

S. BING YAO
EDITOR

PRINCIPLES *of* DATABASE DESIGN

VOLUME I
LOGICAL ORGANIZATIONS

CONTRIBUTORS

B.K. Kahn
Eric K. Clemons
Roger King
Dennis McLeod
Stanley Y.W. Su
Peter P.S. Chen
Y.E. Lien
George U. Hubbard
Alan R. Hevner
S. Bing Yao
V. Waddle
B.C. Housel
Shamkant B. Navathe

C
1845

Principles of Database Design

Volume I: Logical Organizations

S. Bing Yao, ed.

University of Maryland

Prentice-Hall, Inc.
Englewood Cliffs, N.J. 07632

BIBLIOTHEQUE DU CERIST

Library of Congress Cataloging in Publication Data

Main entry under title:

Principles of database design.

(Prentice-Hall series in advances in computing
science and technology)

Bibliography: p.

Includes index.

Contents: v. 1. Logical organizations.

1. System design. 2. Database management.

I. Yao, S. Bing. II. Series.

QA76.9.D3P73 1985 001.64 84-50573

ISBN 0-13-708876-0

Editorial/production supervision and

interior design: *Nancy Milnamow and Tracey L. Orbine*

Cover design: *Chris Wolf*

Manufacturing buyer: *Gordon Osbourne*

© 1985 by Prentice-Hall, Inc., Englewood Cliffs, New Jersey 07632

All rights reserved. No part of this book may be
reproduced, in any form or by any means,
without permission in writing from the publisher.

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

ISBN 0-13-708876-0 01

Prentice-Hall International, Inc., *London*
Prentice-Hall of Australia Pty. Limited, *Sydney*
Editora Prentice-Hall do Brasil, Ltda., *Rio de Janeiro*
Prentice-Hall Canada Inc., *Toronto*
Prentice-Hall Hispanoamericana, S.A., *Mexico*
Prentice-Hall of India Private Limited, *New Delhi*
Prentice-Hall of Japan, Inc., *Tokyo*
Prentice-Hall of Southeast Asia Pte. Ltd., *Singapore*
Whitehall Books Limited, *Wellington, New Zealand*

4566

Contents

Preface

1	Requirement Specification Techniques	<i>(B. K. Kahn)</i>	1
1.1	<i>Requirements for a Successful Database Design</i>		1
1.2	<i>Requirements Documents</i>		4
1.3	<i>Preparing a Requirements Document</i>		13
1.4	<i>Alternative Approaches to the Requirements Process</i>		17
1.5	<i>Classes of Techniques for the Requirements Process</i>		20
1.6	<i>Example Techniques of the Requirements Process</i>		22
1.7	<i>Problem Statement Language and Problem Statement Analyzer</i>		39
1.8	<i>Data Dictionary Systems</i>		58
	<i>References</i>		62
	<i>Additional Readings</i>		65
 2	 Data Models and the ANSI/SPARC Architecture		
	<i>(Eric K. Clemons)</i>		66
2.1	<i>Introduction: Competing Data Models and the ANSI/SPARC Architecture</i>		66
2.2	<i>The ANSI/SPARC Architecture</i>		68
2.3	<i>The External Schema</i>		73

2.4	<i>Relationships in Database Systems: a Brief Introduction</i>	76
2.5	<i>Hierarchical Systems</i>	81
2.6	<i>Second Major Data Model—CODASYL Network Approach</i>	88
2.7	<i>Final Major Data Model—the Relational Approach</i>	100
2.8	<i>Conclusions: Comparisons and Evaluations</i>	109
	<i>References</i>	112
3	Semantic Data Models (Roger King and Dennis McLeod)	115
3.1	<i>Introduction</i>	115
3.2	<i>Conventional Database Models</i>	116
3.3	<i>Semantic Database Models</i>	126
3.4	<i>Summary</i>	146
	<i>References</i>	146
4	Processing-Requirement Modeling and Its Applications in Logical Database Design (Stanley Y. W. Su)	151
4.1	<i>Introduction</i>	151
4.2	<i>Processing-Requirement Modeling at the Data-Item Level</i>	153
4.3	<i>Processing-Requirement Modeling at the Query Level</i>	159
4.4	<i>Processing-Requirement Modeling at the Transaction Level</i>	168
4.5	<i>Summary</i>	172
	<i>References</i>	172
5	Database Design Based on Entity and Relationship (Peter P. S. Chen)	174
5.1	<i>Introduction</i>	174
5.2	<i>Entity-Relationship (ER) Diagram</i>	177
5.3	<i>Translation of ER Diagram into Data-Structure Diagrams</i>	186
5.4	<i>Steps in Logical Database Design and an Example</i>	193
5.5	<i>Other Considerations in Logical Database Design</i>	204
5.6	<i>Design of Hierarchical Databases</i>	206
5.7	<i>Final Remarks and Further Readings</i>	207
	<i>References</i>	208
6	Relational Database Design (Y. E. Lien)	211
6.1	<i>Introduction</i>	211
6.2	<i>The Relational Model</i>	212

6.3	<i>The Database Design Process</i>	226
6.4	<i>Database Design Algorithms</i>	232
6.5	<i>Summary</i>	252
	<i>References</i>	252
7	Computer-Assisted Hierarchical Database Design (George U. Hubbard)	255
7.1	<i>Introduction</i>	255
7.2	<i>Computer-Assisted Design</i>	256
7.3	<i>Preliminary Concepts</i>	256
7.4	<i>Characteristics of DL/I Databases</i>	259
7.5	<i>DL/I Logical Design</i>	260
7.6	<i>Predesign Data-Requirements Analysis</i>	265
7.7	<i>Logical Design Case Study</i>	269
7.8	<i>Using a Dictionary in Database Design</i>	289
7.9	<i>Summary</i>	292
	<i>References</i>	293
8	Network Database Design Methods (Alan R. Hevner and S. Bing Yao)	294
8.1	<i>Introduction</i>	294
8.2	<i>Heuristic Schema Design Methods</i>	297
8.3	<i>Network Design Using Normalized Relations</i>	310
8.4	<i>Optimization Models for Network Schema Implementation</i>	316
8.5	<i>Automating the Database Design Process</i>	321
	<i>References</i>	323
9	An Interactive System for Database Design and Integration (S. Bing Yao, V. Waddle, and B. C. Housel)	325
9.1	<i>Introduction</i>	325
9.2	<i>Methodology</i>	326
9.3	<i>The Functional Data Model</i>	327
9.4	<i>Transaction Specification Language</i>	335
9.5	<i>Operations on the Model</i>	338
9.6	<i>Model Integration</i>	344
9.7	<i>Design Evaluation</i>	351
9.8	<i>Summary</i>	358
	<i>References</i>	358

10 Schema Implementation and Restructuring <i>(Shamkant B. Navathe)</i>	361
10.1 Introduction	361
10.2 The Importance of Schema Implementation and Restructuring	364
10.3 What is Involved in Schema Implementation	365
10.4 Schema Restructuring	371
10.5 Approaches To Schema Restructuring	376
10.6 Development of Schema Conversion Aids	392
10.7 Prognosis	394
References	394
 Index	 397