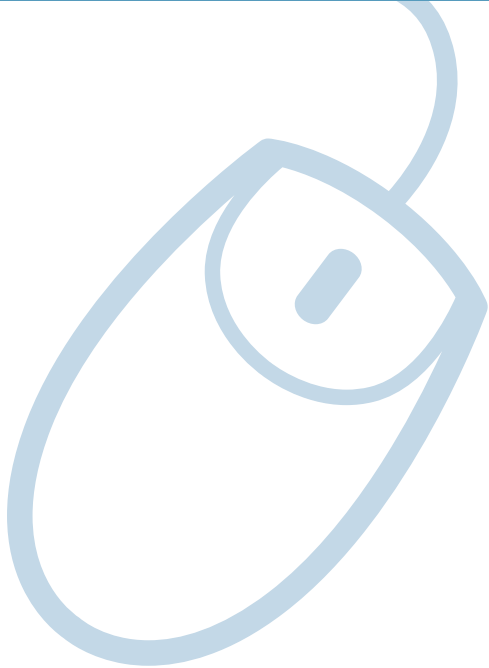




Bringing British
Education to You
www.nccedu.com

Database Design and Development

International Advanced
Diploma in Computer Studies
(IADCS) 2008



DATABASE SYSTEMS
THIRD EDITION

DATABASE SYSTEMS THIRD EDITION

Paul Beynon-Davies

palgrave
macmillan

© Paul Beynon-Davies 1996, 2000, 2004

First published in English by Palgrave Macmillan, a division of Macmillan Publishers Limited under the title Database Systems, 3rd edition by Paul Beynon-Davis. This edition has been reprinted under licence from Palgrave Macmillan. The author has asserted his rights to be identified as the author of this Work. For copyright reasons this edition is only to be sold as part of an NCC Education course.

All rights reserved. No part of this book may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording or by any information storage retrieval system, without permission from the publisher.

ISBN: 1-403-91601-2

Printed by B & Jo Enterprise Pte Ltd in Singapore.



CONTENTS

| | | |
|---------------|--|------------|
| | PREFACE TO THE THIRD EDITION | ix |
| PART 1 | FUNDAMENTALS | 1 |
| | 1 Database Systems as Abstract Machines | 3 |
| | 2 Data and Information | 19 |
| | 3 Database, DBMS and Data Model | 30 |
| | 4 Database Systems, ICT Systems and Information Systems | 48 |
| | 5 Database Systems and Electronic Business | 62 |
| | 6 Data Management Layer | 76 |
| PART 2 | DATA MODELS | 87 |
| | 7 Relational Data Model | 89 |
| | 8 Object-Oriented Data Model | 113 |
| | 9 Deductive Data Model | 125 |
| | 10 Post-Relational Data Model | 143 |
| PART 3 | DATABASE MANAGEMENT SYSTEMS (DBMS) – INTERFACE | 155 |
| | 11 SQL – Data Definition | 157 |
| | 12 SQL – Data Integrity | 168 |
| | 13 SQL – Data Manipulation | 177 |
| PART 4 | DATABASE DEVELOPMENT | 193 |
| | 14 Database Development Process | 195 |
| | 15 Requirements Elicitation | 208 |

| | | |
|---------------|---|------------|
| 16 | Entity–Relationship Diagramming | 219 |
| 17 | Object Modelling | 246 |
| 18 | Normalisation | 269 |
| 19 | Physical Database Design | 292 |
| 20 | Database Implementation | 309 |
| PART 5 | PLANNING AND ADMINISTRATION OF DATABASE SYSTEMS | 321 |
| 21 | Strategic Data Planning | 323 |
| 22 | Data Administration | 334 |
| 23 | Database Administration | 343 |
| PART 6 | DATABASE MANAGEMENT SYSTEMS (DBMS) – TOOLKIT | 355 |
| 24 | DBMS-Toolkit – End-User Tools | 357 |
| 25 | DBMS-Toolkit – Application Development Tools | 365 |
| 26 | DBMS-Toolkit – Database Administration Tools | 375 |
| PART 7 | DATABASE MANAGEMENT SYSTEMS – KERNEL | 381 |
| 27 | Data Organisation | 383 |
| 28 | Access Mechanisms | 395 |
| 29 | Transaction Management | 403 |
| 30 | Other Kernel Functions | 418 |
| PART 8 | DATABASE MANAGEMENT SYSTEMS – STANDARDS AND COMMERCIAL SYSTEMS | 425 |
| 31 | Post-Relational DBMS – SQL3 | 427 |
| 32 | Object-Oriented DBMS – ODMG Object Model | 436 |
| 33 | Microsoft Access | 446 |
| 34 | ORACLE | 457 |
| 35 | O ₂ DBMS | 467 |
| PART 9 | TRENDS IN DATABASE TECHNOLOGY | 475 |
| 36 | Distributed Processing | 477 |
| 37 | Distributed Data | 486 |
| 38 | Parallel Databases | 498 |
| 39 | Complex Data | 512 |



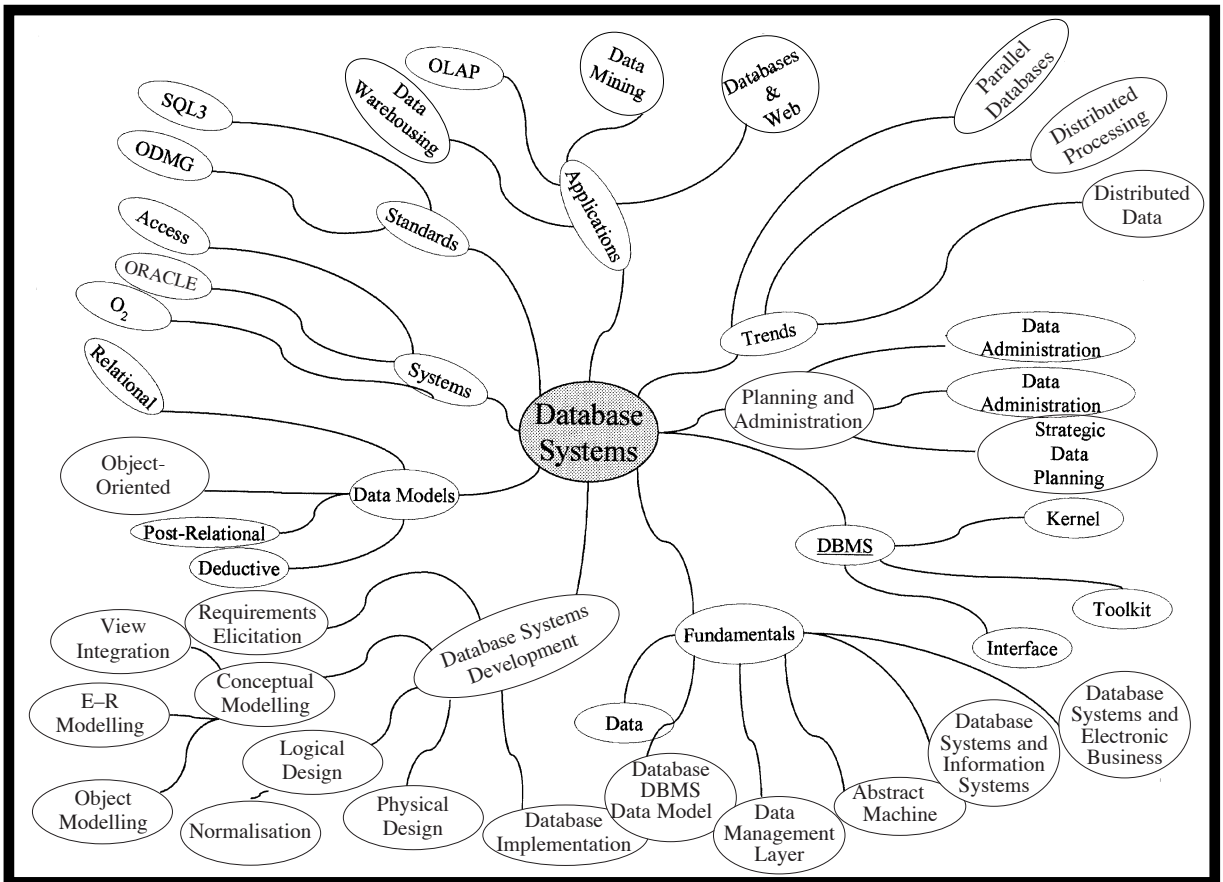
| | | |
|----------------|---|------------|
| PART 10 | APPLICATIONS OF DATABASE SYSTEMS | 525 |
| 40 | Data Warehousing | 527 |
| 41 | On-Line Analytical Processing | 539 |
| 42 | Data Mining | 547 |
| 43 | Databases and the Web | 554 |
| | BIBLIOGRAPHY | 567 |
| | GLOSSARY AND INDEX | 572 |



PREFACE TO THE THIRD EDITION

Perhaps the most valuable result of all education is the ability to make yourself do the thing you have to do, when it ought to be done, whether you like it or not.

Thomas H. Huxley (1825–95)




 MISSION

The main aim of this work is to provide one readable text of essential core material for further education, higher education and commercial courses on database systems. The current volume is designed to form a consolidated, introductory text on modern database technology and the development of database systems.

It is undoubtedly true that database systems hold a prominent place in most contemporary approaches to the development of information systems. It is this practical emphasis on the use of database systems for information systems work that distinguishes the current volume from other texts on the subject. This work therefore forms a companion volume to *Information Systems: An Introduction to Informatics in Organisations* (Beynon-Davies, 2002) and to *e-Business* (Beynon-Davies, 2003), also published by Palgrave Macmillan. The current version has been revised to reflect the successful style and organisation of the *Information Systems* text.

The text is built from the author's experiences of consultancy in this area, as well as in running a number of academic and commercial courses on database technology and database development for several years.

 CHANGES TO THE THIRD EDITION

Two types of changes have been made to the third edition: presentational and content. In terms of presentation, the structure of the chapters has been reorganised and the parts resequenced to make for a better educational experience. In terms of content, the third edition has been expanded considerably. This expansion has enabled particular topics to be covered in more depth:

- The part on database system fundamentals has been extended with a number of chapters, particularly with a chapter defining the concept of data and a chapter considering the important place of database systems in the informatics infrastructure for electronic business
- A new part has been added which extends the discussion on the SQL database sublanguage
- Chapters on the ORACLE DBMS and the Microsoft Access DBMS have been updated
- New chapters have been included on the database development process and requirements elicitation
- The part on trends has been reorganised around four chapters: distributed processing, distributed data, parallelism and complex data. This latter chapter now includes coverage of semi-structured data and XML
- The chapter on database systems and the Web has been updated

Many chapters have been updated with developments since 2000, and the structure of a number of chapters changed to provide a more coherent presentation of key topics. The sequencing of parts has been particularly changed in response to requests for a more natural flow of topics. All chapters have been revised to align with the successful style of *Information Systems*, including examples, Case Studies and spider diagrams (see below).

PARTS

The text is organised into a number of parts:

- *Part 1: Fundamentals.* The introductory chapters set the scene for the core of the text. We begin with a description of the key features of a database system. We then move on to define some key concepts and illustrate the importance of database technology to contemporary information systems and electronic business. We close this part with an example of some of the key features of the data management layer of an information and communications technology (ICT) system
- *Part 2: Data Models.* Part 2 explores a number of contemporary architectures for database systems. Because of its current dominance, particular emphasis is placed on the relational data model, although developments in object-oriented data management explain the extended coverage offered. We also consider another data model that is significant because of its association with 'intelligent' applications – the deductive data model. We close this part with a consideration of a hybrid data model – the extended-relational, object-relational or post-relational data model – which is important because of its popularity among contemporary DBMS
- *Part 3: DBMS Interface.* Part 3 addresses the issue of the standard interface to DBMS – structure query language (SQL). We consider how SQL may be used to declare database schemas, maintain data in such schemas and implement integrity for such schemas
- *Part 4: Database Development.* Part 4 represents a discussion of the major elements of database systems development. We begin with a description of the development process and the toolkit needed by the database developer. This is followed by a description of the features of requirements elicitation. In terms of conceptual modelling we discuss the techniques of entity–relationship diagramming and object modelling. In terms of logical modelling we discuss the technique of normalisation. We conclude with a review of a number of issues involved in the physical design of databases and database implementation
- *Part 5: Planning and Administration of Database Systems.* The issue of planning and administering data in organisations is considered in this part. We first consider the issue of using corporate data models to plan for database systems. This is followed by a consideration of the importance of administering data

within organisations. We conclude with a review of the database administration function

- *Part 6: DBMS – Toolkit.* In this part we consider the toolkit of products that can be used in association with DBMS. The toolkit is divided into end-user tools, database administration tools and application development tools
- *Part 7: DBMS – Kernel.* This part considers some of the critical functions of the kernel of a database management system (DBMS): data organisation, access mechanisms, query management, transaction management, database security and database recovery
- *Part 8: DBMS – Standards and Commercial Systems.* Part 7 discusses the architectures and facilities available in three contemporary DBMS – one relational (Microsoft Access), one post-relational (ORACLE) and one object-oriented (O₂). We also consider developments among the SQL3 and ODMG standards for DBMS
- *Part 9: Trends in Database Technology.* This part considers some of the developing infrastructure for databases. It consists of four chapters which look at areas having a significant effect on the functionality of database systems: the issues of distributing data and processing, parallelism and handling semi-structured data
- *Part 10: Applications of Database Systems.* This part discusses four contemporary applications for database systems: data warehousing, OLAP, data mining, and databases and the Web



PRESENTATION

The presentation of the book is deliberately designed to be used within some structured learning activity. Each part of the book begins with a section summarising the key elements of the database systems domain considered. Each chapter in the book is designed as a learning unit and aims at imparting a number of key concepts in the area of database systems. The structure of each chapter consists of:

- A set of learning outcomes
- A series of sections. Each section provides a description of a key concept and an example of the concept, where relevant
- A Case Study is presented at the end of most chapters and is used to illustrate some real-world expression of the concepts discussed
- A summary of key points
- A set of activities for further consideration. Many activities are designed for readers to attempt to apply a concept discussed in the chapter to some of their own experience or understanding
- A set of references

Each part of the book and chapter now includes a spider diagram. Spider diagrams were originally developed by Tony Buzan (1982) as an effective method of note-taking within study which exploits the natural ability of humans to associate. The idea of a spider diagram is simply to relate concepts together using free-form lines. The centre of the diagram is used to locate the orienting concept. Hence the spider diagram at the start of this Preface details the structure of the entire book. Associated concepts are drawn radiating outwards. Any concept on a spider diagram may act as an orienting concept on its own spider diagram. In this way, most of the detailed structure of the book can be observed in the set of spider diagrams.

Spider diagrams are primarily used as a method of summarising the organisation of information contained in this work. However, we hope that the student of the area will also find them useful as a revision aid, and the lecturer or instructor will find them useful as a way of summarising key elements of the domain.

WEB-SITE AND FEEDBACK

A Web-site, including a teaching pack for lecturers/instructors, has been produced to accompany the book and can be accessed at

www.palgrave.com/resources

The author is keen to receive feedback on the current text. Any comments or suggestions should be addressed to the author (p.beynon-davies@swansea.ac.uk).

SUGGESTED ROUTES THROUGH THE MATERIAL

Below we indicate some ways in which the material may be used in educational modules and courses. These are meant to be purely suggestions.

INTRODUCTORY MODULE IN DATABASE SYSTEMS

An introductory module in database systems should provide a basic understanding of database concepts and an appreciation of database development issues. For this purpose the following chapters are suggested: *four chapters in fundamentals; relational data model; SQL; access; normalisation; E-R diagramming.*

INTERMEDIATE MODULE IN DATABASE SYSTEMS

An intermediate module should impart an understanding of the architecture of a DBMS and issues pertaining to physical design and database administration. For this purpose the following chapters are suggested: *kernel chapters; toolkit chapters; ORACLE; database administration; physical design; database implementation.*

ADVANCED MODULE IN DATABASE SYSTEMS

Advanced modules in database systems should provide an awareness of alternative approaches to handling data and developing database systems over and above that provided by the relational data model and relational databases. For this purpose the following chapters are suggested: *OO data model; deductive data model; post-relational data model; OODBMS; object modelling; strategic data planning; data administration; trends.*

ACKNOWLEDGEMENTS

My thanks to Rebecca Mashayekh at Palgrave Macmillan for encouragement and support in producing this book. My thanks also to a number of anonymous reviewers for their helpful suggestions.

TRADEMARK NOTICE

Access™ and SQL Server™ are trademarks of Microsoft
O₂™ is a trademark of O₂ Technology
ORACLE™ is a trademark of the Oracle Corporation

REFERENCES

Beynon-Davies, P. (2002). *Information Systems: An Introduction to Informatics in Organisations*. Basingstoke, Palgrave (formerly Macmillan).
Beynon-Davies, P. (2003). *e-Business*. Basingstoke, Palgrave Macmillan.