The computer as medium

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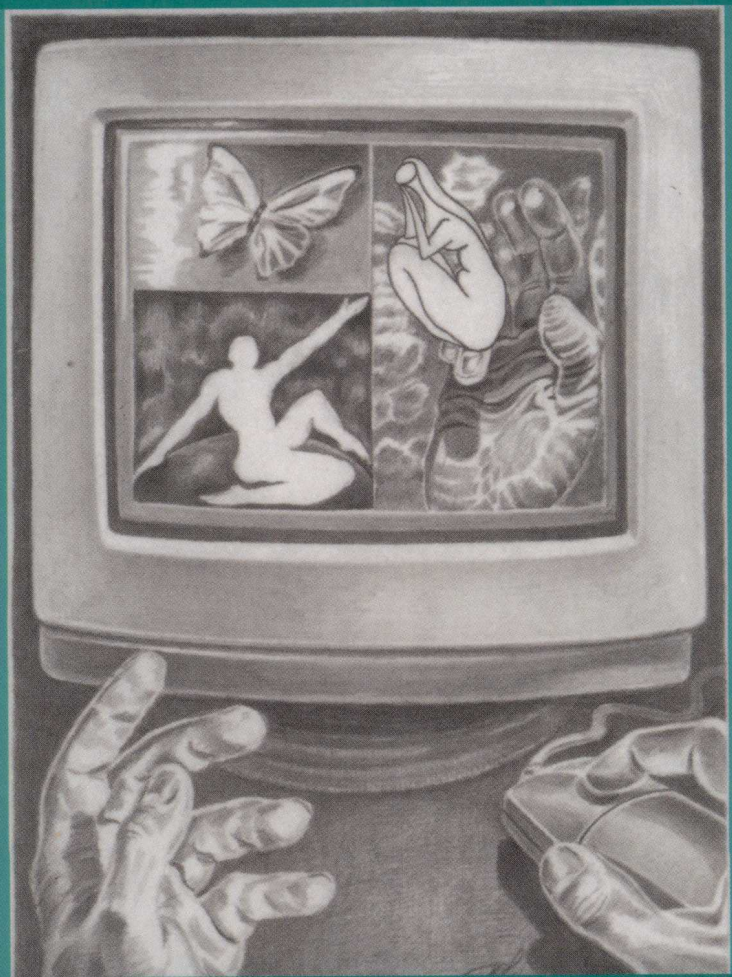

LEARNING IN DOING: SOCIAL, COGNITIVE, AND COMPUTATIONAL PERSPECTIVES

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Series Foreword

This series for Cambridge University Press is becoming widely known as an international forum for studies of situated learning and cognition.

Innovative contributions from anthropology, cognitive, developmental, and cultural psychology, computer science, education, and social theory are providing theory and research that seeks new ways of understanding the social, historical, and contextual nature of the learning, thinking, and practice emerging from human activity. The empirical settings of these research inquiries range from the classroom to the workplace to the high-technology office to learning in the streets and in other communities of practice.

The situated nature of learning and remembering through activity is a central fact. It may appear obvious that human minds develop in social situations, and that they come to appropriate the tools that culture provides to support and extend their sphere of activity and communicative competencies. But cognitive theories of knowledge representation and learning alone have not provided sufficient insight into these relationships.

This series is born of the conviction that new and exciting interdisciplinary syntheses are underway, as scholars and practitioners from diverse fields seek to develop theory and empirical investigations adequate to characterizing the complex relations of social and mental life, and to understanding successful learning wherever it occurs. The series invites contributions that advance our understanding of these seminal issues.

Contents

Preface

Most of the chapters in this book consider computer systems from a specific point of view — as *media* or as *sign systems*. The primary purpose guiding the composition of the book has been to present various theoretical frameworks for working within this perspective.

Computer technology does not lend itself readily to definition. It is made up of many strands and trends, like an optical illusion that changes shape according to the point of view adopted. The central idea of the book is to establish computer systems as media — as intermediate technological agencies that permit communication and as such are used for transmission of information, conversations, requests, entertainment, education, expression of emotional experiences, and so on. Therefore the analogies and metaphors we use for describing and coming to terms with computer systems are not drawn from the domain of machines or tools — as is frequently the case — but from the realm of media (film, theater, television, telephone, books, comics, cartoons, and so on).

But a computer is not just *a* medi*um* in the simple sense of a television set, a radio, a telephone. On the contrary, a computer is an extremely flexible and polymorphous medium. It is a *multi-medium* since the same physical machine can serve as host for a variety of previously independent media-functions: It can simultaneously be an electronic mail system, a word processor, a database, a tool for advanced design, a paint box, a calculator, an electronic book, and a game-machine.

In this view, computers are essentially media for transmitting signals from human senders to human receivers. We are, however, not concerned with any kind of signals, but only with those that stand for something for somebody. At the center of this concern is *the sign*, for *the sign* is exactly something that stands for something for somebody (C.S. Peirce). In other words, signs are signifying constructs.

The '"sign" as a concept has numerous definitions, and this lack of agreement — or better, this copiousness of thoughts — is necessarily reflected in this book, too. Nevertheless, all the sign-concepts share a common core, since all are necessarily preoccupied with three components that must be involved in any construction of meaning: (1) the physical, perceivable sign (*representamen*); (2) the external reality the sign refers to (*object*); and (3) the effect on the mind of the user of the sign (*interpretant*).

The study of signs and the way they function in the production of meaning is called *semiotics* or *semiology*, and this discipline provides the central

theoretical foundation of most of the chapters. However, as any other scientific discipline, semiotics has its limits, which is why other approaches are also a part of the book.

Semiotics is based on the assumption that creation and communication of meaning is based on signs and codes. As a method it draws primarily on approaches and terminology from linguistics, and traditionally it has used spoken language as its prime example of a sign system. However, it is not so much in the analysis of spoken language that it has made progress and achieved success over the past decades, as in the study of other sign systems, especially cinema, literature, pictures, television, cultural codes, and advertisements. And now it is the turn of the most recent sign system, — computer systems.

Computer-based technologies possess special features making them particularly interesting objects of study from a semiotic point of view, and, conversely, making semiotics a particularly privileged scientific approach to the study of computers.

As we know, a computer can be described as a machine that processes data on the basis of a set of operating rules, by means of which it generates new data or combinations of data. Thus the computer is a data-processing machine.

But the data produced has to be read as information (if the computer system is to make sense) — that is, to be interpreted as referring to something else by virtue of a social convention, to be read as signs. Therefore computer systems are also sign-producing machines, semiotic systems, semiotic technologies, and as such a central concern for semiotics. At the same time — as pointed out by Peter Bøgh Andersen in Part I — computer-based signs have specific characteristics that set them apart from all other known kinds of signs. For that reason, too, a semiotic study of computers is an urgent task.

Semiotics is traditionally divided into three main fields of study: (1) the sign itself, including the different types of signs and the different ways they enter into the construction and transmission of meaning; (2) the codes or systems that organize the signs, including communication, encoding and decoding of signs; and (3) the culture within which the signs are used.

This book is divided into three main parts that to a certain extent reflect this classical triadic subdivision of semiotic studies, and at the same time describe a centrifugal movement, starting close to the computer and gradually moving outward in larger and larger circles. The three parts can be outlined as follows:

(1) *Computer-based signs,* which discusses the special nature of signs produced by means of computers, with respect to programming as well as to interface design.

(2) *The rhetoric of interactive media,* which deals with codes of aesthetics and composition for the new medium of communication: interactive fiction and hypertext.

(3) *Computers in context,* which analyzes computer-technology and computer-signs in the larger cultural, historical, and organizational context.

The general approach of the three parts can be characterized with reference to the triadic sign-model. In his chapter in Part III, Jens F. Jensen argues that the computer system occupies all three positions in the Peircean sign model: It acts as a *representamen* when we use it to refer to something else — for example, when we read an inventory control system as assertions about the stock of spare parts; it can itself be the *object* of another sign — for example, in user manuals or advertisements; and we use it as an *interpretant,* governing the way we talk about the world, when we describe humans as data-processing automata.

The humanities normally focus on computers as objects and to a lesser degree as representamens. This book, however, differs by dealing with all three positions, and especially by placing the emphasis on analyses of the computer as *representamen* — as a sign-vehicle that forms part of the construction of meaning. Part I presents semiotic analogs to programming and interface design based on the concept of computer-based representamens. Part II discusses aesthetic issues of these representamens. And Part III elucidates all three aspects of the semiotic functions of computer-systems — in particular in their contextual aspects. In this way, we hope to give a more complete and integrated treatment of computer systems than is normally the case in the humanities.

The concepts of media, sign, and interpretation are thus the glue that keeps the majority of the chapters together. Within this basic framework we have tried to present a diverse and rich range of theoretical approaches, ranging from general semiotics, linguistics, communication theory, literary and art criticism, cultural studies, and conversation analysis to sociological and historical approaches. The range of topics is correspondingly broad. It includes technical issues such as machine architecture, programming methods, interface design, aesthetic issues of interactive systems, hypertext composition, theoretical and empirical investigations of computers used as media for communication in organizations, and computer systems seen as cultural constructions.

Compared with Andersen's *A Theory of Computer Semiotics* (Cambridge University Press, 1990), this book thus presents a richer selection of methods and a broader range of topics, which of course makes it less homogenous and systematic. We have, however, tried to make links and bridges between the essays where we have discovered similarities or differences. These connections are sometimes described in footnotes, sometimes in introductions, and sometimes in the form of mini-chapters.

We believe that the methods presented here are relevant for designing and analyzing computer systems, and that their relevance will increase in the years to come. One reason is that computer technology is changing. One of the major changes is described in Jens Christensen's chapter in Part III as a change from data processing to information handling. The emphasis is shifting from the mechanical manufacture of data to the problems of interpreting and using this data, the main problem being the transformation of data into information, or — in semiotic terms — the genesis of computer-based signs that stand for something to somebody.

We think that the human sciences will play an increasingly important role in this development. We already see how linguistics, psychology, sociology, and aesthetics make their ways into journals and curricula previously dominated by natural science, and we hope that our book can contribute to this adjustment of scientific balance.

We do not, however, see the present approaches from the human sciences as competitors to natural science. On the contrary, there are many important issues that are outside the scope of this book, and the relevant goal for the future, therefore, is to make insights from one scientific tradition combine with knowledge couched in terms from another tradition.

We hope that the "openness" of our approach is reflected in the chapters that follow, and that readers will be aware of this as they proceed.

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PART I

COMPUTER-BASED SIGNS

Introduction

PETER BØGH ANDERSEN

This part presents semiotic approaches to the design and analysis of computer systems. Theoretically, the five chapters range from classical structuralist methodology to new developments in catastrophe theoretical semantics to Peircean traditions. The programming paradigms include object-oriented programming, functional programming, and logic programming.

The chapters by Peter Bøgh Andersen, David Piotrowski, and Per Hasle establish semiotic frameworks for programming. Per Aage Brandt's chapter is concerned with the new kinds of semioses emerging in human-computer interaction, and Keld Gall Jørgensen discusses computer intelligence from a Peircean point of view.

I compare the approaches and coverage of the five chapters by discussing the problem of meaning and machines. The problem that has engaged philosophers like John Searle and Daniel Dennett is the following: Can computers be said to contain and process meaning, or do they just contain and process empty syntactical expression to which humans assign a content?[1]

The concrete point of departure is the following simple fact: Through keyboard or mouse we can input data into the computer, which responds by writing or drawing on the screen or activating the loudspeaker. The input and output are assigned a meaning and thus form a composite sign. Meaning is produced, but how and by whom?

Fig. 1. Document before dragging.

Fig. 2. Document after dragging.

Example 1. So-called direct manipulation programs often allow the user to use the mouse to "drag" objects around on the screen. As Figure 1 shows, I can move the cursor over the document, press the button, and move the

[1] A short summary of this discussion is given in Jens F. Jensen's chapter.

mouse to the folder. The document follows the mouse until I release the button. The result is a shown in Figure 2.

The inputs are signals I create by moving the mouse and pressing its button. The response on the screen is a change of location of the document. The relation between inputs and outputs is meaningful, because I can interpret the whole process as "I move the document". My actions are interpreted as a physical cause of the changes on the screen.

Example 2. The relation between inputs and output can be interpreted quite differently. Consider the following input and output pairs (lines preceded by "?" are typed by me; lines without are written by the system).

```
?- human(socrates).
    yes
?- mortal(socrates).
    yes
?- mortal(zeus).
    no
?-
```

My actions are interpreted as questions, the outputs as answers, and the relation between the two as logical inferences.

Brandt's chapter analyzes these phenomena in a Peircean framework: The stream of alternating inputs and outputs is seen as a representamen the user tries to interpret. The object of the sign is the user's mental images, which in our case could either be "a physical causation" or "a logical inference." Brandt's main concern, however, is the interpretant, the user's "explicative schemes" that insert the images into the gap between user action and system response.

The particular stream of inputs and outputs, interpretable as inferences, in Example 2 is the topic of Gall Jørgensen's chapter. Clearly the programmer intended the user to interpret the pairs as inferences, but are AI and cognitive science right in concluding that machines can think? Jørgensen's chapter discusses this from a Peircean point of view: Assuming that machines can *represent* human thought, can we conclude that the machines also *are* what they represent? Can the map be identified with the landscape? The case of machine intelligence is an old controversy that in my opinion has always suffered from standpoints that were as irreconcilable as they were unfounded. The semiotic approach in Jørgensen's chapter provides a new setting that could replace the ideological deadlock by more rational and sober pros and cons.

In Hasle's and Piotrowski's chapters, we move inside the machine and take a closer look at then "cognitive gap between the initial and terminal in-

stances of the sign" (Brandt's chapter). The gap is of course specified in a program, but users do not see it and are therefore ignorant about how input and output is related technically. Still, they cannot help generating mental images, since humans are compulsory creators of meaning, as implied in Brandt's chapter.

In our two examples, the gaps are filled by very simple pieces of code inside the computer. The document is dragged by the following pseudo code that keeps recording the location of the mouse (OldMl and NewMl) and adds the x and y-displacements (xdiff, ydiff) to the x and y coordinates (targetX, targetY) of the document:

```
on dragobject
 put the MouseLoc into OldMl
 put the x of the target into targetX
 put the y of the target into targetY
 repeat until the mouse is up
  put the MouseLoc into NewMl
  if newML ≠ OldMl then
   put (the x of NewMl - the x of OldMl) into xdiff
   put (the y of NewMl - the y of OldMl) into ydiff
   add xdiff to targetX
   add ydiff to targetY
   set the location of the target to targetX,targetY
   put NewMl into OldMl
  end if
 end repeat
end dragobject
```

Code 1. How to drag an object.

This text interprets the computer as a two-dimensional space where objects are located and change location. The logical example presents a different interpretation. The program is written in Prolog, which interprets data processing as logical inferences. It contains one rule of inference (major premise) and one fact (minor premise):

```
mortal(X) :- human(X).
human(socrates).
```

Code 2. How to reason about Socrates.