Computer Science
and Applied Mathematics

MICRO DATABASE MANAGEMENT

PRACTICAL TECHNIQUES FOR APPLICATION DEVELOPMENT

Robert H. Bonczek, Clyde W. Holsapple,
and Andrew B. Whinston

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Practical Techniques for Application Development

ROBERT H. BONCZEK

CLYDE W. HOLSAPPLE

ANDREW B. WHINSTON

Management Information Research Center
Krannert Graduate School of Management
Purdue University
West Lafayette, Indiana

1984

ACADEMIC PRESS, INC.

(Harcourt Brace Jovanovich, Publishers)
Orlando San Diego New York London
Toronto Montreal Sydney Tokyo

ACADEMIC PRESS, INC.
Orlando, Florida 32887

United Kingdom Edition published by
ACADEMIC PRESS, INC. (LONDON) LTD.
24/28 Oval Road, London NW1 7DX

Library of Congress Cataloging in Publication Data

Bonczek, Robert H.
Micro database management.

(Computer science and applied mathematics)
1. Data base management. 2. Microcomputers--Programming. I. Holsapple, C. W. II. Whinston, Andrew B. III. Title. IV. Series.
QA76.9.D3B66 1984 001.64 83-15670
ISBN 0-12-113060-6

PRINTED IN THE UNITED STATES OF AMERICA

84 85 86 87 9 8 7 6 5 4 3 2 1

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This is a volume in
COMPUTER SCIENCE AND APPLIED MATHEMATICS
A Series of Monographs and Textbooks
Editor: WERNER RHEINBOLDT
A complete list of titles in this series appears at the end of this volume.

PREFACE

As the title suggests, the central purpose of this book is to help readers understand the possibilities and practicalities of building application systems with database management software. The microcomputer world presents nearly limitless opportunities for creators of application systems. Though not yet widely exploited by microcomputer users, database management is an extremely valuable aid in the design, construction, and maintenance of integrated application systems that are nontrivial and "bullet-proof." Despite our focus on utilizing database management in the micro world, the presentation is generally applicable to mini- and mainframe worlds as well. Descriptions of leading mainframe database management systems (DBMSs) are included to allow us to put micro database management capabilities into proper perspective.

We assume that the reader has a knowledge of the basic principles of programming. Preferably, this should be based on the first-hand experience of having written programs in either a traditional programming language (such as BASIC, COBOL, FORTRAN, Pascal, C, or PL/1) or the programming facilities offered in high-end integrated systems (such as KnowledgeMan). The book itself is not specifically oriented toward any one of these languages. It is helpful, though not mandatory, to have some familiarity with file management. An appendix reviewing file management highlights is provided as a refresher or introduction to the topic. There are no further prerequisites.

The book has been designed to fill several gaps in the existing collection of database management books. As the others, this book enables the reader to acquire a reading knowledge of database management. However, it also enables the reader to gain first-hand working knowledge of database management. The presentation is organized so that it can be used in conjunction with a fully

functional micro database management system. Such hands-on experience in actually using a DBMS to build application systems is an invaluable ingredient in developing a full and true appreciation of database management.

While the conceptual underpinnings and theoretical aspects of database management are not ignored here, there is a much greater emphasis on applied aspects of database management than is normally encountered in DBMS books. Extensive examples are included for illustrative purposes. In our view, the applied emphasis makes this book a useful introductory complement to strictly theoretical DBMS texts.

Another departure from existing DBMS texts is the extensive treatment given to a comparatively new postrelational approach to database management. Perhaps due to its name *(extended-network),* some observers mistakenly categorize it with the CODASYL-network model. There are both subtle (yet important) and quite striking differences between the two. We examine the traits and significance of this new approach. Due to its great flexibility in representing relationships and its high- and low-level manipulation languages, we find that an understanding of this approach makes it very easy to quickly reach an understanding of the older approaches. These older data models (inverted list, relational, hierarchical, shallow-network, CODASYL-network) are treated in sufficient depth to convey a practical appreciation of what is involved in using a DBMS based on any of them.

For the most part, existing DBMS texts ignore the micro world. We have chosen to emphasize the micro world because of its explosive growth and because it allows hands-on DBMS instruction very inexpensively relative to costs of mini- and mainframe DBMS usage. A few short books aimed specifically at the issue of data management on microcomputers have recently begun to appear. These typically consist of useful feature comparisons among popular micro file handling systems. In some cases, they also include descriptions of DBMSs. In keeping with the prevalent trend in the micro world, these books typically use the term "database management" very loosely. As a result, the multitude of micro file handlers (which store data in flat files and which sometimes allow the merging of files based on their redundant data), and in some cases even programming languages and operating systems, are frequently called "database management systems."

This is not a book about file management. We believe that it is very important for application developers to understand the distinction between database management and file management. Without this understanding, they are likely to remain unaware of the tremendous opportunities that exist for building extensive, integrated application systems for micros. Throughout this presentation, we use the term "database management" in a manner consistent with its customary, well-established meaning in the mainframe world.

The decision to support learn-by-doing experiences with this book necessitated the selection of a particular micro DBMS for use in discussion, examples,

exercises, and projects. This selection was based on a variety of criteria, the most important of which were as follows:

(1) availability of a comprehensive collection of database management abilities comparable to what is normally expected of a mainframe DBMS (e.g., logical structuring, physical structuring, query, multi-user, security, host language interface, recovery mechanisms);

(2) a proven track record in the micro world, having been successfully used by professional application developers to build systems that handle extensive and/or complex applications in diverse application areas;

(3) availability in a variety of the popular micro hardware/operating system environments (including Z80, 8086/8088, and 68000 hardware; CP/M, PCDOS/MSDOS, and UNIX operating systems);

(4) ability to be used with a variety of host languages, so that a reader need not learn a new programming language to make full use of the DBMS.

The product MDBS (Version 3 created by Micro Data Base Systems, Inc.) satisfies these criteria.

Because it provides so many of the abilities of a fully functional mainframe DBMS, MDBS is a useful vehicle for illustrating a wide range of database management facilities. Professional application developers have used it to build diverse application systems, some of which handle very complex application problems involving tens of megabytes of data. This DBMS is supported in a variety of popular micro (and mini) environments including: PCDOS (on the IBM PC and XT), MSDOS (on various 8086-based machines), CP/M (on Z80, 8080 and 8086 based computers), UNIX (on the AT&T 3B2-3B5 series, PDP-11 series, and various 68000-based machines), XENIX (on the Intel 80286-based model 286/310 and Altos 8086-based machines), and ULTRIX (on the Vax 11/780). MDBS has interfaces to numerous host programming languages and to the integrated KnowledgeMan system. Furthermore, a special inexpensive version of MDBS for use in educational settings is available from Micro Data Base Systems, Inc.

The book has been written with several audiences in mind:

(1) students in introductory database management courses of undergraduate computer science, management, and technology curricula or an MBA curriculum; the material has been organized also to be suitable for a two-semester sequence (with a recommended break at Chapter 9) that gives application development an in-depth treatment;

(2) application developers (analysts, designers, programmers) and consultants catering to the microcomputer software market;

(3) developers of decentralized systems on small computers within large organizations;

(4) small business proprietors and professionals with an interest in developing their own customized application systems;

(5) research scientists in large and small organizations who are already accustomed to small computers and who have an interest in more sophisticated ways of handling their data;

(6) microcomputer enthusiasts, in general, and those interested in database management, in particular.

In closing, we express our thanks to the many university students and application developers whose participation in coursework and in professional training seminars has played an important role in the evolution and refinement of the lecture notes on which this book is based. The general atmosphere of the Management Information Research Center (MIRC) in Purdue University's Krannert Graduate School of Management was particularly conducive to the development of insights and perspectives presented in this book. MIRC has received generous corporate support from IBM and General Electric. Mr. Frank G. Rodgers, Vice President of Marketing, and Mr. Charles Bowen, Director of Plans and Program Administration, both at IBM, have supported our MIS program in many ways, and we wish to thank them. We are also grateful to Dr. Gary Koehler and Dr. Mike Gagle (and their respective technical staffs) of Micro Data Base Systems, Inc. for providing the MDBS software that was used to verify the accuracy of examples shown in this book.

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Chapter 1

THE SIGNIFICANCE OF DATABASE MANAGEMENT FOR MICROCOMPUTERS

The pervasive impact of microcomputers on business and society is universally recognized. However, the significance of database management for microcomputers is not yet widely realized. Although most persons working with microcomputers would agree that a database management system is valuable, very few of them have a full appreciation of what database management really is. This is largely a result of repeated misuse of terminology in much of the micro trade press and marketing literature.

It is commonplace to see file management systems erroneously called database management systems. Sometimes even programming languages and operating systems are loosely referred to as database management systems. The unfortunate result is that there are many who believe that they know about database management and that they are in fact using database management systems. As long as they labor under this misconception, microcomputer users remain oblivious to the startling capabilities and benefits of real database management.

A different kind of misconception is common among persons working with mainframe computers. Database management systems have a long history on mainframes, and their significance is appreciated by mainframe users. However, there is a tendency to regard micros as *toys* that are incapable of effectively supporting the storage and processing of large volumes of interrelated data. While this is a fair assessment for low-end micros, there are 8- and 16-bit micros

that support database management software comparable in every respect to the most advanced mainframe database management systems. Indeed, an integrated micro database can be spread across numerous multi-megabyte hard disks.

Over time, the significance of database management for microcomputers will become more widely appreciated. It is an important key for unleashing the entire potential of high-end micros and is essential for taking micros beyond games, word processing, file management, spreadsheet analysis, and mediocre applications systems based solely on programming languages. With micro database management tools, micro application software of superlative quality becomes economically and technically possible. Chapter 2 provides an in-depth examination of the critical ingredients for building high-quality application software. Chapter 3 traces the origin and evolution of database management. The remaining chapters focus on practical techniques for using micro database management in the design and implementation of application software.

In this introductory chapter, we concentrate on organizational contexts within which microcomputers can appear. The implications of micro database management are examined in each of these contexts. In particular, we explore its potential contribution to decision support systems, its facilitation of information decentralization in large organizations, and its importance for small organizations.

1.1 DECISION SUPPORT SYSTEMS

Nobel laureate Herbert Simon has stated that we are experiencing the initial stages of the third information revolution, the first two such revolutions corresponding to the development of written language and the printed book respectively. According to Simon, the current revolution is motivated by the major technological improvements in computing and the dramatic increase in the complexity of our social, business, and governmental organizations. The latter phenomenon results in the increasing difficulty of analyzing problems that face organizations and a resulting demand for technological support of decision-making processes. The former phenomenon, which manifests itself as a continual fall in the hardware cost of processing information, has a great potential for assisting in the complex decision-making processes that are required for organizational survival.

Both human and computer systems can be effective information processors. Humans have problem-solving abilities based on training, experience, and intuition. These abilities cannot be used effectively unless the human decision maker has information relevant to the problem at hand. Computer systems can be effective providers of relevant information through data retrieval and/or com-