Introduction

What good is mathematics? What is *supply-your-favorite-topic-commonly-taught-in-any-math-course* used for?

Have you ever had undergraduate students ask either of these questions? If not, you are in a very small minority of college math teachers, probably a set of measure zero. If you have had either of these questions asked, how do you answer? The first question is such a blockbuster that it invites a sweeping reply although one that could be given incrementally: Bar codes to bridges. The second question cannot be satisfactorily answered without some feel for the interests of the person asking the question. Suppose it is pre-med students who ask this question. They will be satisfied by an answer that relates to their professional interest. Geometric series, for example, have application in determining the concentration of a certain drug in a patient's blood system after a treatment of periodic injections, to cite an example drawn from an introductory course in calculus. But a business or an economics major will not find this answer particularly satisfying. Such a student will be happier with an example drawn from the accruing value of a bank account into which periodic payments are made.

This collection deals with these questions but from a somewhat different point of view. Problems are identified and, given the nature of those problems, the appropriate mathematics is brought to bear on their solutions. More specifically, the problems are drawn from sources in what is called–perhaps a tad pretentiously–the Real World. This is to say that mathematicians seek out problems from business, industrial, and local government sources and turn their students loose on these problems with varying amounts of assistance provided by faculty.

The origin for some of this collection was a workshop given at Marquette University in Milwaukee, Wisconsin, during the summer of 1996. This workshop, funded by a grant from the National Science Foundation (NSF), brought together four mathematicians involved, one way or another, in undergraduate consultancy projects, representatives from industry, and an audience of mathematicians interested in trying out the ideas presented by them. A unique aspect of the workshop was the inclusion of representatives of client companies who commented on their own experiences and their perceptions of student work in a business/industrial context.

The chapters that follow are adaptations of transcripts made at the workshop. We contend that the material herein is as relevant today as it was ten years ago, but with the passage of time, it has been necessary to update that material and each of the contributing authors has graciously done so. There are three supplementary chapters containing material that was not presented at the Marquette workshop: The opening chapter, *An Industrial Mathematics Program*, is based on a talk which George Corliss gave to an audience at the institution which is now called the University of Louisiana at Lafayette. It is an excellent overview of the subject of this collection. The two concluding chapters by Dan Maki and myself (Robert Fraga) are also supplementary. A sample student group report from the Math Clinic at Harvey Mudd College, in a slightly edited version, is provided as an appendix.

Let me say a few words about the principal contributors to this book.

George Corliss received his Ph.D. from Michigan State University. He has taught mathematics and computer science/engineering at Marquette University since 1978. A consultant with industry on a number of subjects, he has given talks to a variety of academic audiences on the practice and teaching of industrial mathematics.

Robert Borrelli received his doctorate from the University of California, Berkeley, and has been a professor at Harvey Mudd College since 1964. With industrial experience at Ford Aerospace and GTE Research Labs, he co-founded the Mathematics Clinic at Harvey Mudd and served as its director until his retirement.

Paul Campbell received a Ph.D. in mathematical logic from Cornell University. Working at Beloit College since 1977, where he served as Director of Academic Computing from 1987 to 1990, he has been Reviews Editor for *Mathematics Magazine* since 1977 and has been editor of *The UMAP Journal* since 1984.

Martha Siegel obtained her Ph.D. from the University of Rochester. From 1991 until 1996, she served as editor of *Mathematics Magazine*, one of many positions she has held with the Mathematical Association of America (MAA).

Daniel Maki has worked at Indiana University since 1979. His Ph.D. (1966) comes from the University of Michigan. In 2004, he was a recipient of the President's Award for Teaching Excellence.

Tom Davis was Senior Vice President of Super Steel Products Corp at the time he contributed his chapter to this book. Previously he had served as Dean of Faculty of the Milwaukee School of Engineering. His consultancy roster included more than four hundred companies and five hundred projects over a wide variety of topics.

Robert Fraga got his Ph.D. from the University of British Columbia in 1965. Currently at Baker University, he has worked in the calculus reform movement and on undergraduate consultancy projects, the subject of this book.

The authors who have contributed to this book come from a variety of backgrounds, and their remarks, although focusing on different aspects of consultancy projects, indicate how such projects can be carried out in a variety of academic contexts. Represented in this book are

- A large Jesuit university in an urban setting
- A small, prestigious college focusing on mathematics, science and engineering
- A state-supported university serving both residential and commuter students
- Two liberal arts colleges, one in a small city, the other in a rural environment
- A multi-campus state university

The workshop at Marquette concluded, not surprisingly, with the question "Where do we go from here?" Participants were inspired to emulate the practices described by the principal speakers, and some of them, in fact, returned to their home institutions where they conducted successful consultancy-type projects. But the ideas expounded at the workshop beg a wider audience, and that has provided the impetus for the creation of this book. It aims to promote an activity that has proven beneficial to its authors. The structure of the book is provided by various aspects of consultancy work, and these are generally suggested by the chapter titles. Running in parallel with this structure is an underlying theme: The variety of contributors and the institutions at which they work indicate that student consultancy work can be successfully undertaken over a wide spectrum of academic institutions. The hope is that this will provide the encouragement necessary to motivate readers to start programs of their own.

Acknowledgements

Lastly I need to thank the reviewers of the book for providing many insightful comments, some of which I have shamelessly cribbed in revising the text. Mistakes and lapses of judgement, however, are entirely my own and no one else's.

Robert Fraga
April 2006