

Cambridge University Press

978-0-521-06335-7 - Information Systems Development and Data Modeling: Conceptual and Philosophical Foundations

Rudy Hirschheim, Heinz K. Klein and Kalle Lyytinen

Excerpt

[More information](#)

1

Introduction

1.1 Background

It is a truism to say that computers have become ubiquitous in today's organizations. Since their application in administrative data processing in the mid-1950s, they have become one of the key instruments for improving the formal information processing activities of organizations. In less than four decades, computer-based information systems (IS) have evolved from supporting back office, already formalized, systems such as payroll, to penetrating the entire organization. New applications and technologies have emerged with great fanfare, and the enthusiasm for information systems continues to run high. Indeed, many enthusiasts conceive of information technology as the primary vehicle for organizational problem-solvers, increasing an organization's capacity to cope with external and internal complexity and improve its performance. Nor is there any doubt that information systems will play an even more vital role in tomorrow's organization.

The development of these information systems has received considerable attention in both the popular and academic literature. New methods for designing systems, new approaches for analysis, new strategies for implementing the developed systems, and the like, have proliferated over the past 30 years. Yet, a majority of information systems design approaches conceive of information systems development (ISD) with the assumption that they are technical systems with social consequences. This leads one to focus on IS design problems as problems of technical complexity. Proponents of this view assume that IS development problems can largely be resolved by more sophisticated technical solutions (tools, models, methods and principles).

In recent years, however, there has been a growing interest in viewing IS as social systems that are technically implemented. They serve as the agent for significant social interactions which implies their connection to human communication through the medium of language. Contrary to 'second wave technologies' (i.e. matter and energy transforming machines; *cf.* Toffler 1980), information technology is by its very nature a social technology because its existence depends on social institutions like language, the legitimation and control of power and other forms of social influence, and other norms of behavior. The proponents of this view also claim that in fact all technological solutions are social solutions. As a consequence they regard IS design problems as dealing primarily with social complexity and only secondarily with technological complexity. We can conclude that such a socially informed view of IS assumes that all technical designs constitute

Cambridge University Press

978-0-521-06335-7 - Information Systems Development and Data Modeling: Conceptual and Philosophical Foundations

Rudy Hirschheim, Heinz K. Klein and Kalle Lyytinen

Excerpt

[More information](#)

interventions in the social institution.

The ‘paradigm shift’ implied by the above has led to the proposal of new ‘social approaches’. Most of these have come from academia but have not yet been widely employed in practice. An interesting feature in these new approaches is the bewildering variety of views and processes they propose in dealing with IS as a social design problem. This suggests that ‘social complexity’ should be distinguished from ‘technical complexity’ because the former is of a different sort and more ambiguous (Weinberg 1981). Accordingly the IS design problem is a far more complex phenomenon than is realized in most cases, because it affects the conditions of human existence in similar ways as law making or other social institutions. Yet the mainstream literature continues to deal with it as a one-dimensional technological issue.

It is our contention that all involved in the framing of IS development bring to bear certain assumptions and beliefs about what is ‘social’, and that it is these assumptions which generate the variety of design approaches. The diverse assumptions and beliefs about the nature of IS have led to methodological pluralism in the IS research community (Mumford *et al.* 1985; Nissen *et al.* 1991). This pluralism can be said to reflect the multidimensional nature of complexity of ISD that cannot be reduced to any type of well-defined technical complexity. In other words, the complexity of IS development cannot be captured in some formal model and finally resolved through improved formalisms.

An interesting question arises immediately. Can this type of social complexity be analyzed and can we systematically trace its origins? We believe that it can be done but it requires a different type of inquiry than is usually followed in circles that regard IS design problems as mainly technical problems. Simply put, we do not need more refined mathematical theories, models or new sophisticated technologies. Instead, what we need is the ability to pose and debate — in a critical manner — traditional philosophical questions in the context of IS design that have been the subject of discourse by philosophers and social thinkers. At the same time it requires critical assimilation and acquaintance with problems and questions addressed in the mainstream of social theory and philosophy so that the latter can be used to speak to the issues that are relevant in IS development.

To address these issues, we engage in a critical analysis of assumptions and beliefs about the nature of social phenomena as revealed in a number of design methods and approaches that have been proposed for ISD. In more specific terms we shall conduct a critical analysis of systems development methods and methodologies that have emerged during the last two decades. We interpret methods and methodologies here quite broadly as any process oriented prescriptions of how to go about developing an information system. In this sense our analysis covers process models, methods and tools, and ways to organize systems development (e.g. participation). A more detailed analysis of these concepts is provided in chapter 3. Another target of our

Cambridge University Press

978-0-521-06335-7 - Information Systems Development and Data Modeling: Conceptual and Philosophical Foundations

Rudy Hirschheim, Heinz K. Klein and Kalle Lyytinen

Excerpt

[More information](#)*Introduction*

3

examination is those methods that focus on describing, organizing and analyzing data that are stored and manipulated in the IS. This area, in general, is denoted as data modeling. A more detailed description of the pertinent data modeling concepts is provided in chapter 3. The reason for choosing this as a specific area of interest in our book is that data modeling deals with concepts like information, knowledge, meaning, and language which cannot be handled without explicit (or implicit) recourse to philosophical analysis. We believe that this type of analysis can serve two important goals:

- (1) to systematically trace the complexity of IS design problems and methods into a set of beliefs and assumptions about the nature of 'social' reality (and social knowledge), and
- (2) to point out some principal alternative approaches in which IS design and data modeling problems can be framed depending on the assumptions and beliefs about the nature of social reality.

1.2 Purpose of the Book

It is our contention in writing this book that it is not possible to develop information systems without bringing to the development task a set of implicit and explicit assumptions. The most basic assumptions concern the nature of the world around us (ontological assumptions) and how one inquires or obtains knowledge about the world around us (epistemological assumptions). Different sets of assumptions are likely to yield very different approaches to information systems development. Yet, this kind of philosophical analysis of an applied field is a genre which has not received much attention in the IS literature. We do, however, note a few kindred companions who have tried to articulate the fundamental assumptions on which the discipline of IS in general or ISD in particular rests. Among these kindred spirits are Boland (1979), Iivari (1991), Dahlbom and Mathiassen (1993), Winograd and Flores (1986), Ehn (1988), and Floyd *et al.* (1992).

For whatever reason the number of studies of this genre is small, and since its beginning the field of IS has not spent much effort to explore the different sets of assumptions which consciously and unconsciously influence systems developers as reflected in their use of preferred methods and tools. The closest representative of this genre is perhaps Dahlbom and Mathiassen (1993) who tried to capture the issues emerging from the controversy between technical enthusiasts and social critics in information systems under the headings of mechanism and romanticism. From the romantic perspective, change is unpredictable and beyond human control, the expression of hidden and unknowable forces. The mechanist, on the other hand, believes in the power of good representations to predict and control social change. In this book, we shall build on different distinctions. Some of the key issues which we shall address include: what is the nature of social reality and social causation; how can we obtain information about it; what is the relationship between the inquirer and the object of inquiry in a social context;

Cambridge University Press

978-0-521-06335-7 - Information Systems Development and Data Modeling: Conceptual and Philosophical Foundations

Rudy Hirschheim, Heinz K. Klein and Kalle Lyytinen

Excerpt

[More information](#)

what is the meaning of meaning and how is it created through language; what are the fundamental values that are guiding IS development in practice (Kling 1978; Mowshowitz 1984; Burns 1981) and those underlying different methodologies (Klein and Hirschheim 1991), and finally: does the concept of rational choice extend to value questions, or are value choices merely a matter of faith and politics? (*cf.* Klein and Hirschheim 1993). By looking at different answers to these questions in social theory and philosophy we believe that we can shed light on the social complexity in IS development. In short, some of the origins of this complexity can be found in the eyes of the beholder, i.e. with what type of assumptions and beliefs he or she approaches the social reality of IS design.

This is a different answer than usually adopted in the IS research literature. Instead, it is usually taken for granted that there exists only one set of fundamental assumptions which are essentially the same for all. But is this true? The purpose of the book is to explore this belief and expose it as misguided. There is simply more than one set of assumptions guiding systems development and which have commonly been taken for granted. They are associated with the ‘paradigm’ of functionalism. The purpose of this book is to explain this in more detail, and in particular we focus on the following three claims:

- (1) There are fundamentally different sets of assumptions about the nature of the world and how one obtains knowledge of it which have important implications for both information systems development and use. In this book we limit our discussion to IS development. In fact, we will show it is possible to see four different sets of assumptions yielding four paradigms of ISD, one of which is functionalism. Moreover, each paradigm has its own way of looking at information systems; highlighting certain aspects of the IS, and de-emphasizing others.
- (2) It is possible to see in the literature that radically different approaches exist to information systems development which are influenced by these paradigms. However the understanding of these different approaches has suffered because much of this literature is not well-documented, and hence not easily accessible. Also, the language of some of the literature is impenetrable without some understanding of philosophical principles. Therefore, a second purpose of this book is to provide a survey of this literature, articulating and clarifying its underlying, different philosophical assumptions. This is necessary for interpreting the diverse streams of research on information systems development.
- (3) The relative inaccessibility of much of the literature informed by alternative paradigms has produced an imbalance in the way the field is defined. This bias has led to the overlooking of important issues: for example as IS are widely perceived as providing effective representations of organizational reality for the purpose of organizational control

Cambridge University Press

978-0-521-06335-7 - Information Systems Development and Data Modeling: Conceptual and Philosophical Foundations

Rudy Hirschheim, Heinz K. Klein and Kalle Lyytinen

Excerpt

[More information](#)

and problem solving, alternative paradigms highlight the information systems' role in the process of social reality construction through sense-making, or their contribution to the improvement to arguments in the organizational discourse with possible implications for emancipation. Depending on which issue is defined as the principal project goal, a rather different approach to ISD will be appropriate. If it turns out that the most popular approaches follow the tenets of only one paradigm, an imbalance arises.

We believe this book is a first step toward correcting the intellectual imbalance of the field in that we focus on those approaches informed by alternative paradigms which have received insufficient attention in the refereed research literature. Our book is more than an intellectual exercise as it contributes to emancipation: the book may help the IS community to question the legitimacy of its current practices and resulting social arrangements.

We would like to acknowledge that this book is not meant as a contribution to philosophy, but rather its purpose is much more modest: to simply supply the current state of discussion in information systems with a broad philosophical basis.

1.3 Goals and Organization of the Book

More specifically, the principal goals of this book are:

- (1) to develop a philosophical and conceptual foundation to analyze and discuss representative ISD and data modeling approaches. This foundation is based on recent debates in the philosophy of science and language and it helps to clarify the conceptual foundations upon which all development approaches rest.
- (2) To suggest a way to analyze systems development and data modeling approaches which is consistent with the proposed conceptual foundation. This is based on a systematic analysis of several development approaches and data modeling schools in which the concepts of systems development and data modeling are elaborated and refined.
- (3) To provide a useful inventory of archetypical development approaches and their conceptual and philosophical foundations. In particular we want to point out what the main underlying theoretical underpinnings in current ISD approaches are and what areas of ISD are less developed and in need of further refinement.
- (4) To develop a critical synthesis of the current philosophical debate about IS.
- (5) To examine the implications of this debate for possible theoretical improvements in future approaches to ISD and data modeling.

Our grand goal in writing this book is to show that the IS community cannot remain aloof from the philosophical controversies that have washed

Cambridge University Press

978-0-521-06335-7 - Information Systems Development and Data Modeling: Conceptual and Philosophical Foundations

Rudy Hirschheim, Heinz K. Klein and Kalle Lyytinen

Excerpt

[More information](#)

over social research during the last two decades. There is much to be learned from the serious scholarly work in social theory and philosophy — an issue that has been largely overlooked by the IS community as pointed out above. At the same time the scholarly work in social theory and philosophy teaches us that IS research is basically a study of our (possible) social conditions (of knowing and communicating) that is inspired and supported by the immense potential of information technology. The application of social theory and philosophy to social research in general, and IS research in particular, is beneficial because it permits us to be much more realistic about the potential and the likely impacts of information technology. It also helps us to become critically aware of the limitations of all of our approaches in the face of the pluralistic and complex reality of ISD.

To address these goals we shall organize our argument in terms of eight chapters which address the following five topics. The principal dependencies between these five topics are outlined in figure 1.1:

- I Chapter 2 introduces some basic definitions and a historical perspective of the fundamental subject matter of this book, namely alternative approaches to ISD and data modeling.
- II Chapter 3 lays the philosophical and conceptual foundations which are fundamental for the structure of the remainder of the book, i.e. the paradigms.
- III Chapters 4 and 5 apply the notion and conceptual foundations associated with paradigms to the analysis of ISD methodologies.
- IV Chapters 6 and 7 apply the notion and conceptual foundations associated with paradigms to the analysis of data modeling approaches.
- V Chapter 8 summarizes our study, and considers the implications of our ideas on IS research and practice.

The following presents a more detailed outline of each chapters' purposes and motivations:

Chapter 2's purpose is to inform the reader of our view of information systems development. We define the key concepts of ISD by abstracting from its historical evolution without reference to their paradigmatic assumptions. These are presented in more detail in chapter 3. The concepts defined in this chapter are used throughout the book. An additional purpose of the chapter is to reveal the breadth of alternative approaches to ISD (including data modeling) in their historical context. It is necessary to provide an overview of the various approaches that have been proposed for systems development because a subsequent chapter (chapter 3) provides a comprehensive classification scheme for alternative systems development approaches. Without this chapter, the classification would lack a critical historical perspective. Furthermore, the historical review of the evolution of systems development approaches provides the broader picture by which the selection of certain approaches for detailed discussion done in subsequent chapters (chapters

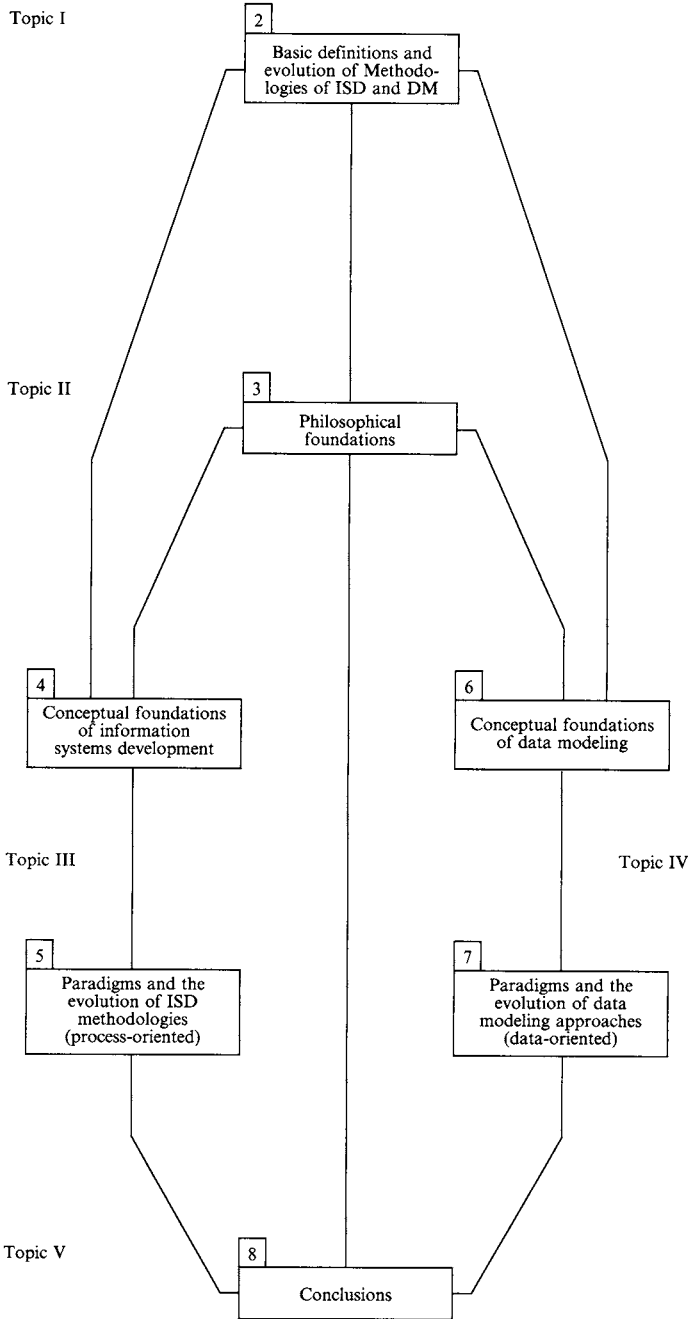


Figure 1.1: Grouping of chapters into five topic areas

Cambridge University Press

978-0-521-06335-7 - Information Systems Development and Data Modeling: Conceptual and Philosophical Foundations

Rudy Hirschheim, Heinz K. Klein and Kalle Lyytinen

Excerpt

[More information](#)

5 and 7) becomes meaningful. The selection and discussion of the chosen approaches illuminates critical features of the classification scheme. In particular, chapter 2 introduces a distinction between ‘process-oriented’ and ‘data-oriented’ approaches. When we speak about information systems development methodologies we are primarily referring to process-oriented approaches and these are taken up chapters 4 and 5. When we speak of data modeling approaches we are referring to data-oriented approaches; these are discussed in chapters 6 and 7.

Chapter 3’s purpose is to introduce our classification scheme which is the core of our view of the field and provides the plot for the book. We contend that such a classification scheme should be grounded in ideas which have a long standing tradition and the philosophical analysis of alternative epistemologies and ontologies. Our choice is to adopt a paradigmatic assumption analysis following the work of Burrell and Morgan (1979). The notion of a paradigm is explained and four paradigms are distinguished. Our proposal is that they offer a fruitful way to classify approaches to systems development. The classification allows one to see the unique features and contributions of alternative approaches. It leads one to see the significance of radically different approaches, some of which may appear idiosyncratic. The paradigms lay the philosophical basis for analyzing both process- and data-oriented approaches.

Chapter 4’s purpose is to apply the four paradigms of chapter 3 to ISD without reference to specific methodologies. We apply the philosophical basis of the previous chapter to reveal the content and structure of different methodological approaches to ISD. Each paradigm portrays ISD in different ways. Each paradigm suggests preferred interpretations of the key concepts presented earlier and imposes a specific bias on our view of information systems development. The bias is explained for each paradigm in terms of key actors, narrative, plot and assumptions.

Chapter 5’s purpose is to show how the four paradigms of chapter 3 apply to a representative sample of ISD methodologies excluding data modeling. The paradigmatic assumptions of each methodology are stated and their strengths and weaknesses explored. The chapter shows the value of a paradigmatic assumption analysis by suggesting how methodologies could be improved.

Chapter 6’s purpose is to apply the four paradigms of chapter 3 to data modeling without reference to specific approaches. It shows how paradigms portray data modeling in different ways. In order to explain the bias that different paradigms impose on data modeling, it discusses the epistemological, ontological, social context, and representational assumptions of alternative approaches to data modeling.

Chapter 7’s purpose is to discuss several data modeling approaches and their relationship to different paradigms. This corresponds to chapter 5 but instead, covers data modeling approaches. Its primary contribution is that

Cambridge University Press

978-0-521-06335-7 - Information Systems Development and Data Modeling: Conceptual and Philosophical Foundations

Rudy Hirschheim, Heinz K. Klein and Kalle Lyytinen

Excerpt

[More information](#)*Introduction*

9

it draws attention to radically different approaches to data modeling which are relatively unknown and deserve more attention. It also provides a critical evaluation of alternative approaches of data modeling.

Chapter 8's purpose is to return to the stated goals of the book and critically review how they have been met. A secondary purpose is to ask the question: 'what, if anything, should now happen?'. We conclude our analysis with the provocative question: why is it that most of academic research, ISD approaches arising from academia, and the teaching of university students has been confined to the domain of functionalism, when practitioners have for some time, evidently, embraced selective insights from multiple paradigms.* If this is so, the next step for the practitioner is to continue to draw on alternative paradigmatic foundations more consciously and systematically. For academia, our question implies the need to distribute its effort in research and teaching in a more balanced way; that is, to give equal attention to the different insights emanating from each paradigm. For example, one might consider what each paradigm implies for prudent information systems policies; however, this is a matter for another book. Stay tuned . . .

* Episkopou (1987) and Baskerville (1991) provide empirical evidence to the claim that practitioners, in applying the different methodologies, have intuitively acted in a way which was consistent with insights drawn from different paradigms. Apparently, some practitioners in applying a methodology, feel uncomfortable with its intrinsic underlying assumptions; if so, they bend them to better fit their own orientations. This might lead to, for example, producing a social relativist interpretation to some of the features of a functionalist methodology and vice versa.

2

Definition and Evolution of Information Systems Development Methodologies and Data Modeling

2.1 Introduction

The purpose of this chapter is two-fold: firstly, the chapter suggests a set of terms and concepts to describe and converse about information systems development which is independent of any particular or preferred way of dealing with it. Not surprisingly, as the IS field evolved, many different and sometimes inconsistent uses of terms to describe key notions appeared. For example, the part of the organization that is targeted for change through an IS development project is variably referred to as utilizing system, domain of change, target system, or universe of discourse. We shall use the term object system to cross-relate these terms coming from different sources. The concepts proposed in this chapter were selected with two requirements in mind:

- (1) they should be maximally consistent with the literature base; and
- (2) they should serve as a compass directing us deeper into the underlying philosophical issues often ignored in the literature on ISD.

Secondly, the chapter provides a brief overview of the history of information systems development and data modeling. This analysis serves as a historical background for understanding the origins (genealogy) of theoretical concepts and definitions offered in the chapter. It also provides the historical context for the more detailed treatment of specific systems development methodologies in chapter 5 and the analysis of data modeling approaches in chapter 7. Though methodologies and modeling are important parts of the evolution of IS, a full historical treatment of IS is beyond our scope here (but see Dickson 1981; Couger 1982 and Friedman and Cornford 1989).

To meet the challenge of keeping the historical review concise, the following treatment uses a broad brush to highlight the fundamental features which characterize important directions among the hundreds of methodologies that have been proposed over the years. History is, of course, too complex for any single taxonomy to do justice to its richness. As will be seen, the grouping of the methodologies into 'generations' is inspired by certain theoretical and philosophical principles discussed in later chapters of the book, particularly those associated with paradigmatic assumptions (see chapters 4, 5 and 7). The following discussion of the methodologies suggests a possible, but by no means absolute, ordering and the placement of specific methodologies is open to debate. Our discussion of the evolution of data modeling as well as its chronological placement, is also subject to