Information Systems Development

Methodologies, Techniques and Tools

D. E. AVISON
AND G. FITZGERALD

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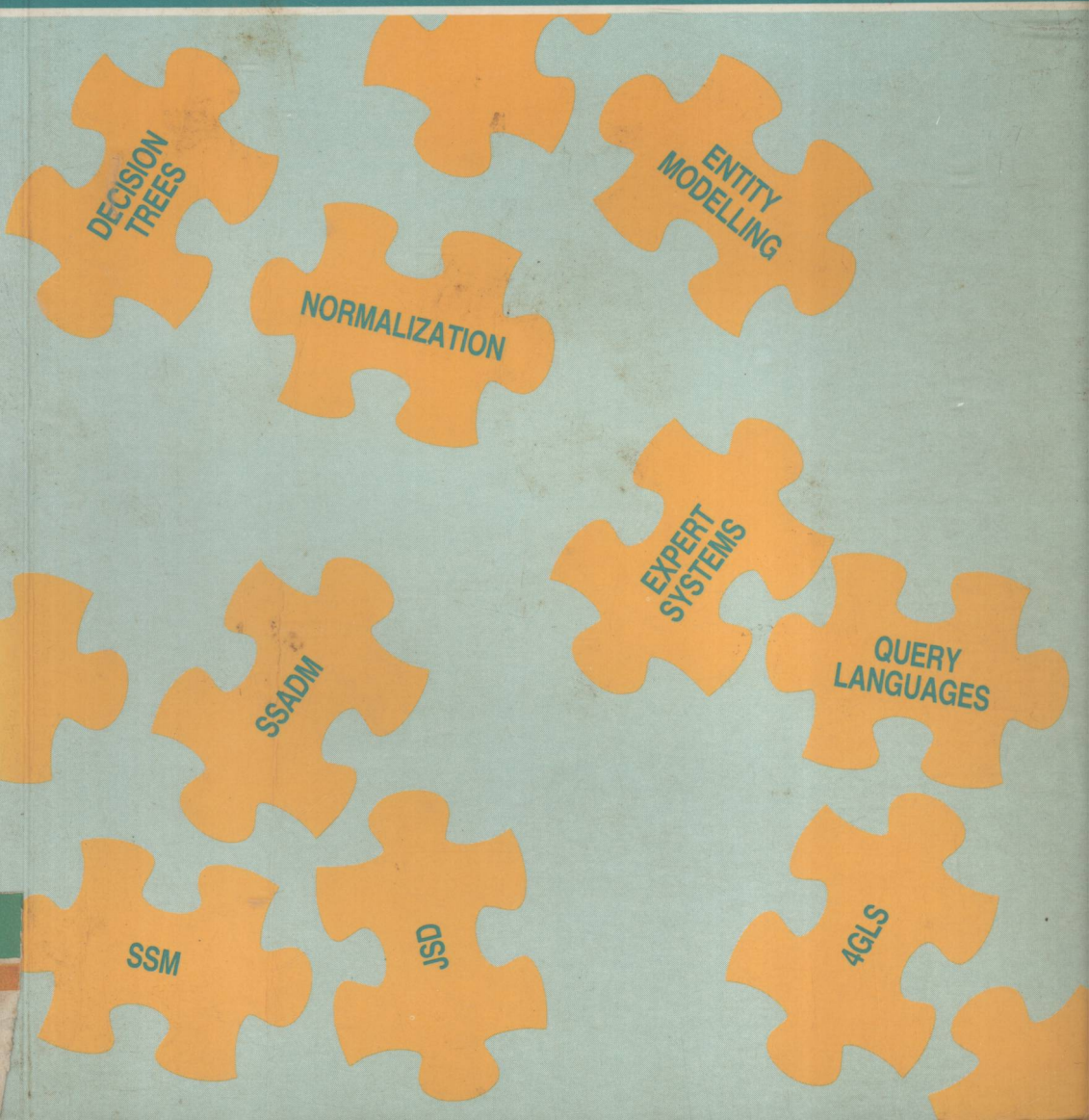

INFORMATION SYSTEMS SERIES

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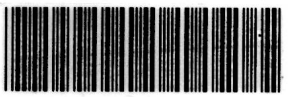

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This is a brand new series of student texts covering a wide variety of topics relating to information systems. It is designed to fulfil the needs of the growing number of courses on, and interest in, computing and information systems which do not focus purely on the technological aspects, but seek to relate these to business or organizational context.

Preface

This book is designed for students of data processing, systems analysis and information systems at both undergraduate and masters levels. It is also aimed at practitioners and managers who wish to make sense of this currently highly confused field. The process of developing information systems has not always been successful and this book explains why this has happened. It examines some of the more recent methodologies, techniques and tools that aim to improve the record. Given this knowledge, the reader should be able to understand the principles involved, the benefits that are claimed, and to make a contribution to the practice of information systems development.

Early computer applications were implemented without the aid of an explicit information systems methodology. The emphasis was towards programming and this meant that the analysis work was rarely done well and that the design was frequently inappropriate for the application. This was at least partly due to poor communications between users and programmers. Soon the need for a more formal methodology was recognized, and the methodologies of the late 1960s and 1970s emphasized the importance of documentation standards and good training for systems analysts. This was certainly an improvement. However, there were still a number of problems associated with the methodologies of the 1970s. The systems that they produced were sometimes inflexible, unambitious, incomplete, had a high maintenance overhead, and frequently led to user dissatisfaction. The 1980s have witnessed a growth in the number and variety of information systems methodologies. Some are becoming widely used. Their designers claim that they will solve at least some of the problems associated with earlier methodologies and offer advantages over their competitors.

This increase in the number of methodologies has caused much confusion. Many are the same (or very similar) and yet they have different 'brand names'. They may use similar techniques and tools but give them different names. Some emphasize particular techniques and offer a 'scientific' approach, others emphasize the role of the computer, of documentation, and others, the role of the people using the system. Some methodologies emphasize the importance of data and the development of a computer database, whilst others concentrate on the processes that use the database. Some concentrate on analysis, others on design or implementation. Some methodologies have developed according

to national traditions. Some are associated with particular consultancy houses or computer manufacturers. When looking at any approach in isolation, it is difficult not to be convinced by the advantages of that particular approach, but it may not be appropriate for all situations and its shortcomings may not be revealed without comparing it to other approaches.

The purpose of this text is to offer order out of the chaos. It looks at a number of information systems methodologies, and the techniques and tools that might be used in them. This book also attempts to classify methodologies, suggesting reasons why a type of methodology is important, perhaps suggesting situations where that type of methodology might be appropriate, and describing a particular example of each 'genre'.

Chapter 1 sets the scene, introducing information systems and methodologies as a way of developing information systems. It is argued that there is a need for a methodology. The track record of early computing is not a good one — schedules not followed, promises unfulfilled, and systems implemented but not used. Suggestions are made regarding what might be expected from a methodology.

Chapter 2 looks at the various approaches to information systems of the mid and late 1970s. It could be looked upon as a history of ideas and practice that led up to the present interest in information systems methodologies. This period was one where the need for a methodology to develop information systems was recognized but there were problems with the techniques and tools used. More importantly, they were limited in scope so that the methodologies tended to computerize the existing manual system without taking the opportunity to reassess the system itself.

Chapter 3 looks at the many themes in information systems methodologies which addressed the weaknesses described in Chapter 2. They include themes which could be described as process orientated, data orientated, software orientated and people orientated. Some can be described as formalized, others as being based on automation, and others on strategic planning. A section is also given to those themes which are at the moment research based, but may later bear fruits in new approaches to information systems development. Information systems is a fairly new discipline and a number of differences of opinion exist and are to be expected. This chapter also begins to categorize the approaches used by the 'brand-name' methodologies which are discussed in Chapter 6.

Chapter 4 describes the various techniques which are used in information systems methodologies. Many methodologies share techniques and a description of them at this point avoids unnecessary repetition. It also means

that in Chapter 6, the general principles of a methodology are not obscured by a need to understand the particular techniques that it uses. Techniques described include data flow diagrams, decision trees, decision tables, structured English, action diagrams, entity modelling, normalization and entity life cycles. These techniques might be used to aid the analysis, design or implementation of the information system. They might be used to help communication between the technologists who are developing the system and users who will eventually use the information system.

Chapter 5 looks at the various tools that are available which support a number of methodologies and might be used to speed up the development of an information system or help to make the resulting system closer to the real needs of the users. These tools include fourth generation systems, database management systems, query languages, data dictionaries, analyst workbenches, project management packages and expert systems.

Chapter 6 looks at a number of information systems methodologies which are well used, respected, or typify the themes described in Chapter 3. These include: a structured approach, STRADIS, based on the work of Gane and Sarson; IE, based on the work of Martin and Finkelstein; SSADM, a methodology developed by Learmonth and Burchett; JSD, a systems development methodology by Jackson; ISAC, a methodology developed in Scandinavia by Lundberg; ETHICS, a methodology developed by Mumford; and SSM, a methodology developed by Checkland. We also look at Multiview, a hybrid methodology, which brings in aspects of other methodologies and adopts techniques and tools which might then be used in a contingency framework, applied as the application demands. In Chapter 6 the methodologies are described largely uncritically so that the readers can follow their principles and practice. We have not described similar methodologies, even if they are both equally well used, but have referenced this similarity where appropriate.

The main purpose of Chapter 7 is to step back and compare the background, philosophy, applicability, and concepts of the various methodologies. A framework is proposed for evaluating methodologies and we have illustrated the use of this framework by applying it to the methodologies described in the text. Its function is not to offer a 'best buy', as each methodology has different objectives as well as its strengths and weaknesses. Applying a methodology 'blindly' will not necessarily lead to success. The secret is to know when and where a particular methodology might be appropriate.

The book has been designed to be used in a number of ways. Students of

information systems and business readers interested in an overview of the area might wish to read the text from beginning to end, but there are many situations where it is more appropriate to choose particular chapters or sections. For example, some readers may wish to assess methodologies in general and it might be best to start by reading Chapters 6 and 7. Others may wish to look at a particular methodology and read only the relevant section in Chapter 6. If readers come across particular techniques or tools which are new to them, then they can read the relevant sections in Chapters 4 and 5 for this information. Other readers may wish to have an overview of particular techniques (Chapter 4) or tools (Chapter 5). In order to provide this flexibility it has been necessary to incorporate some repetition in the text as well as cross-referencing.

The text will be of particular value to students of data processing and systems analysis in both computer science and business courses at polytechnics and universities. These readers could use the book to gain an overall appreciation of information systems development, and to understand the methodologies, techniques and tools used. We have assumed that readers have at least a basic knowledge of computer data processing which could have been provided by an introductory course or equivalent experience. The material in the text has been used as the basis of a final year undergraduate option in management studies and in various Masters programmes at the School of Industrial and Business Studies at the University of Warwick. It is also used in second year and final year options in the undergraduate courses in computer science and in the MSc courses in software engineering applications and information technology in the Department of Computer Science and Applied Mathematics at Aston University.

The text aims to be useful to students and courses following the IFIP/BCS curriculum for Information Systems Designers defined in Buckingham *et al.* (1987b). It is relevant for a number of modules in that curriculum, but especially the level 3 module, 3.1 'Information systems: the evolutionary process'.

The text should also be useful to professionals involved in the analysis, design and development of information systems. It would be useful to data processing managers before making a decision on 'what methodology to adopt?' or to re-assess the methodology used. Other professionals could be users or managers involved in an information systems project or the analysts and programmers developing that system. Systems analysts have often been trained to use a particular approach as if it were the only approach available

but, armed with the knowledge gained from this text, they should be aware of its weaknesses and might compensate for them by incorporating certain relevant elements from other methodologies.

We are all too aware of the problems of writing such a text. Each methodology, technique and tool could merit a book in its own right. Sometimes such a book already exists. This present text provides an overview and appropriate references for further reading. Another problem is that the area of information systems development is a moving target. For example, since starting to write this book, the power and influence of 'fourth generation systems' has grown enormously. Efforts are now being made to develop expert systems which could hold the expertise of the systems analysts and researchers in information systems in their knowledge base. We have tried to reflect these aspects of this exciting area as well as reflect present practice.

We are also aware that we have attempted to be systems analysts, engineers, computer scientists, mathematicians, management scientists, sociologists, political scientists and psychologists in this work, because the world of information systems covers all these disciplines and more. We are not all of these things. Worse, we may have neglected and misinterpreted the views of many writers, researchers, and practitioners in the information systems field. The views expressed here are those of the authors of the text, not those of the methodology authors or vendors. You may also detect bias in our accounts. We have tried to avoid bias, but it almost certainly will be there, no-one is completely objective (even if some methodology vendors claim to be objective). We hope and expect that lecturers will question some of the arguments presented and use the text as the basis for discussion, rather than a factual account of the 'state-of-the-art'.

The authors are both academics who are presently teaching and researching into information systems. They have also had considerable experience in industry and commerce working in information systems development at, for example, CACI International, Conoco Europe, John Laing, British Telecom, Ranks Hovis Macdougall, Jones Lang Wootton, Rothschilds Intercontinental, and Abbott Laboratories.

We would like to thank Gilbert Mansell of Huddersfield Polytechnic and Bob Wood of Bristol Polytechnic who contributed much to the early planning and content of this text. We also express thanks to many of our friends and colleagues who have commented on the text at various stages in its production including Carol Byde of Aston University, Paul Catchpole of

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David Avison and Guy Fitzgerald
May 1988

Contents

Chapter 1
Introduction

1.1 INFORMATION SYSTEMS

This text is about information systems and discusses ways of developing information systems which will prove useful to organizations. The system is a grouping of people, objects and procedures. An information system provides information about the organization and its environment. This information, which is useful to members and clients of that organization, could concern its customers, suppliers, products, equipment, and so on. The organization could be a business, church, hospital, university, bank, library, and so on.

Most of the methodologies described in this text concern themselves with *formalized* information systems. By formalized, we do not mean 'mathematical', which is one interpretation of the term 'formal' (see section 3.6). We use the term to distinguish information systems discussed here from less formalized information systems such as the 'grapevine', consisting of rumour, gossip, ideas and preferences, which is also a valid information system. These informal information systems tend to be intuitive or qualitative. Organizations need also to develop formalized systems which will provide information on a regular basis and in a pre-defined manner.

We are mainly concerned with *computer-based* information systems, for the computer can process data (the basic facts) speedily and accurately and provide information when and where required and at the correct level of detail. This does not mean that it is 'purely' a computer system — there will be many manual (or *clerical*) aspects — it means that part of the system is likely to use a computer. The computer might be used to store data, produce reports or handle management enquiries.

Some examples of information systems might be helpful:

- A payroll system is an information system. All organizations have employees and they will normally be paid. The raw data of a payroll system includes the number of hours worked by the employees, their rates of pay, and deductions, such as tax and national insurance. The system might produce payslips, and reports for management about the payroll.

- A sales ledger system is an information system. It is a system relating to the accounts of customers. The raw data of a sales ledger system relates to sales to customers and remittances from them. The system will provide statements of any balances owing, and could produce analyses of debtors' balances according to area, sales representative and customer group.
- A project planning and control system is an information system. The raw data will include the various activities that make up the project and the range of resources that might be used to develop the project. The system schedules projects so that completion is at the earliest possible date, with the least drain on resources, and provides reports on progress during the life of the project. These reports enable management to act on projects that are behind schedule or where costs are above predictions.
- A decision-support system is an information system. The raw data includes the whole range of facts about the organization, or part of the organization, or sometimes relates to aspects external to the organization, (that is, its *environment*). The system is designed to enable managers to retrieve information which will help them make decisions about, for example, where to build a factory, whether to merge with competitors, which products to sell, the prices of products, and the salaries of employees.
- An airline ticket reservation system is an information system. It processes customers' requests for seats on aircraft. It may also be used to provide information regarding the take up of seats.

1.2 THE NEED FOR A METHODOLOGY

There have always been information systems, although it is only in the recent past that they have used computers. If firms have employees, there needs to be some sort of system to pay them. If firms manufacture products, then there will be a system to order the raw materials from the suppliers and another to plan the production of the goods from the raw materials. Companies need to have a system to deal with orders from customers, another to ensure that products are transported, and yet another to send invoices to the customers and to process payments.

In the time before computers, these systems were largely manual. The word 'largely' is appropriate, because the manual workers would use adding machines, typewriters, and other mechanical or electrical aids to help the system run as efficiently as possible. The use of computers represents only

an extension (though a significant extension) of this process. If a manual system proved inadequate in some way, for example:

- increasing workloads have overloaded the manual system;
- suitable staff are expensive and difficult to recruit;
- there is a change in the type of work; or
- there are frequent errors,

a solution which involves the use of computers may well be contemplated.

The early applications of computers — say, until the 1960s — were implemented without the aid of an *explicit* information systems methodology. In these early days, the emphasis of computer applications was towards *programming*, and the skills of programmers were particularly appreciated. The systems developers were therefore technically trained but were not necessarily good communicators. This often meant that the needs of the users in the application area were not well established, with the consequence that the information system design was frequently inappropriate for the application.

Few programmers would follow any formal methodology. Frequently they would use rule-of-thumb and rely on experience. Estimating the date on which the system would be operational was difficult, and applications were frequently behind schedule. Programmers were usually overworked, and frequently spent a very large proportion of their time on correcting and enhancing the applications which were operational.

Typically, a user would come to the programmers asking for a new report or a modification of one that was already supplied. Often these changes had undesirable effects on other parts of the system, which also had to be corrected. This vicious circle would continue, causing frustration to both programmers and users. This was not a methodology, it was only an attempt to survive the day.

As computers were used more and more and management was demanding more appropriate systems for their expensive outlay, this state of affairs could not go on. There were three main changes:

- The first was a growing appreciation of that part of the development of the system that concerns *analysis and design* and therefore of the role of the *systems analyst* as well as that of the programmer.
- The second was a realization that as organizations were growing in size and complexity, it was desirable to move away from one-off solutions to a particular problem and towards a more *integrated information system.*
- The third was an appreciation of the desirability of an accepted *methodology* for the development of information systems.

As Utterback and Abernathy (1975) argue, innovation has three elements: improved process, in this context better information systems development methodologies, improved product, in this context better information systems; and improved organization, in this context better decision support. We look next at the process of developing an information system.

1.3 REQUIREMENTS OF AN INFORMATION SYSTEMS METHODOLOGY

It was to answer the problems discussed in the previous section that methodologies were devised and adopted by many computer data processing installations. A *methodology* is a collection of *procedures, techniques, tools,* and *documentation aids* which will help the systems developers in their efforts to implement a new information system. A methodology will consist of *phases*, themselves consisting of *sub-phases*, which will guide the systems developers in their choice of the techniques that might be appropriate at each stage of the project and also help them plan, manage, control and evaluate information systems projects.

But a methodology is more than merely a collection of these things. It is usually based on some *philosophical* view, otherwise it is merely a *method*, like a recipe. Methodologies may differ in the techniques recommended or the contents of each phase, but sometimes their differences are more fundamental. They could differ according to the philosophy on which they are based. Some methodologies emphasize the humanistic aspects of developing an information system, others aim to be scientific in approach, others pragmatic, and others attempt to automate as much of the work of developing a project as possible. These differences may be best illustrated by their different assumptions, stemming from their philosophy which, when greatly simplified, might be that, for example:

- a system which makes most use of computers is a good solution;
- a system which produces the most documentation is a good solution;
- a system which is the cheapest to run is a good solution;
- a system which is implemented earliest is a good solution;
- a system which is the most adaptable is a good solution;
- a system which makes the best use of the techniques and tools available is a good solution;
- a system which is liked by the people who are going to use it is a good solution;

and so on.