I graded these problems on style and correctness. Correcting these assignments was laborious, and while some students benefited from my meticulous grading, many did not appreciate or learn from these problems. Knowing that I had an excellent grader in Courtney Davis, I decided to try another scheme. I partitioned the homework exercises into three categories. The first group was comprised of suggested problems that I would discuss in class, and the second group was a collection of 2-point problems graded by Courtney. The third group contained a smaller number of challenging problems that I graded on presentation, logic, and correctness. This division allowed students to acquire feedback in class and on written assignments. Moreover, the smaller collection of problems that illustrated the mathematical concepts was more tolerable to grade. I found that this scheme provided a nice balance between theory and technique.

The student evaluations for the calculus courses were good, with the median scores ranging from 5 to 6 and the average scores ranging from 4.7 to 5.7. I was happy with the numbers and the comments, especially for these particular courses. The majority of first year students expect to excel at Trinity because they excelled in high school, and I have sensed that many of Trinity's students feel entitled to a quality education. These two attributes combine to become a formidable challenge. From the comments and attitudes of some students, I often feel like they expect me to simply open their skulls and pour in knowledge. I believe that all of Trinity's educators are faced with this dilemma, and I further believe that we do a good job of teaching students in their first year what it means to earn a quality education. Educating first semester calculus students has the added difficulty that many of these students believe that they already know calculus. Indeed, the question that scored the lowest in both classes was the one inquiring about the learning experience, with several commenting that they enjoyed the course but had previously seen the material.

Differential Equations was a joy to teach. This was the 'off' semester for this course as the majority of the engineering students take it in the spring, and as such, the engineering students did not dominate the class. The students were better distributed over the sciences, which made it easier to discuss a variety of models from different disciplines. The students frightened me on their first test, with their average being 63.79. I thought the test was easy, so this was a disappointing average. One problem could have been that I provided them with a prior test, and I think that several of the students studied for this exam by only working the old test. I did not want to curve the grades because this doesn't encourage student learning, and I decided to let them re-work the entire exam. I re-graded the exam and increased their original score by 50% of the difference in the two scores. This raised the average to 73.81, with a median grade of 77.08. Still not stellar, but I felt this was fair. As one would expect, the students were not happy with their scores either, and several of them later confided in me that this 'scared' them into studying. Whatever happened worked, because the next three tests had averages of 89.16, 84.78, and 83. I increased the difficulty of the third and fourth tests, and I was happy to see that the students rose to the challenge. The average on the final was a respectable 78.47, and the average student grade for the course was 83.61. At the end of the semester, my initial thoughts of this class being weak were a bleak memory, and I was proud of their performance.

This was my second time to teach Differential Equations at Trinity, and I was becoming fond of the course. I originally approached this course with disdain after teaching it twice in Denver, but the course we delivered at Trinity was a vast improvement over what was offered in Denver. I was happy with how well the students could 'feel' the behavior of a solution at the end of the semester. This is an important characteristic to impart on the students, as many of them will face a modeling situation in their own discipline where they will have information about what is and is not a suitable solution. Having the ability to know the general behavior of an equation's solution allows these students to quickly decide on an appropriate model. The only downside to this course is that I never get as far into the Laplace transform as I would like. This is my own fault, as I always slow down when we begin the eigenvalue decompositions required to solve first order systems. I guess I enjoy linear algebra too much. Most of the students recall how to calculate eigenvalues and eigenvectors with a brief review, but only a scant few remember any of the mathematical underpinnings. I find this to be a convenient time to review the linear algebra that the students have seen but not absorbed. I do not plan to skip this review in the future, as I believe students are mathematically stronger with a reinforced understanding of linear algebra rather than with more information about the Laplace transform. The teaching evaluations from this course were very good, with every question having a median score of 6 and the mean scores ranging from 5.5 to 5.8. The student comments indicate that they learned the material and enjoyed the course. I found the comments to be uplifting.

I continued to be active with students outside of normal teaching. In our modeling group (TM^{2}G), I worked with three students on an optimization model for Dr. Saphire. Each year Dr. Saphire selects the courses in which she administers the senior questionnaires. This was a time consuming process because she had to hand select about 30 courses that sampled at least half of the seniors. She attempted to find courses that did not share students, for she wanted to decrease the number of students that had to wait while their classmates answered the questionnaire. She also tried to sample the seniors so that the distribution of majors was preserved —i.e. if 15% of the seniors were history majors, then she tried to find a sample population with 15% history majors. After discussing the situation with Dr. Saphire, the students developed a clever, multiple-objective, binary optimization model. The four objectives were to 1) sample as many seniors as possible, 2) minimize the number of students that would receive the survey more than once, 3) minimize the number of non-seniors that would receive the survey, and 4) have the proportion of majors in the sampled population as close to the distribution of majors in the entire senior class. With the sample data provided by Dr. Saphire, a naive model would have had 5.5 million binary variables, which would have made it impossible to solve with modern technology. The students developed an alternative model that required about 1300 variables, which solved on the department's server in under 4 minutes. Daniel White continued by writing a graphical interface that allows Dr. Saphire to 1) adjust the number of classes to be sampled, 2) set a lower bound on the number of students to be sampled, and 3) adjust the weights placed on the four objectives. Moreover, Dr. Saphire can include or exclude classes from the sample. This is important because some courses are not possible (such as study abroad courses) and because once an instructor agrees to allow her to use a class, it needs to be included in subsequent samples. The software reports the classes to use, the number of seniors sampled, the number of seniors that would receive the survey more than once, the number of non-seniors in the sampled courses, and the distribution of majors in the sample. After using the software, called SenQuest, to select the courses, Dr. Saphire wrote:

> The program worked like a charm. I find that in 20 sections I can get almost as many seniors as in my usual 30 sections – the distribution across majors is ok, and I save probably about 10 hours of time! Thank you! Thank you!

So, this project was a tremendous success. Not only did the students develop a clever optimization model, but they had the added benefit of seeing how their work helped someone.

Before my leave-of-absence, I started working with a small group of students on some applied optimization problems. We called the group APOG for the APplied Optimization Group. I wanted to continue working with a small group, but the previous students were preoccupied with their senior projects. Early in the fall semester a student asked about undergraduate research opportunities, and I told him about my plans to re-start APOG. Before long I had four students working on two different projects (2 math majors, one engineer, and one computer science major). This group did not bond as well as the previous group, but they did enjoy learning about our project and each other. We met several times near the end of the semester, and the last meeting was wonderful. I posed some basic results from duality theory, and they grabbed some chalk and constructed proofs.

In addition to APOG, I worked with two undergraduates as part of the mathematics NSF-REU program. Jesse Holzer was from Carleton College in Minnesota and Lawrence Cayton was from Washington University in St. Louis. These students were better prepared than the students I had the previous summer, but this preparation did not provide them with an improved research experience. Jesse was a bright, personable young man who acquired new mathematics easily, and he was the strongest REU student that I had worked with. However, he did not possess the 'fire in the belly' for mathematics that is often required to attack a challenging problem. Jesse did demonstrate some enthusiasm near the end of the summer when we discovered the economic implications of our main result. Lawrence was difficult to read because he was quiet for much of the summer, and from what I can gather, he worked hard in the beginning to learn the background material. In the end, Lawrence helped prove our main result, and his written and oral presentations were superb. My primary complaint about these two was that they did not demonstrate any excitement for mathematics, which was different from the previous summer's students. Daily I presented a variety of problems that I was confident would coalesce into a nice paper, but they never took the bait. This gave them a passive role in the research process, and instead of working on a problem themselves, they watched as I developed the material over the summer. This was not the research experience I had hoped to provide. I worked hard not to show them solutions, and I kept thinking they would become excited once they made progress. We talked about their role many times, but this did not help. I'm not sure how to explain the difference between these students and the ones I worked with the previous summer. The three prior students appreciated the chance to work on new mathematics, and their energy, excitement, and fortitude was what I had hoped to replicate. The result produced over the summer was an extension of one of my previous results, and the economic extensions were interesting.

Several of my former students were doing well. Alexa Gedlaman, a 2001 REU participant, was in graduate school at The University of Texas at Austin (UT). She contacted me before moving to Texas to inquire about any leads I could give her on part-time employment in Austin. I wrote a previous student of mine, Son Quach, who worked for a Department of Defense contractor, and he told me that they were always interested in mathematics students. Alexa interviewed and was hired. This was an excellent position, as her 20 hours a week covered her tuition and books in addition to paying her a salary. Later in the year I talked with Son at the INFORMS conference in San Jose, and I learned that he had decided to complete his Ph.D. in Operations Research at UT. Courtney Davis was a graduating senior, and I directed her senior project in the area of computational biology. My Ph.D. adviser had started a new research center in computational biology at the University of Colorado at Denver, and he was excited about the possibility of attracting Courtney. He flew her to Denver, where she visited the mathematics department and the Center for Computational Biology. Such visits are rare in mathematics, and Courtney was excited about the opportunity to work in the center. Ashley Brown, my St. Mary's student from the 2001 REU program, called often to talk about graduate school. She is now a graduate student at Texas A & M. Alex Kolliopolous decided to go to graduate school in computer science instead of mathematics and is now at The University of Toronto. Dustin Ragan applied to programs in mathematics and medical physics and is now in the physics program at M. D. Anderson. So, many of my students were continuing with graduate school, and I was (and still am) proud of their continued success.

The Fall of 2002 was my first semester to advisee incoming students, and as a new adviser I approached this responsibility with trepidation. I attended all the advising meetings before the start of the semester and read much of the *Courses of Study*. The mentor program was invaluable, as I was clueless about the nuts-and-bolts of the process, but my mentor made sure that I was where I needed to be. I took my advisees to Amy's Ice Cream on our first meeting, which worked well. I informed them of their responsibilities and scheduled individual meetings, which Dr. Cooper and Dr. Hasfura guided me through. Although the process was time consuming, I appreciated the experience. My focus had always been on science, and working with bright young students with diverse interests helped me realize how much Trinity had to offer.

As a last note, since my arrival at Trinity I had organized a flag football game on Saturday mornings for several faculty and students. This weekly gathering had become a social cornerstone for many of us, and I found that I could keep in touch with several of my students. It was a joy to watch them mature and grow at Trinity.

Research

The year at Ole Miss allowed me to 1) complete several research projects that I had partially completed, 2) work on some new problems, and 3) accept a project that I otherwise would have rejected. I started to build a citation index that included both self and non-self citations. I had 36 citations (including 16 self citations). Since I only had 5 articles in print, this indicated that my research was making an impact.

The research for the paper *An Extension of the Fundamental Theorem of Linear Programming* was completed as part of the 2001 REU project, and we originally submitted this paper to *The American Mathematical Monthly*. We received a review stating that the paper was not appropriate because it was research oriented and not mathematical exposition. These were positive comments, and with some rewriting I submitted the article to *Operations Research Letters*, a quality, peer-reviewed journal for short articles. The article was sent to two referees but was accepted on the strength of the first referee's comments, which ended with:

> The paper is well written and the result is extremely interesting .... It may well be that it is the first element of something that will be developed in the future and that may be useful. Therefore, I think it is important to make the result known to a wide audience, and I consider ORL as a perfect outlet. Thus I recommend publication, without hesitation.

The three 2001 REU students were co-authors, and they were ecstatic to learn of the article's acceptance. Ashley Brown's family was especially proud, and I was asked to acquire a copy of the journal for her grandfather (the Editor-in-Cheif was happy to help).

My Ph.D. dissertation posed more questions than it answered, and I had hoped to work on several of the unanswered questions the first few years after graduation. However, I got interested in different projects, and the teaching load at Trinity did not allow the time required to work on these problems. I started looking at these problems in earnest at the end of January, and it was like putting on comfortable pair shoes that were filled with thorns. As I reacquainted myself with the problems, I also reacquainted myself with the subtle mathematical difficulties that I could not overcome as a graduate student. I am happy to say that by the end of the semester I had answered many of the outstanding questions and had overcome most of the prior difficulties. The results are found in *Simultaneous Data Perturbations and Analytic Center Convergence*, which appeared in *SIAM Journal on Optimization*.

Most of my funding at Ole Miss was provided by Naval grants that required me to work on a Navy personnel problem. I did not think that I would find this problem interesting, and I was hesitant to direct time towards this project. However, I made several visits to the Millington Naval base, and after several discussions with the Navy's research group, I started to see the importance of the problem. The Navy had a high attrition rate, and they were in dire need of a way to entice highly trained sailors to remain in the Navy. I began to realize that some of my previous work could aid the process of how sailors are assigned to jobs. In particular, I knew how to show a detailer (the person who assigns sailors to jobs) the entire collection of optimal jobs for each sailor. Additionally, after discussing the problem with a couple of discrete mathematicians, I was able to develop a mathematical analysis that allowed the detailers to measure the competition for a job. These two pieces of information were combined to form a technique that provided a sailor with a choice of jobs (instead of a job being assigned). The Navy is excited about this work because they believe sailor satisfaction will increase as sailors have more control over their careers. The paper *Navy Personnel Planning and the Optimal Partition* explains how the mathematical results apply to the Navy's problem. I hesitantly submitted the paper to *Operations Research* because the difficulties of having a paper accepted in this journal are notorious. I received comments in August from the editor, the associate editor, and two anonymous referees, and to my surprise, they all thought that the article was appropriate for publication in *Operations Research* upon revision. The revision was non-trivial, as each of the editors and referees wanted me to explain more about the Navy's dilemma, and at the same time, the head editor wanted me to shorten the presentation. I spent a couple of months writing, editing, and re-writing the article, and in the end I had two versions, one that was shorter and easier to read and one that was longer and more complete. I sent both versions back to the editors and appealed to their expertise as to which version was most appropriate. The head editor choose the shorter version, which is now accepted.

I was invited in January to write a chapter on radiation oncology for *Operations Research and Health Care: A Handbook of Methods and Applications*. I debated whether or not to write this chapter and decided to accept the invitation because of the research time I had at Ole Miss. Unfortunately, the extensions of my dissertation and the Navy's personnel problem consumed the Spring semester. I wrote a draft over the summer while directing my REU students, and completed the chapter in the following semester. The chapter appeared in 2004.

I had worked for three years on a new software package called Sleuth. This software was built on the mathematical principles of sensitivity analysis that were developed over the previous 15 years, with much of the work being in my dissertation. I traveled in March to the Netherlands to link Sleuth to Dr. Jos Sturm's optimization solver, SeDuMi. I arrived in the Netherlands to find that the new version of SeDuMi was not ready. This did not deter me from working on Sleuth, and I made significant progress towards a stable release.

I had three primary research directions for the following year. First, Courtney Davis and I had started to work on a haplotyping problem from computational biology. As mentioned earlier, my Ph.D. adviser is working in the field of computational biology, and he has encouraged me to direct some of my research energy into the field. I had not done this because of other projects, but Courtney's interest made it convenient to get involved. Courtney and I worked in collaboration instead of a typical student/teacher interaction. Indeed, I don't think I could have comprehended the supporting biological research in a timely fashion without Courtney's expertise. Courtney proved one small result in the Fall, and we posed some questions to address in the Spring. Second, in the

Spring I was able to extend a new result in the area of positive semidefinite programming by Halicka, de Klerk, and Roos. My extension was not significant enough to stand on its own, but it lead to several new questions. I briefly discussed these questions with Dr. Hasfura, and I hoped that we could work on these in the coming year. Third, I was awarded a summer stipend to work on pruning radiotherapy treatments.

2002 was professionally stimulating in other ways. I gave six talks at scientific conferences and was invited to give seven colloquia. I also accepted an offer to guest-edit a special edition of *Optimization and Engineering* on optimization and radiotherapy. I was contacted by a research group in Brazil that was using $\mathcal{RAD}$, the radiotherapy software Son Quach and I wrote. They were using the software to test different models and techniques, and it was good to know that others were benefiting from the software. Dr. Lawson and I received an InterMath grant in February to reform the first two years of our curriculum (more on this below). I continued to manage the *Operations Research & Oncology* web site. This web resource is now an electronic outlet for researchers in the field, and such a venue was needed because most research groups were working in isolation. We now have 25 technical reports and 76 researchers listed on the site.

Service

The service component of my job grew as I became more established in the department, the university, and my profession. I served on my first university committee, the Security, Safety, and Health Committee. This was a new committee comprised of faculty, staff, and students, and we addressed campus-wide safety concerns. The majority of my service remained within the department. I continued to organize the departmental colloquia, which had developed into a useful research outlet for our faculty. The department was generous with its support, purchasing meals and the occasional plane ticket for speakers that needed to travel. We were successful in attracting world class researchers and had visitors from England, the Netherlands, Canada, and Spain. As mentioned earlier, I also co-advised TM^{2}G with Dr. Lawson. I had a secondary role with the group, as Dr. Lawson thankfully managed the COMAP competition, but I enjoyed working with the students. Lastly, I was the faculty adviser for the newly formed Trinity cycling club.

Our department's reliance on technology had steadily increased, and I supported this reliance in several ways. I maintained our web site, a responsibility that required me to regularly check and update our web pages. We purchased a departmental workstation, and I became the system administrator for this machine. We collected all of our mathematical software onto a single machine to facilitate access. Under Dr. Hasfura and Dr. Saphire's guidance we also received a TIF grant to change MMS 104 and 130 into technology classrooms/labs, and I helped with the design of these classrooms.

Dr. Lawson and I received an InterMath grant in February to implement the curricular reforms that were discussed with the Department of Engineering Sciences. These reforms affected the first two years of the mathematics curriculum and included significant changes in calculus, statistics, and differential equations. The grant was used to support three task forces, one each for calculus, statistics, and differential equations. I chaired the calculus task force consisting of Dr. Vafeades, Dr. Ponomarenko, and myself. We were charged with designing a new calculus sequence that 1) had an early introduction to the transcendental functions, 2) covered first and second order, linear differential equations, and 3) taught vector calculus through Green's and Stokes' Theorems. We were successful in organizing the material and finding three appropriate texts. All three task forces succeeded, and the UCC accepted our reforms. The new curriculum is an improvement for both the mathematics and engineering students.

Professionally, I was increasingly involved in the Health Applications Section (HAS) of INFORMS. I was the HAS web-person, and in November I was elected to be the 2003 HAS treasurer. I also served the previous two years on the HAS committee that selected the Pierskalla winner, which required me to read and judge several research papers. The time commitment needed to judge the submissions was non-trivial, and I was uncertain about continuing with this service. There was talk within the HAS of petitioning INFORMS to become a society instead of a section, the difference being that a society has better representation within INFORMS. Part of establishing ourselves as a society would be to hold our own conferences, and the HAS supports this idea. Conferences will not happen for several years, but I have considered volunteering to organize a HAS conference at Trinity. There is a natural fit with the University of Texas Health Science Center at San Antonio (UTHSCSA) and our Health Care Administration program. I am sure that this topic will be discussed at future business meetings, and I may volunteer.

Outside of the HAS, my professional service included refereeing articles and grants for *Optimization Methods and Software*, *Networks*, *The Electronic Journal of Mathematical and Physical Sciences*, and the Natural Sciences and Engineering Research Council of Canada (the Canadian equivalent of the NSF). I was also a conference organizer for the 15^{th} Cumberland Conference on Combinatorics, Graph Theory, and Computing.

Review of 2003

As I reflect on 2003, the first word that comes to mind is 'hectic.' In a year that I had hoped to create more time for family and research, I instead witnessed my role in several organizations increase. As a demonstration of the many tasks that I simultaneously balanced, on top of my normal teaching responsibilities I 1) organized a picnic for the mathematics and engineering departments (in celebration of a successful curriculum reform), 2) prepared 4 students to talk at the Texas MAA meeting, 3) directed 2 senior projects, 4) organized Dr. Janös Pinter's visit and workshop on global optimization, 5) looked for referees for an issue of *Optimization and Engineering*, and 6) made arrangements for Dr. Bill Cherowitzo's visit. My increased involvement broadened my research interests, increased student opportunities, and improved the department's facilities. The highlights of the year, in no particular order, were:

- I received 2 teaching awards.
- I had 1 paper appear, 3 accepted, 1 submitted, and 4 others were in progress.
- I gained two editorships.
- I received the national Moving Spirit award from INFORMS.
- I directed 5 senior projects and served on an additional 2 senior committees.
- I was elected Vice President/President Elect of the HAS.
- I gave 6 talks/colloquia.

Teaching

In the spring, I taught two sections of Calculus II and a special topics course in Optimization, and in the fall, I taught two additional sections of Calculus II and the Mathematics Modeling course. From the student evaluations it is clear that the students thought highly of the courses. Out of 742 total responses, only 10 disagreed with some aspect of the course (9 slightly disagreed and 1 Disagreed). The average response of a question ranged from 4.9 to 6.0, and the medians were between 5 and 6.

I was fortunate to receive two teaching awards this year. First, Amanda Falcone selected me as her Blue Key Honor Society favorite professor. Amanda was one of those students that teachers live for. She worked hard, enjoyed learning, and enjoyed life. I was proud to be selected. Second, the Alpha Lambda Delta honor society chose me as September's Professor of the Month. Professors are nominated by members of the society who then vote to determine the award. Again, it was an honor to be recognized.

The calculus courses in the spring were significantly different from the ones in the fall because our new curriculum began during the 2003-2004 academic year. The new Calculus II curriculum includes an introduction to Differential Equations. After teaching the revised Calculus II course, I believe that there are advantages beyond our original intent. Incoming students taking Calculus II are typically our strongest students, and many of them are familiar with the traditional material. This familiarity does not mean they go unchallenged, but it does lead to the frustration of being re-tested on material that they have already seen. Since only a few students are exposed to Differential Equations in high school, this frustration does not appear in the new course. I found it easy to motivate the traditional topics using simple Differential Equation models, which gave the students a reason to (re)learn the traditional material.

I continued to experiment with separating the homework into different categories. In all four calculus courses there was a list of problems that the students were to work on their own, a smaller list that was graded by a grader, and an even smaller list of challenging problems that I graded. The first group of questions was for student practice, and the second group provided feedback. The last group of questions was answered during 'trial' days in which students prepared solutions in groups.

I wanted students to attempt these challenging problems outside of class and then collectively form solutions in class. I continue to like this idea as I encourage students to learn from each other. However, in practice the good students prepared answers that the rest of the group simply accepted. I required the solutions to be logically presented with correct notation. Mathematics can teach much about organizing ideas and presenting logical, consistent arguments, but for students to see this they need to understand that mathematics is not about matching an answer in the back of a book. I had previously collected problems from individual students, but the grading demands were severe. This is why I experimented with group solutions. The 'trial' days did not provide the learning experience I desired, and in the fall I returned to collecting individual solutions. I reduced the number of challenging problems to about 2 per chapter (instead of 2 per section) and raised the point total so that about half of their homework score was decided by these problems. This still required a significant amount of grading, but this scheme was more in-line with my goals.

The optimization course was a joy to teach. I wanted to use a text that developed the foundations of mathematical optimization from the basic analysis and algebra skills in our undergraduate curriculum. There were many texts on modern trends in optimization, and many others directed at application oriented audiences, but I was unsuccessful in finding a book that fit the needs of the class. I decided to write my own notes, a decision I later regretted. At the end of the semester, I had written and organized 35 pages of mathematics and developed 26 homework exercises. This does not sound like a serious task, but I recall spending many, many evenings thinking and writing. I severely overestimated our student's understanding of vector calculus and topology, and I spent about a third of the semester reviewing topics I thought they would already know. The remaining two-thirds of the semester was spent on convex analysis and Lagrangian duality, with special consideration given to linear and quadratic optimization. This course has much to offer as a capstone experience. I need to add a section on algorithms and another on integer programming. With the inclusion of these sections, students will see in a single course how analysis, linear algebra, and modern algebra combine to form a branch of mathematics. None of our current senior courses provides such an experience. I plan on finishing the notes when the course is next taught, and one day I hope to publish the notes as a small text.

The course on mathematical modeling was also enjoyable. I taught this course through case studies, and there were six, two-week long projects in which the students worked in groups. The last of these projects was on Data Envelope Analysis (DEA), which is a technique to compare efficiencies. Using fictitious data, the students built a model that identified inefficient academic departments, and they presented their findings to Dr. Fischer and Dr. Gibson (all chairpersons were invited). Following the talk, there was a lively discussion about measuring academic departments. This modeling experience was a success, for not only did the students learn about DEA, but they further learned that the conclusions drawn from their model were debatable. In addition to the six, two-week projects, students selected one of two problems to pursue throughout the semester. The choice was between an investigation into protein folding and the design of an optimal batting order in baseball. I was impressed with the efforts of both groups, but the solution to the batting order problem was remarkable. This group modeled the game of baseball as a Markov decision process, something they taught themselves. Not only were they able to abstract the game of baseball so that it could be captured with mathematical notation, but they further collected data on the Houston Astros and designed an optimal batting order. The calculation took 20 computers and over 400 hours of computing time.

My role in the modeling course is to provide basic modeling tools from which the students themselves build sophistication. Some students thrive in this environment as they quickly see that their creativity is useful, while others struggle because the problems do not have an obviously correct answer. Students are required to write a report after each case study. I did not observe the improvement in writing that I had hoped to see, and I will increase the importance of writing next time I teach the course. My biggest disappointment was that I did not succeed in getting the students to explore the capabilities of a model. The reason models are important is that we can use the language of mathematics to predict behavior that is otherwise difficult to observe. The students were good at answering the questions that I posed, but even with substantial encouragement they were reluctant to pose their own questions. I'm not sure how to address this pedagogically, but next time I teach the course I will focus on the idea that models are often built not only to answer an initial set of questions but also to answer new questions suggested by the model.

The modeling students complained throughout the semester about their workload. These complaints were the result of a significant computer component. The models were built in a language called AMPL, and students struggled with basic computer use. Most of the students acquired the needed skills, which I saw as an added benefit (especially since our alumni repeatedly inform us that we need to increase our computer science exposure). However, a majority of the students saw the technology as a burden. We could teach modeling without technology, but such an ivory tower approach hides how mathematics can aid other disciplines, which is one of the primary goals of the course. I am willing to live with this criticism because I believe it is important for students to see how mathematics solidifies into a useful model. Building, understanding, and querying realistic models is time consuming, and masking this from students is not an option.

I continued to work with students outside of class. I directed five senior projects, two of which led to publishable quality results (one paper was submitted and one was in progress). Over the years, I have become increasingly familiar with the nature of undergraduate research. Many of our students are double majors, and they often want to complete a project that bridges their interests. I enjoy these projects because I learn about other disciplines, and the first step of the project is to have the student teach me. This immediately puts them in a leadership position, which helps them understand that they are in charge of their project. I can not overstate the importance of this. Many of the students who struggle with their senior projects expect to be taught as if they were in class. The project's intent is to provide a research experience, and the faculty's job is to direct the work, not do the work. Once I understand something about the other discipline, I help the student identify mathematical problems. Some of these questions are typically beyond the undergraduate level, and once the semester concludes, I continue to work with the student on the more difficult questions. In Courtney Davis' case, we proved some surprising graph theory results that had biological implications. A similar experience occurred in the fall with Domingo Llagostera. He taught me about photodynamic cancer therapy, an emerging treatment that recently received FDA approval. Whereas the radiation oncology work that I had done is based on radiological cell damage, photodynamic therapy is designed to take advantage of a destructive chemical process (so cancerous cells are destroyed via chemistry instead of physics).

The Applied Optimization Group continued to meet on Friday afternoons, and was comprised of six students (3 math majors, 2 computer science majors, and 1 engineering student). We made significant progress in the fall semester. Chris Smith nearly completed a project that would have allowed us to realistically calculate the amount of radiation that is deposited into the anatomy by a high-energy particle beam. Josh Reese and I were able to successfully prune radiotherapy treatments using a vector quantization technique (an idea that he suggested). I have been attempting to prune treatments since coming to Trinity, with several failed attempts. In fact, I had given up on this problem, but Josh's suggestion worked beautifully. Dr. Matthias Ehrgott works on the same problem in New Zealand, and he visited in the fall. He had his own technique that he claimed worked well, but he too was amazed at the success of the vector quantization method.

I worked with three REU students over the summer, one of whom was the strongest REU participant that I had had. These students were able to correctly prove a result that the previous summer's REU students were unable to establish. Their path to a correct proof provided some new results in an area of linear algebra called sign-solvable systems. A paper on this work and its economic implications was completed the following year.

Research

The paper that won the Pierskalla award appeared in *Health Care and Management Science*. Three other papers were accepted for publication. After 18 months of refereeing and 3 revisions, the paper *Navy Personnel Planning and the Optimal Partition* was accepted by *Operations Research*. This is the most highly regarded journal in Operations Research, and the journal's description states:

> The mission of Operations Research is to serve the entire Operations Research (OR) community, including practitioners, researchers, educators, and students. Operations Research, as the flagship journal of our profession, strives to publish results that are

> truly insightful. Each issue of Operations Research attempts to provide a balance of well-written articles that span the wide array of creative activities in OR. Thus, the major criteria for acceptance of a paper in Operations Research are that the paper is important to more than a small subset of the OR community, contains important insights, and makes a substantial contribution to the field that will stand the test of time.

The mathematical results of the paper were not complicated, but I was able to show how theoretical results on parametric analysis provide a competition measure for the Navy's career management problem. The paper's important contribution was that it showed how theoretical results in graph theory and parametric analysis established new insights into a classical optimization problem.

I reviewed the galley proofs for *Simultaneous Data Perturbations and Analytic Center Convergence* in December, and this paper later appeared in *SIAM Journal on Optimization*. This is a lengthy article (28 pages) containing many new theorems, the most important of which characterizes the convergence of the central path under simultaneous parameterization. It also introduces two new types of convergence and shows how they guarantee other convergence properties. The paper received good referees' reports, with one referee stating:

> The paper addresses an important theoretical problem that has immediate algorithmic implications, as in the context of infeasible interior-point path-following algorithms.

We also received referee reports on *The Asymptotic Optimal Partition and Extensions of The Nonsubstitution Theorem*, co-authored with J. Hasfura and J. Stuart. The editor accepted the paper but requested a revision. The paper will appear in *Linear Algebra and Its Applications*.

Being in a department with only 8 faculty, each with their own research interests, does not promote a traditional research environment, and I have replaced the research activities of a larger school with undergraduate research. As mentioned above, students are a great source of new problems because they teach me about other disciplines, and the bulk of my research now resides in the interactions between mathematics and other fields. This type of research is natural to Trinity, and it allows the students to participate in the research process. I would say that my strength now lies in my ability to abstract problems in other disciplines and then combine a broad range of mathematical tools to form new results that analyze the situation. This differs from how I would have measured myself when I left graduate school, when I would have said that my research ability rested in the intersection of optimization, functional analysis, and topology.

I was invited to six talks and colloquia over the year. These ranged from a mathematics colloquium at Texas State University to an invited lecture at the European INFORMS conference in Istanbul, Turkey. Traveling and speaking at conferences is important, and I am fortunate to be at a school that supports this research outlet. I was also a co-PI on a Naval grant awarded to the mathematics department at the University of Mississippi, where I continued to work with the Navy. My guest editorship of *Optimization and Engineering* for the special issue on optimization and radiation oncology was ongoing. We completed the first round of refereeing, and I planned to have the final papers in press by the summer of 2004. The monograph series, *Topics in Operations Research*, invited me to be on the editorial board over the summer, and I accepted. This series publishes one to two texts a year.

I had two researchers visit over the year. Dr. Janös Pinter, an expert on global optimization, spent a week at Trinity in March. Besides his numerous publications, he authored the popular software LGO. I wanted to explore how global optimization could aid my radiation oncology work. Janös was a pleasant person, but I gathered that he no longer had interests outside of code development. He was interested in my ideas but had nothing to contribute besides LGO. So, from a research perspective his visit was not fruitful. However, he was kind enough to give a workshop on global optimization that attracted 5 off-campus attendees. The workshop was a success, and it brought some visibility to Trinity and the local INFORMS chapter. In September, Dr. Matthias Ehrgott visited from New Zealand. Matthias has an applied mathematics degree from Kaiserslautern University in Germany, and much of his work mirrors my own. He also works on pruning radiation treatments, and he has had moderate successes. During his visit I was able to explain my research with Josh, and once he saw it work, he was amazed. In fact, he spent an entire day trying to make his technique perform as well ours on a single example. We were able to devise many hybrid schemes, and there are several unsolved mathematical questions about error analysis. As a first step, we are working on a numerical paper that investigates the computational aspects of different pruning techniques. I will travel to New Zealand in December, 2004 to complete this work.

Service

The service component of my job grew significantly over the year. I continued to maintain the department's web page and technical reports, organize the mathematics colloquia, and advise the modeling group (TM^{2}G). This year I also directed the Trinity University Math Society (TUMS) and acted as the departmental system administrator. With our new electronic classrooms in place, our server needed more upkeep, and I was in charge of this work. There were two weekends in the fall that I spent working on our server. Directing the student groups was interesting. The modeling group won two meritorious rankings in the spring, making this our ninth consecutive year to achieve this ranking. Most of the students in the modeling course were going to compete in the next competition, and I expected the streak to continue. The math society was active on many fronts. On Friday afternoons they tutored 7$^{\text{th}}$ and 8$^{\text{th}}$ graders at Rhodes middle school in preparation for the SAT. They also designed and sold T-shirts, served hot-chocolate during finals week, and went ice skating with the physics society.

Dr. Lawson and I took five students to the Texas MAA conference, where they gave four talks. This was a great experience for our students. Courtney Davis' talk on diversity graphs and haplotyping was selected as the best student presentation. Coaching students through their first conference talk is time consuming. I teach them how to organize a talk, how to make transparencies, and what to emphasize. It was rewarding to see them do well and have a good time.

My involvement within INFORMS increased. I was the treasurer of the HAS, and in October, I was elected as the 2004 vice president. This meant that I would be the president in 2005. As vice president, I was in charge of organizing the 10-15 sessions (about 40 talks) sponsored by the HAS at the national meeting. I began to search for session chairs and hoped that this task would go smoothly. I also increased my involvement with the local INFORMS chapter. Together with the president of the San Antonio chapter, Mary Crissy, we found support for 3 speakers. Mary nominated me for the INFORMS Moving Spirit award for my help with the local chapter, and I won the award in October.

In addition to the above service, I wrote letters of recommendation for more than 15 students, which always takes (surprisingly) longer than I expect. I organized a picnic for the Mathematics and Engineering departments in celebration of our successful curricular reform, and I continued to be the faculty sponsor for the bicycle club. I advised 8 underclass students and 2 mathematics majors, and I refereed 9 research articles. Outside the department, I served on the Faculty Development Committee (FDC), which reviewed the proposals for summer stipends and leaves of absences.

The spring and summer of 2004 were successful in many aspects: I taught two new courses, completed 3 research articles, sponsored three student groups, mentored 2 NSF-REU participants, and directed 3 NCI-SURF students. Much of my research production follows from my affiliation with the University of Texas Health Science Center at San Antonio (UTHSCSA). In particular, Dr. Bill Salter and I have begun a fruitful research program that promises to transform academic insights into real-world benefits for cancer patients. I have benefited from this affiliation in many ways, as it strengthens my understanding of the clinical nature of radiation oncology and fosters collaborations with oncologists and medical physicists. Moreover, this affiliation has enriched Trinity students through summer research support, and 3 Trinity students participated over the summer in an NCI-SURF program. These mathematics and computer science students built an academic treatment system that optimally designs radiotherapy treatments. This project has required them to learn and use mathematics, physics, biology, and computer science. The web-based software will connect the academic and clinical worlds, and for the first time, different techniques will be compared head-to-head. This has been a superb educational/research project for both the students and myself.

Teaching

Teaching Calculus III and Analysis II for the first time brought new challenges. Outside the added effort of selecting homework and preparing new notes, I enjoyed the material. The Calculus courses were largely populated by first year students that arrived at Trinity with credit for Calculus I. These students tend to be among Trinity's best, and it was clear from the outset that both classes were academically strong. In my opinion, the multi-variable analysis of Calculus III is one of the most appealing topics in our beginning curriculum. As a student, I recall having a strong appreciation for this material's geometric insights and its numerous applications. I found Multivariable Calculus to be one of the easiest courses not because the material was easy, but rather because I was able to connect the notation to the geometry. This connection is one of the educational goals of Calculus III, and I was surprised by students who struggled with the geometry. Many students saw the geometry quickly, but presenting the material so that (nearly) all the student's understood the relationship between notation and geometry was more difficult than I had expected. Through office visits and evening help sessions, I was confident that the majority of students, or at least those who made an attempt, came to appreciate and understand the mathematics.

Our reformed curriculum includes an introduction to matrix manipulations in Calculus II, and after consecutively teaching Calculus II and III, I find that an increased understanding of linear algebra better equips students for Calculus III. In fact, a student with an introduction to vector spaces and eigenvalues is significantly better positioned to grasp the multi-dimensional character of Calculus III. I reviewed this material in Calculus III but at the expense of a shortened presentation of Vector Calculus at the end of the semester. While a fundamental understanding of linear algebra strengthens a student's position in the course, the hastened development of Vector Calculus burdened students at the end of the semester. I am confident that I can improve the time management of the course so that the review of matrix algebra does not prevent a more thorough presentation of Vector Calculus.

Other than the time problem created by the need to review some material, Calculus III was a wonderful course. Indeed, the lectures on optimization and Lagrange multipliers were among the best that I have given at Trinity. By large the students enjoyed the course and gave it favorable reviews. Out of 251 student responses (36 total students in two classes), all the replies were either 5 or 6. I look forward to teaching the course in the future.

The Analysis II course was a challenge in several ways. First, the majority of our majors fear the first course in analysis, which is required by the major. In an attempt to deliver a first analysis course that is accessible to all our majors, we have approached the traditional topics through the study of sequences. This approach does not require a substantial introduction to the topology of the real line, and in my opinion, this is a fatal flaw of the course. Having taught advanced courses in optimization, real analysis, and complex analysis, I find that students, even the stronger ones, lack the foundations required to use and generalize basic real analysis. While I agree that a topological approach in Analysis I would increase the difficulty of the course, not taking this route means that subsequent courses need to spend a significant portion of the semester filling this gap. The specific topics in Analysis II are left to the individual instructor, and I decided to present a course from Royden's *Real Analysis*. This is a classic text on Lebesgue measure and integration that is often used in graduate courses. Realizing that real line topology is crucial to a successful course, Royden has an introductory chapter that tersely presents the material. We spent the first third of the semester covering this chapter, and I was frustrated by how little the students grasped. After having a similar experience in optimization, I'm convinced that we need to adjust Analysis I. The last two-thirds of Analysis II were spent on the development of Lebesgue measure and integration. We concluded the semester with a brief introduction to the topic of bounded variation.

There were 4 students in the Analysis II course, one of whom was significantly weaker than the other three. Instead of forcing the students to work on multiple sets of short problems, I decided to have only a midterm and final exam. The topics of this course are difficult, and my philosophy was to challenge the students with a few substantial problems. I had hoped that the students would have the experience of solving a problem after a lengthy investigation. In mathematics, no joy is greater than successfully proving a result after an extended and multi-faceted attack. Learning that many problems require hours, days, months, and even years to solve is valuable. Moreover, as an advanced group of seniors, I expected them to have the maturity to distribute their efforts over the semester. However, even though the exams were distributed weeks in advance, 3 of the 4 students compressed their efforts into a few days before a due date. Reading their solutions with the confidence that they were capable of much more was frustrating. In the future, I will distribute similar problems over the semester to better guide their work. I am disappointed that such guidance is required, as I wanted this to be a window into graduate work, where students are typically expected to pursue a subject on their own.

I conducted the Analysis II course in an informal manner in an attempt to increase student comfort. I also graded on a 20 point scale to address the difficulty of the material. The student comments were favorable and included:

> Dr. Holder's lectures flow smoothly and cover vast ranges of information, which he effectively makes understandable and accessible.
>
> Dr. Holder is eager to ensure that his students understand the material.
>
> Awesome class!
>
> Individual consultation on assignments - GREAT!
>
> Dr. Holder does an awe-inspiring job of making dense material accessible. He is a great teacher and mathematician and refuses to move on until all his students understand what he is presenting.

From these comments I am confident that the students appreciated my attempt to expose them to the difficult and elegant material of the course. While it is comforting to know that the students appreciated my effort, they were overly kind. In the end, I was sorely disappointed by their command of the material. On the final exam even the strongest student gave incorrect solutions to the most basic problems. Although I am disappointed with student performance, material at this level takes time to comprehend, and my hope is that this introduction will facilitate a second attempt in graduate school.

In addition to the courses above, I directed an overload course in undergraduate research. Domingo Llagostera needed an upper divisional course to complete his double major in mathematics and molecular biology, and I decided to help him extend his senior project, which I had directed, into a publishable paper. Much of the computational effort had been accomplished the previous semester, and instead of having Domingo do 'book work', I approached the course as an opportunity to educate him about the challenges of scientific writing. A preponderance of our students overestimate their writing ability, and they have the misconception that the process of writing is complete once an assignment is due. Scientific documents have their own terse style and are void of embellishment. The idea is to clearly and concisely present your contributions. Organization and notation are paramount. We started with the traditional system of Domingo giving me a draft to mark-up followed by him revising the paper. The problem with this system is that the student simply makes changes to please the teacher instead of taking a personal interest in his or her work. About half-way through the semester, I decided to have Domingo proof-read the document himself. The task was for him to mark-up the paper twice before he returned it to me. He had to return his mark-ups as well as the revised paper. This worked well, and his second mark-up showed that he was beginning to contemplate improved language and notation. Over the semester, the article distilled into a quality document, undergoing 18 revisions. By the end of the semester he argued with me if I suggested a change, and I felt the joy of knowing that I had done my job. On his questionnaire he wrote,

> My project with Dr. Holder has been probably the most exciting thing for me at Trinity as far as class work. I care about my project <u>a lot</u> and so does Dr. Holder.

The paper is now submitted to *OR Spectrum*, and I anticipate favorable referees' comments.

Outside the classroom, I directed 2 undergraduate research groups over the summer. One of these groups was comprised of two NSF-REU students working on a hapltopying problem in computational biology. The first of these students was bright and energetic, but the second was lazy and patronizing. It was difficult to direct these two. The mathematical results suggested over the summer are the strongest of my REU experiences, but none of the proofs supplied by the students are valid. I will attempt to correctly prove and rewrite these results in the upcoming academic year. The other group was formed by the 3 Trinity students in the NCI-SURF program mentioned earlier.

Research

I (co-)authored three research articles and an invited tutorial over the spring and summer of 2004. The first article extends some earlier work on optimization and economics and is the result of the 2002 and 2003 REU programs. The earlier article, co-authored with Hasfura and Stuart, received final acceptance in *Linear Algebra and Its Applications* in June. The extension shows that it is possible within an economy having a non-homogeneous labor source to identify a collection of optimal processes, meaning that they maximize profit, on the infinite time horizon. From my intuition of the earlier result, I was certain that the extension was true, but finding a rigorous proof required two summers. Our new proof uses the earlier result to establish a new theorem about asymptotic sign-solvable systems, from which our extension follows. I enjoyed this material and am happy with the paper.

The second paper was the work with Domingo Llagostera mentioned above. Domingo had previously participated in a chemistry project that had attempted to improve the synthesis of a photosensitizer, which is a chemical compound that destroys tissue when activated by infrared light. Chemists design photosensitizers so that they accumulate in undesirable tissues, like cancerous growths. A physician injects the drug, waits until the chemical localizes in the targeted regions, and then focuses an infrared light on the area to be treated. Domingo and I used a standard pharmacokinetics model to capture the chemical's flow through the anatomy. This model provided time dependent data for an optimization problem that calculated optimal treatments –i.e. the model decided for how long and from what angle the light source should be focused on the target region. We used these models to decide the best time to treat a patient and to investigate the effect of increased localization within targeted regions. We found that increasing the chemical's concentration within targeted regions is crucial to a successful treatment, and hence, improving the chemical design of a photosensitizer is paramount to the emergence of this technology.

I was invited by Bill Salter and Dennis Cheek to become a co-author on the third article because the paper required a significant revision after the initial submission. The paper was authored by my colleagues at the UTHSCSA and submitted to the special issue of *Optimization and Engineering* (OPTE) that I was editing on optimization and radiation oncology. My co-editor, Francis Newman, handled the article. The initial referees' reports were not favorable because the paper was written for a medical audience instead of the engineers and mathematicians who typically read OPTE. I was asked to help address this issue and 'mathematized' the article by streamlining notation and expressing their optimization process in a standard form. This was not a trivial task. I originally thought I could complete the revision in a week, but it took 2 months. Unfortunately, this is the nature of working with practitioners who have spent years understanding the nuances of their problem. My first few attempts were overly general and disguised much of the important details. Working closely with my co-authors, I successfully explained the primary modeling contribution without compromising the clinical perspective. The writing process was complicated by the fact that the lead author was a graduate student with poor writing skills. In many ways, this was like directing a senior project, as I would edit the paper and return it to my co-author who would then inappropriately add and alter material. His comments on content were important, but his presentation was lacking. Like many of my Trinity students, I asked him to read Strunk & White's *Elements of Style* and make revisions after I reviewed his suggested changes. He definitely improved, and the article benefited. We received final acceptance in July.

Dr. Bill Salter and I completed an invited tutorial on optimizing radiotherapy treatments, which we will deliver at the national INFORMS meeting in October. The tutorial will appear in *Tutorials on Emerging Methodologies and Applications in Operations Research*. This 47-page work was challenging because of its educational intent. Our task was to organize the literature in a way that presented both the academic and clinical issues so that readers could quickly identify areas where their expertise was most useful. Dr. Hasfura meticulously proofread the tutorial near the submission deadline, and I was thankful for his assistance. Bill and I were invited to expand this work into a text for medical physics students. This is a long range goal that I hope to complete in the next 5 years.

In addition to the research activities above,

- The paper "Simultaneous Data Perturbations and Analytic Center Convergence" appeared in *SIAM Journal on Optimization*, vol. 14, num. 3, pp 841-868, 2004,
- The paper "An Extension of the Fundamental Theorem of Linear Programming" was the 4th most requested article in *OR Letters* from 2000 to 2004,
- My research was cited at least 66 times, including 26 self citations,
- I gave an invited talk and organized/chaired a session at the CORS conference,
- I was invited to organize a cluster of 3 sessions (9 - 12 talks) for the national INFORMS meeting in October,
- I was a consulting investigator on an NSF-SBRI grant submitted by OptTek in Boulder, CO.

Finally, the paper "Partitioning Multiple Objective Optimal Solutions with Applications in Radiotherapy Design" was accepted for publication in the *Journal of Optimization Theory and Applications*. This article's saga to acceptance is complicated. I originally submitted the article to an area editor that was killed by a drunk driver. This prolonged the official submission by 6 months. After 18 additional months and several emails to the Editor-in-Chief, I was asked to contact the managing editor, Yin Zhang, directly about the status of the article. Dr. Zhang informed me that the Editor-in-Chief had asked him the previous day to handle the article. I know Dr. Zhang well, and I am confident that the Editor-in-Chief mishandled the paper. Dr. Zhang quickly processed the article and recommended publication. I received a letter stating that the article was accepted but that some formating issues needed to be addressed. The main concern was that the article was 60% above the suggested page limit. After returning the copyright statement, I have been told that the article is on "hold" until I conform to the reduced page limit. The article's merit will be significantly reduced if it is shortened, and I am considering alternatives.

Service

The preponderance of my service remains with the department and my profession. Within the department, I continue to maintain our web site and technical report series, which currently has 90 reports of which 42 are available online. I also administer our departmental server and maintain our staff's linux machines. Professionally, I was the Vice President of the HAS and was responsible for organizing the 38 talks sponsored by the HAS at the national meeting. This was a tedious task that required a huge amount of email, and I was glad when it was over. I also refereed 3 papers, 1 for *Information Systems and Operational Research* and 2 for *INFORMS Journal on Computing.*

I directed both the Trinity University Mathematics Society (TUMS) and the Trinity Mathematical Modeling Group (TM^{2}G) in the spring of 2004. TUMS activities included 1) sponsorship of Dr. Saul Gass as an INFORMS guest speaker, 2) a successful campaign to become a student chapter of SIAM, 3) the selling of shot glasses, and 4) a putt-putt golf trip. I enjoy working with this group and look forward to helping over the next few semesters. TM^{2}G successfully competed in the annual COMAP modeling competition. Participation was high, with Trinity fielding 4 teams of 3 (the maximum allowed). Moreover, students and advisers were drawn from mathematics, computer science, economics, molecular biology, and business.

Teams

- Dr. Jorge Gonzalez (Adviser, Economics), Ryan Acosta, Galen McQuillen Aaron, Fullerton.
- Dr. Diane Saphire (Adviser, Mathematics), Allison Beste, Scott Schwartz, Chris Smith.
- Dr. Robert Laird (Adviser, Physics), Maeve Goetz, Barbara McClain, Ricky Castillo.
- Dr. Allen Holder (Adviser, Mathematics), Daniel Nevin, Kevin DeHoff, Paul West.

The teams advised by Dr. Gonzalez, Dr. Saphire, and Dr. Laird chose to work on the design of a quick-pass system for a theme park. The team advised by myself modeled the biological and environmental effects of the formation of an individual's fingerprints. Unfortunately, for the first time in 10 years we did not receive a Meritorious award. Dr. Gonzales' and Dr. Saphire's teams were awarded Honorable Mention (top 38%) and other two were Successful Participants. Competition was high with 599 teams participating from around the world.

I continue to organize our departmental colloquia, which were jointly sponsored by the Biology department last spring. We attracted 7 speakers including 5 talks on mathematical/computational biology. Two of these speakers were supported by the Lectures and Visiting Scholars Committee and another was supported by INFORMS. The series was strong, and we had attendees from Trinity Mathematics, UTSA Mathematics, St. Mary's Mathematics, Trinity Biology, and Trinity Engineering. It was one of the best attended series we have had, a success that I contribute to the timely subject matter.

At the University level, I was a member of the Faculty Development Committee, and I reviewed Alpha Lambda Delta scholarship applications for Trinity Students applying for a Mercer Scholarship. I was also the faculty sponsor of the Trinity Cycling Club, in which capacity I had to mediate some student quarrels. Lastly, I wrote letters of recommendation for 10 students, a responsibility that I happily accepted. I'm always excited to help students succeed and am amazed at the diverse interest of our students.