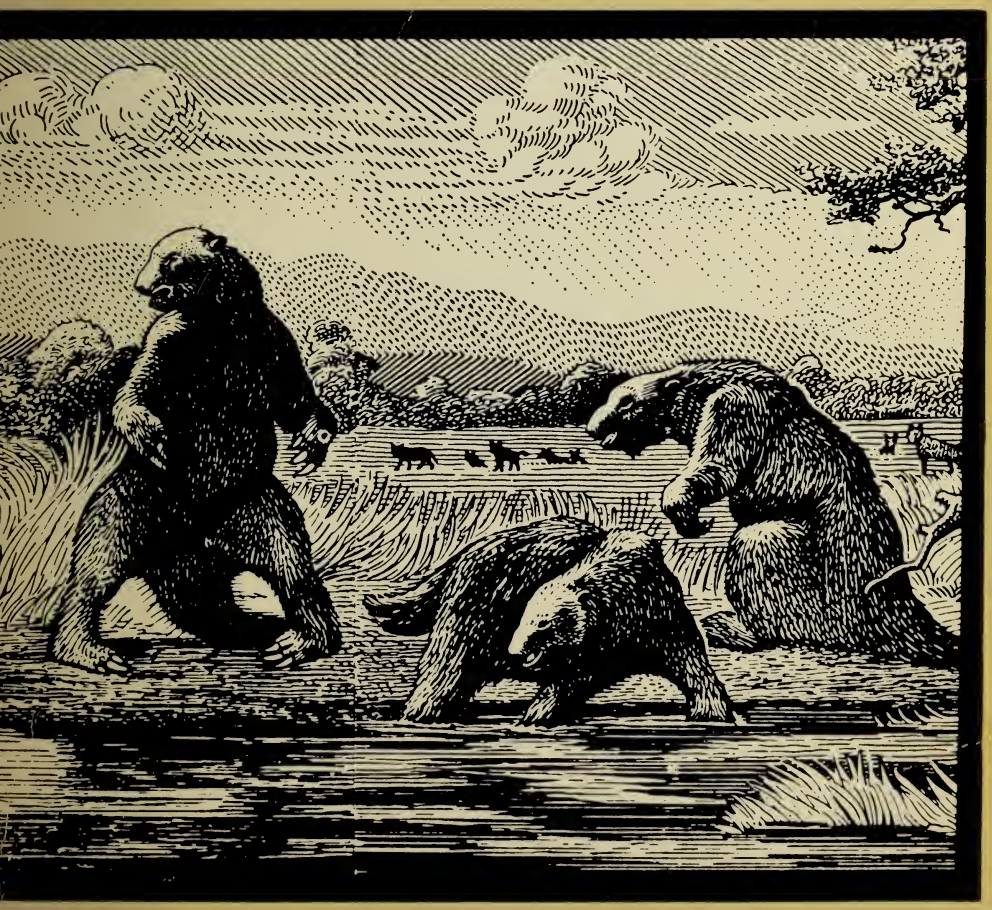
the mythical man-month

Essays on Software Engineering



Frederick P. Brooks, Jr.

ABOUT THE AUTHOR

Frederick P. Brooks, Jr., is Professor and Chairman of the Computer Science Department at the University of North Carolina at Chapel Hill. He is best known as the "father of the IBM System/360," having served as project manager for its development and later as manager of the Operating System/360 software project during its design phase. Earlier, he was an architect of the IBM Stretch and Harvest computers.

At Chapel Hill, Dr. Brooks has participated in the establishment and guiding of the Triangle Universities Computation Center and the North Carolina Educational Computing Service. He has published *Automatic Data Processing,* the *System/360 Edition* of *Automatic Data Processing,* and chapters in several other books.

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To two who especially enriched my IBM years:
Thomas J. Watson, Jr.,
whose deep concern for people still permeates his company,
and
Bob O. Evans,
whose bold leadership turned work into adventure.

Preface

In many ways, managing a large computer programming project is like managing any other large undertaking—in more ways than most programmers believe. But in many other ways it is different —in more ways than most professional managers expect.

The lore of the field is accumulating. There have been several conferences, sessions at AFIPS conferences, some books, and papers. But it is by no means yet in shape for any systematic textbook treatment. It seems appropriate, however, to offer this little book, reflecting essentially a personal view.

Although I originally grew up in the programming side of computer science, I was involved chiefly in hardware architecture during the years (1956–1963) that the autonomous control program and the high-level language compiler were developed. When in 1964 I became manager of Operating System/360, I found a programming world quite changed by the progress of the previous few years.

Managing OS/360 development was a very educational experience, albeit a very frustrating one. The team, including F. M. Trapnell who succeeded me as manager, has much to be proud of. The system contains many excellencies in design and execution, and it has been successful in achieving widespread use. Certain ideas, most noticeably device-independent input-output and external library management, were technical innovations now widely copied. It is now quite reliable, reasonably efficient, and very versatile.

The effort cannot be called wholly successful, however. Any OS/360 user is quickly aware of how much better it should be. The flaws in design and execution pervade especially the control program, as distinguished from the language compilers. Most of

these flaws date from the 1964–65 design period and hence must be laid to my charge. Furthermore, the product was late, it took more memory than planned, the costs were several times the estimate, and it did not perform very well until several releases after the first

After leaving IBM in 1965 to come to Chapel Hill as originally agreed when I took over OS/360, I began to analyze the OS/360 experience to see what management and technical lessons were to be learned. In particular, I wanted to explain the quite different management experiences encountered in System/360 hardware development and OS/360 software development. This book is a belated answer to Tom Watson's probing questions as to why programming is hard to manage.

In this quest I have profited from long conversations with R. P. Case, assistant manager 1964–65, and F. M. Trapnell, manager 1965–68. I have compared conclusions with other managers of jumbo programming projects, including F. J. Corbato of M.I.T., John Harr and V. Vyssotsky of Bell Telephone Laboratories, Charles Portman of International Computers Limited, A. P. Ershov of the Computation Laboratory of the Siberian Division, U.S.S.R. Academy of Sciences, and A. M. Pietrasanta of IBM

My own conclusions are embodied in the essays that follow, which are intended for professional programmers, professional managers, and especially professional managers of programmers.

Although written as separable essays, there is a central argument contained especially in Chapters 2–7. Briefly, I believe that large programming projects suffer management problems different in kind from small ones, due to division of labor. I believe the critical need to be the preservation of the conceptual integrity of the product itself. These chapters explore both the difficulties of achieving this unity and methods for doing so. The later chapters explore other aspects of software engineering management.

The literature in this field is not abundant, but it is widely scattered. Hence I have tried to give references that will both illuminate particular points and guide the interested reader to

other useful works. Many friends have read the manuscript and some have prepared extensive helpful comments; where these seemed valuable but did not fit the flow of the text, I have included them in the notes.

Because this is a book of essays and not a text, all the references and notes have been banished to the end of the volume, and the reader is urged to ignore them on his first reading.

I am deeply indebted to Miss Sara Elizabeth Moore, Mr. David Wagner, and Mrs. Rebecca Burris for their help in preparing the manuscript, and to Professor Joseph C. Sloane for advice on illustration.

Chapel Hill, N.C. F. P. B., Jr.
October 1974

Contents

1
The Tar Pit