

To: David Reed, Provost
John Lowther, Sabbatical Leave Committee
From: Mark Gockenbach
Department of Mathematical Sciences
Re: Report on sabbatical leave (Fall 2004)
Date: 13 January 2006

My sabbatical leave of Fall 2004 was approved based on the following plan:

1. Primary projects:
 - Finish a book on the finite element method.
 - Give some concentrated attention to two PhD students.
2. Secondary project:
 - Develop a new book project (on numerical optimization).

The primary goals were accomplished:

1. I finished the book, not quite by the end of the sabbatical, but soon after. It was submitted to the publisher, the Society for Industrial and Applied Mathematics (SIAM), for final review. SIAM's reviewers gave the final version a good report and the manuscript received final approval for publication. The book will appear later this year (2006).

Attached to this report is one of the (anonymous) reviews of the final manuscript.

The sabbatical leave was critical in finishing this project in a timely fashion. I have no doubt that the book would still be far from finished had I not had the ability to concentrate on it for several months.

2. My work with Akhtar Khan and Anatoli Andreev, PhD students in Mathematical Sciences, was productive. Mr. Khan successfully defended his dissertation in August 2005; based on the work done during my sabbatical leave, we have submitted the following papers, which are still under review:

- M. S. GOCKENBACH, A. A. KHAN *An abstract framework for elliptic inverse problems. Part 2: An augmented Lagrangian approach.*
- M. S. GOCKENBACH, B. JADAMBA, A. A. KHAN *Estimation of discontinuous coefficients by the method of equation error.*

I was also able to work with Dr. B. Jadamba, who was a visiting instructor in our department during AY2004-05, resulting in the second paper above and the following work, which is still in preparation:

- M. S. GOCKENBACH, B. JADAMBA *Error analysis of the modified output least-squares approach to elliptic inverse problems.*

Mr. Andreev was not as advanced as Mr. Khan at that time, but he is now nearing the completion of his PhD. The sabbatical leave was helpful in establishing the direction of the research that he has since pursued.

I was not able to address the secondary goal of my sabbatical. Finishing the book on finite elements required more time than expected, and I did not begin developing the book on numerical optimization.

Review of manuscript *Understanding and Implementing the Finite Element Method* (anonymous review provided to the author by SIAM)

1 Please write a brief evaluation on the following aspects of the manuscript:

- (a) **Organization:** The organization of this book is excellent. I would suggest that regardless of any changes made the manuscript the organization remains as is.
- (b) **Content:** The book contains an academic year of work aimed at either advanced junior/senior level undergraduates or early graduate students. The book does a good job of presenting both the theory and details of implementation. This content traditionally has been packaged separately.
- (c) **Writing style:** The writing style is clean, crisp and clear. A serious tone is set in the first few pages of the basic framework section and this academic writing style is present throughout the book.
- (d) **Accuracy:** The author should be applauded for taking the time (and pages) to be thorough and accurate in the presentation of this sometimes exhausting-to-learn subject matter. Upon completion of the material in this book a student or researcher would be well prepared to employ finite elements for an application problem or proceed to the cutting edge of research in finite element methods. The accuracy and the thoroughness of the book is excellent.
- (e) **Currentness:** The book falls short, ever so slightly, on the currentness of this subject matter. There are some interesting trends in implementation of finite element methods, some interesting new applications of finite element methods and finally, although quite technical, there are some mathematical advances in finite element methods. Clearly these things cannot be presented in a rigorous way, but it would not be unreasonable for the author to 'point at' some of these current trends.

5 **How would you describe this book to a colleague?** I would describe this book as an excellent introductory treatise on finite element methods with an eye towards implementation.

6 **How does this book compare to similar works with which you are familiar?** The book is similar to combinations of books with which I am familiar but there is no single text that I am aware of that accomplishes what the author has done here.

7 **What are the primary and secondary audiences for this book?** The primary audience for this book would be junior/senior level undergraduates pursuing degrees in mathematics, computer science or engineering or first or second year graduate students who may be learning about finite element methods to solve some specific applications problem (e.g. a first or second year graduate student in physics). The text is perfect for this primary audience. I could see this text being used in a year-long (two semester) course. The secondary audience would be scientists who are interested in using finite

elements as a tool to simulate or compute something specific. For this secondary audience I could see individuals using the book as a self-help book and also as a reference book.