

# **A Theory of Computer Semiotics: Semiotic Approaches to Construction and Assessment of Computer Systems**

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(University of Aarhus)

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## **1. Semiotics: Its Relevance to Computational Linguistics**

Semiotics is, or seeks to be, the science of sign systems, just as linguistics is, or seeks to be, the science of language. Semiotics therefore includes linguistics, as well as the study of all other sign systems. These include:

- Those sign systems that are used in parallel with language, such as tone of voice and body posture (including pointing, etc).
- Those that operate on a longer time scale such as the 'presentation of self' through our choice of clothing, of car, etc.
- Those with a broader conception of 'self,' such as the self presented by civic architecture, etc.

Semiotics also includes the general principles that underlie all sign systems. It is thus more comprehensive than linguistics—very much more, because there is a semiotic dimension to practically every human artifact. (Indeed, since we can 'read in' meanings to natural events, e.g., as in 'the lack of rain shows God's displeasure,' semiotics is not even limited to human artifacts.)

In recent years there has been a rapid growth of interest in the ways that humans and machines may communicate with each other by the use of modes and codes other than written natural language text. For example, one theme of the recent International Natural Language Generation Workshop at Trento was the 'extension of language generation to multiple media.' Relevant contributions in Dale et al. (1992) include the chapters by Claasen and Reithinger on pointing and, perhaps more futuristically, Magnenat-Thalmann and Kalra's "A model for creating and visualizing speech and emotion." There was a panel discussion with published statements by Arens, Dale, Kerpedjiev, Stock, and Wahlster et al. Earlier works in this line of development include Taylor, Neel, and Boushuis (1989); the account of COMET (CoOrdinated Multimedia Explanation Testbed) by McKeown and her colleagues (McKeown et al. 1990); and the descriptions by Wahlster and his colleagues (Wahlster et al. 1989, 1992 and references therein) of their multi-media system, WIP. So computational semiotics should be an idea whose time has come—or, at least, whose time is coming.

The breadth of coverage of semiotics is at the same time both its great strength and its great weakness. The reason that semiotics has developed only slowly as a field of study is, I think, that the level of generalization at which it operates is too great to attract the committed attention of more than a score or so of human minds in every generation. Paradoxically, it flourishes less strongly in its home environment of philosophy than in undergraduate courses in the humanities with titles such as 'cultural studies' and 'communication studies,' and in literary studies with a slant to 'new historicism' (in the U.S.) or 'cultural materialism' (in the U.K.). 'Big names' in semiotics include Barthes and Eco. But the starting point for an inquirer should be one of the standard introductions to the subject (and not, ideally, the book under review here). The concepts of semiotics are challenging but, despite their origin in structuralism, they are somewhat unformalized—even by the relatively informal standards of text-descriptive linguistics. They will therefore probably be familiar to rather few computational linguists. Nonetheless they concern important and fascinating matters that, in the long run, have to be taken into account in the expanded models of artificial intelligence that we should expect to develop over the next quarter century.

Almost 20 years ago a group of scholars (Charles Frake, M. A. K. Halliday, Sydney Lamb, W. C. Watt, and, interestingly for readers of this journal, the computational linguist Martin Kay)<sup>1</sup> planned a symposium on the semiotics of culture and language, where the invitees were cultural anthropologists and linguists working in 'network' theories (systemic functional and stratificational linguistics). When the book of that symposium finally appeared in 1984, the editors wrote:

If the 1970s were the decade of social man, perhaps we should now, in this age of the explosion of information technology, begin to prepare for the 1990s to be the age of 'semiotic man.' (Fawcett et al. 1984, p. xxv)

While there has been steady growth, it appears that we were over-optimistic, at least with respect to the number of academic departments of semiotics, etc. In 1992 the world of ideas seems still not to be ready to grant to semiotics the center-stage place that it claims and, in my view, deserves. It must surely be of value to establish the principles governing the nature of all communication systems (pace the information theorists, who would no doubt claim to have done this already).

Yet, even if our goal as practitioners of computational linguistics is simply to understand better the sign system of language itself, we might bear in mind the advice of the father of modern linguistics:

If we are to discover the true nature of language, we must learn what it has in common with other semiological [= semiotic] systems. (Saussure 1916/74, p. 17)

My experience is that Saussure is right; my own view of language has been strongly influenced by placing it in the context of other semiotic systems, and I recommend the exercise to others. Thus there are at least two reasons that a computational linguist should take an interest in semiotics: the need for a theoretical framework within which to accommodate codes other than language at the human-computer interface (HCI), and the need to understand language itself better.

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<sup>1</sup> Regrettably, Martin Kay was unable to attend the symposium; it would be interesting to know how the then-embryonic study of computational semiotics might have developed if he had.

So should we who call ourselves computational linguists now broaden our conceptual framework to embrace a theory of computer semiotics? If we should, is such a theory available? The main title of the book under review here suggests that it is. And under the view that computers are essentially machines with a special ability in manipulating symbols, we might expect that the conceptual linking of computer science and semiotics would yield a theoretical framework that could underpin such an enterprise. How far is it the goal of the book under review here to provide such a theory? Andersen defines computer semiotics as “a branch of semiotics that studies the special nature of computer-based signs and how they function in use” (p. 2). And, in his own words: “My main aim is theoretical, namely to adapt semiotic theory to computers.” He therefore accepts the challenge. So we must ask: How far does this book succeed in this high purpose?

## 2. Andersen’s Approach to the Problem

The author was, in his original disciplinary base, a linguist, but he has been working with computers and computer scientists since the late 1960s. He is also deeply interested in the language people use when at work, so that the book is illustrated at various points with examples of this. He explains that, in the seventies, his theoretical orientation was formal linguistics, mainly transformational grammar, but he later grew disenchanted with the limitations of this approach. He then turned to what he describes as “classical European structuralism, as founded by Ferdinand de Saussure, systematized and reinterpreted by Louis Hjelmslev, given a sociological and contextual orientation by M.A.K. Halliday and his followers, and used as a basis for developing the discipline of semiotics by semioticians like A. Greimas, R. Barthes, and U. Eco.”<sup>2</sup> In practice, he takes Hjelmslev’s Copenhagen School of ‘glossematics’ as “the basic theoretical framework” (p. 21); the theory “evolved in the thirties, flourished during the fifties and sixties, and finally almost disappeared during the seventies, overthrown by the rising generative paradigm.” While Andersen uses only “elements of glossematic theory” (p. 11), it seems clear that one goal of this book is to help toward the rehabilitation of Andersen’s fellow countryman, the great (but somewhat abstract) linguist Hjelmslev—not in itself a bad goal. The modern linguist from whom Andersen has taken the most inspiration is Halliday (about whom more shortly).

In the introduction, Andersen names his intended readership: he expects them to be (a) “linguists who like myself have found themselves in a job concerned with information technology,” and (b) “computer scientists and engineers . . . who have taken up the human aspects of technology and are searching for a suitable theoretical framework.” To these might be added (c) the researcher with general interests in natural language processing who is interested in developing an integrated framework for multi-modal communication at the HCI.

## 3. Summary and Critical Discussion of the Book

The book divides into an introductory chapter, three ‘parts’ (each a long chapter), and a brief epilogue. The introduction begins the discussion of the theory to be proposed,

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<sup>2</sup> I offer a reinterpretation of Saussure from the viewpoint of systemic functional linguistics in Fawcett 1983. In my view, Hjelmslev added relatively little to the concepts developed by Saussure, except a fuller spelling out of the key concepts and the considerable weight of his support. I do not consider that the formal linguistics tradition initiated by Chomsky is the true heir to Saussure, despite Chomsky’s early evocation of Saussure in support of his ultimately misleading ‘competence-performance’ distinction.

and Part I takes this further. Part II claims to provide an interpretation of computer systems as signs, and Part III is concerned with the practical application of the ideas presented, based on a large-scale systems development project at the Postal Giro in Stockholm. The main interest of the book lies in the extent to which it provides a theory of semiotics that is both adequate in itself and insightful as a theory of computational semiotics, and in the many thought-provoking ideas that emerge along the way. I shall therefore concentrate in particular on the introductory chapter and Part I.

Andersen outlines the reasons for basing his work in Hjelmslev's glossematics:

- The primacy of textual analysis.
- The focus on the form and function of the linguistic system (as opposed to focusing on (phonetic) substance).
- The equal importance of 'content' ('meaning') and 'expression' (form).
- The view that language is a special kind of semiotic system.

But there were "inner weaknesses in the tradition" (p. 13), and Andersen's view of linguistics today is that there are two "impressive formal paradigms": the logical paradigm associated with the names of Carnap, Reichenbach, and, most recently, Montague; and the generativist tradition of Chomsky and the formal linguistic models developed under the influence of his ideas. It is a little odd to place the logical tradition as an equal influence on linguistics with that of the Chomskyan paradigm (which to a large extent it has supported), but with regard to influences on Andersen's own thinking this is clearly how it was.

However, says Andersen, in between these two major influences "a new approach has slowly made its way to the journals and the publishers; compared to the two Goliaths, this linguistic David at first appeared a little sloppy and untidy, its adherents appeared undisciplined, its methodology by no means explicit, and it progressed in roundabout ways. The paradigm is called systemic or functional grammar." In fact, the name is *systemic functional grammar*; this is part of a more general theory of language called *systemic functional linguistics (SFL)*, whose major architect is Halliday (e.g., 1973; 1985). Most of the criticisms cited are at least partly justified—though it is doubtful if 'disciplining' is what the adherents of this or any other theory need! The crucial point is that, in order to open oneself to the insights in such a theory, one needs to accept that it can be a valid path to progress in understanding a phenomenon to allow a little sloppiness in the theorizing, as one works one's way towards increasingly satisfactory solutions. The Popperian approach that has dominated the formal linguistics paradigm has had its problems too.<sup>3</sup>

Andersen is therefore both offering a new theory of semiotics and claiming that it is adequate as a theory of computational semiotics. His claim rests heavily on his ability to do two things:

- Bring out the general principles from the somewhat obscure theory of glossematics and demonstrate their relevance to the construction of an adequate overall model of the HCI.
- Show how systemic functional linguistics complements and extends this theory in a way that is relevant to an insightful model of the HCI.

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<sup>3</sup> For a fuller presentation of this view, see Halliday and Fawcett (1987, pp. 1–5).

This (with or without Hjelmslev) would be a worthwhile enterprise. But this book does not quite provide that. Rather, Andersen draws on his wide reading and experience to present what is essentially his own synthesis. He cites work from whatever quarter fits in with the position that he is developing, including Halliday's approach to register (pp. 54–55), Katz and Fodor's approach to semantics (p. 75), Halliday's concept of system networks (pp. 80–82), Fillmore's Case Grammar (pp. 100 ff.). He adds his own tree structure of the actions involved in an engine-removal task in a car workshop (reminiscent of Steiner's adaptation of the ideas of the Leont'evs; see Steiner [1988]). There is nothing wrong in this, but it does mean that we have to evaluate the book in terms of its own theory, and not as an exposition of glossematics and SFL.

The reasons that Andersen takes SFL as a useful complement to glossematics in developing a computer semiotics include the following:

- "Its data is drawn to a large extent from authentic language usage" (as in glossematics).
- "Language is basically seen as a social phenomenon."
- "The semantic aspect of language has highest priority."
- "Language is seen as a meaning potential, a set of alternatives from which language users can choose when they create meaning."
- "There are fairly explicit rules for relating meanings to observable expressions."

These are all fair points, given his initial specification that he is seeking a functional framework. He cites as criticisms "the view that systemic grammar does not . . . offer support for [the] active design and creative use of signs," and that, "systemic grammar, with few exceptions, is not used for describing codes other than verbal ones." The first is largely justified, but the second is hardly a criticism at all, in that to have even a 'few' uses of a grammar for sign systems other than language is quite unusual. In fact quite a number of such studies have been done, though few have been published.<sup>4</sup>

Whatever the merits of this work as a stimulus to fresh thinking, it is my reluctant duty to point out that it does not provide a good guide to the linguistic theories on which it purports to depend, i.e., glossematics and SFL. Rather, the inquirer with a CL background should read, for SFL, the relevant parts of Winograd (1983), Matthiessen and Bateman (1991) and Fawcett, Tucker, and Lin (in press). (I can make no recommendation with confidence for glossematics, other than the original works by Hjelmslev [1963] and Uldall [1967].) Andersen presents SFL inaccurately in a number of places; e.g., on page 112 he suggests that Halliday's sense of the term *transitivity* concerns "types of verb," whereas for Halliday it is types of clause (though there is of course a connection); and that for Halliday "types of verb" = "Aktionsart," i.e., the aspectual type of verb (quite wrong; the closest equivalent is case grammar). On page 55 he implies that a register is a unit of discourse, when it is in fact the name for a situationally conditioned 'style' of discourse. And the presentation of the notation for what he calls "systemic nets" (for which the standard term is *system networks*) is much less clear than the standard systemic presentations (e.g., Halliday [1973, p. 47]; Fawcett [1980, p. 20; 1988, p. 45]).

<sup>4</sup> In Fawcett (1983), I discuss the general validity of systemic grammars for modeling any semiotic system, and illustrate the claim with a simple traffic-light code. In Fawcett (1984), I advocate the use of systemic grammars for semiotic systems other than language.

But in the broader perspective Andersen is, I believe, right in suggesting that SFL provides a promising framework that can be used as a general theory of semiotics, and so as a theory of computer semiotics. He offers a "tentative map of computer semiotics." From the viewpoint of linguistics, it is a highly conventional 'map,' with "signs as system" at the center and three satellite areas: "signs as knowledge" (representing, he claims, the psychological view), "signs as behavior" (representing the sociological), and "signs as art(ifacts)" (representing what he terms the "aesthetic"; really it is language as text). Arrows lead off to various aspects of computing, e.g., program development, interface design, systems description, and (surprisingly, since it is another interdisciplinary approach) cognitive science.

Part I has the grand title "Theory," but the first of the two main sections is taken up with describing the 'work language' texts in which he is interested, as fields from which to illustrate his ideas. The crunch comes—or should come—in the second half, entitled "Adapting and extending structuralist methods." It is here that the rather selective and at times idiosyncratic interpretation of SFL comes, mingled in with all sorts of other material based on Andersen's experiences of implementing systems in the environments described.

One would expect that Part II, headed simply "Computers," would apply the concepts of Part I to computers. It discusses, in detail, the HCI as "a collection of computer-based signs, *viz.* all parts of system processes that are seen or heard, used, and interpreted by a community of users." Many new concepts are in fact introduced, and Part II even takes time out to discuss briefly the semiotics of theater and of dance. I did not get much out of this part of the book, nor from Part III, which has the title "Language, Work, and Design." But those who have been working in a similar field of application to Andersen may well do so.

#### 4. Summary Evaluation

This book is a bold enterprise. It is an interesting and sometimes fascinating stab at a statement of a theory that is needed. Often Andersen is saying challenging things that need to be said. My main difficulties in reading it were searching for the line of argument (which could not always be found) and the level of generality at which the author stops. The work reads more like a set of notes on interesting topics arising out of Andersen's work over the last few years, with a fairly brief and general statement of a new idea, and then a quick move on to the next. Sometimes I found it hard to see how some new idea advanced the argument. This might have been my fault; I can well imagine that, for those many practitioners of computational linguistics who are wrestling with the problems of reconciling the insights they have from linguistics and sociolinguistics with the practical day-to-day problems of a computer implementation that involves language or some other semiotic system, there will be a frequent sense of the recognition of a fellow explorer in a fascinating but poorly mapped area of study. Perhaps the book should be regarded more as a quarry for exploring than the presentation of an argument—though the latter is how it is presented to us.

But I have to say that in general I found the theorizing both too thin in exposition and insufficiently integrated into a coherent whole, and the structure of the book as a text lacking in clear structure. The book—which at over 400 pages is quite long—would have benefitted from drastic self-editing. There may well be quite a challenging 100-page monograph hidden away in it.

When I started to read this book I was expecting a lot—perhaps too much. Andersen is in my view right about many things; e.g., that the focus in CL on PSG-type formalisms for syntax has obscured the development of functionally oriented models,

which are ultimately more insightful. But it may be asking too much for any single book to take two giant steps away from the established research paradigm at one go: i.e., to broaden out from language to take account of other semiotic systems, and to move from a form-centered to a function-and-process-oriented view of interaction at the HCI. Perhaps the book's subtitle gives a better picture of what is accomplished in the book: "Semiotic approaches to [the] construction and assessment of computer systems." By the time we reach the epilogue, the first purpose that Andersen hopes he has achieved is "to give a consistent semiotic interpretation of computer systems in their context of use." The word *theory* does not occur at all.

My advice is to order this work for your library, and to use it as a source of stimulation. Those seeking a clear exposition of the theory that is promised by the title will be irritated by the book at many points, but it reflects an honest change of direction of a scholar with over two decades of work at the interface where linguistics and computing meet, and for this alone the book deserves respect. Many of those with a background in the humanities will empathize with the effort to distil theory from experience that the work represents, and will therefore find it valuable in the development of their own thinking. It might not be the holistic theory that we ultimately need but, for those computational linguists who are beginning to feel over-confined by the currently dominant research paradigms in CL, it might prove a spur to explore further—and perhaps more thoroughly?—some of the areas to which this book, rightly, directs attention. This innovative book, for all of its faults, points in the right direction.

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