PREFACE

First look backward in order to look forward.
Thomas J. Watson, Sr.

In this day of ever greater and greater scientific advances it is very tempting to pursue a course of study that concentrates on the advancing frontier of scientific knowledge. People who take this path often find that, although they are well equipped to deal with the latest ideas and machines, they lack an understanding of how these ideas germinated and why the latest tools are in their current forms. They also occasionally find that they produce, after a great deal of work, a process or instrument that is already well known to more experienced workers in the field, but had never come to their attention because of their own consuming interest in the "outer limits" of the subject. This is particularly true of the very rapid development, and subsequent abandoning, of various tools and techniques of computer science.

Many works have been written about the early history of the more traditional scientific subjects such as mathematics, chemistry, or physics, but very few have attempted to outline the historical development of the newer disciplines. This is unfortunate because most scientists are both more interesting to their friends and better prepared to meet new challenges if they have some understanding of how their subject has developed from its earliest beginnings.

Of all the different scientific topics that have been the subject of investigation, arithmetic is one that best combines an abstract character with universal use in all other branches of knowledge. This abstract character has led to the development of very elegant theories and the usefulness of the subject has resulted in the creation of many different machines, in almost every conceivable form of technology, to aid in the automation of the arithmetical processes.

It is the purpose of this book to explain and describe some historical aspects of *calculation* with an emphasis on the physical devices used, in different times, to aid people in their attempts at automating the process of arithmetic. It is quite impossible to cover all the different ideas and inventions produced to this end, and even more impossible to adequately describe the complete series of technological breakthroughs that led to the very rapid development of the electronic computer during the late 1950s and early 1960s. Not only are some of these developments the product of hundreds of different people working in very advanced laboratories, but some of them are considered as trade, or even state, secrets, and the owners of these rights are not about to let a simple historian in on their development sequence. I hope, however, that I have at least touched the highlights of the major advances in arithmetic from the beginnings of counting, through the three most important developments in the subject: the invention of the zero, logarithms, and the electronic computer. Along the way there are many interesting stories about both the machines and the scientists who produced them.

In attempting to set this material down in some logical form and sequence, a difficulty arose as to the arrangement of the subject matter, whether each subject should be considered in strictly chronological order or a full description be given to one aspect of the subject before going on to the next. After considerable debate, I have decided to use neither plan, but to use one or the other as best suited the subject matter.

As always in works of this kind, there will be errors. I have attempted to use only original source documents for many of my claims and statements but, when these were not available, I have resorted to secondary (and sometimes even remoter) sources. The errors remain, of course, mine. When I have neglected a certain line of development, it was usually for a good reason, but the fact remains that I may simply he unaware of its existence. I would welcome correspondence on any topic a reader feels has been misrepresented or simply skipped completely.

I would like to say a simple word of thanks to the National Science and Engineering Research Council of Canada and to the Social Science and Humanities Research Council of Canada, both of whom have provided several opportunities for me to gather the information contained in this volume. My colleagues and students at the University of Calgary, some of whom consider me mad because of my interest in the history of this subject, were the inspiration for this work. I would like to acknowledge their assistance in brewing tea for me at all hours of the night. Finally, I should thank my wife and family for being so understanding of my activities that they could condone my nocturnal habits and not complain when my nocturnal work (and tea drinking) interrupted our family life.

This work is dedicated to those computer pioneers I have met and admired, and to those whose life spans did not allow our actual meeting but whose work will stand as proof of their genius and hard work. It is also ded-

icated to my colleague, the man who writes strange programs, whose friendship I have enjoyed for over thirty years, may it last another forty!

Michael R. Williams, 1985

After about 8 years this work was no longer in print. Because it was still in use for a number of classes, and because several people pressed me to produce a revised edition (mainly to correct a few errors that were in the original version), I decided to revise the work in the summer of 1995. I have refrained from making major changes to the text or illustrations (although there are a great many minor changes) because of the large amount of time it would have taken. In the ten years since this book was originally published a number of scholars have made great contributions to the historical record and, where it was compatible with the goals of this revision, I have included some of this material. However for a more modern view of many topics I would recommend that serious readers consult the issues of the journal *Annals of the History of Computing* as well as several of the excellent books that have been published during the last ten years.

I am very pleased to indicate that my association with the man who writes strange programs has continued and I look forward to it lasting well in to the future.

Michael R. Williams, 1995