Metaphor and Information Systems: From Syracuse to Computer Use

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Abstract: In this paper, we discuss the concept of metaphor within rhetoric, philosophy, cognitive psychology and computer science. The history of rhetoric and metaphor is surveyed, the state of the art in the computer science sense of metaphor is examined, and we try to show that the study of metaphor in information systems has proceeded from ad hoc approaches to theories that eventually establish a connection back to the studies of metaphor within other disciplines. Finally, we discuss the implications of the metaphor concept for the office information systems of the future.
Chapter 1

Introduction

In recent years, there has been an increasing interest in the concept of "metaphor" in information systems design and use. This is probably correlated with the birth of direct manipulation user interfaces and the concept of the electronic desktop, in the late 70s. However, metaphor has been a subject of theoretical interest for at least two thousand years within the discipline of rhetoric. The purpose of this paper is manifold:

- To give a brief overview of the origins of rhetoric as a discipline and to identify the place of metaphor in the classical taxonomy. This is to be found in chapter 2.

- To analyse the concept of metaphor within the framework of rhetoric, philosophy and cognitive science. This analysis, which shows the metaphor evolving from the classical scope of a single word via the sentence scope to a hermeneutical phenomenon on discourse level, is presented in chapter 3.

- The concept of metaphor in information systems is discussed in chapter 4. We will see how these studies evolve from the first ad hoc approaches of the beginning of the 1980s to some attempts to form a pragmatic, cognitive theory that connects back to previous work in other disciplines.

- In the last chapter, the focus of interest is narrowed down to office information systems as a specific subset of information systems. We discuss the implications of the metaphor concept for the design and use of office information systems in the future.

Even though it might seem that rhetoric and computer science have very little in common, it is our hope that this paper manages, at least to some extent, to present the subject of metaphor in a cross-disciplinary way instead of just discussing different concepts of metaphor in different areas. We also hope that there might be something of interest to every reader; a historical survey, a theoretical treatment of metaphor, the state of the art in metaphor research within information systems, or future visions of office information systems.
Chapter 2

Classical rhetoric

In this chapter we aim at giving an introductory overview of the history and techniques of the rhetoric of ancient Greece and Rome. In particular, we identify the place of the metaphor in classical rhetorical taxonomy.

2.1 History

Plato placed the origins of rhetoric in the founding of democracy in Syracuse in the 5th century BC [19]. Teachers began to offer something like systematic instruction in rhetoric in order to help returning exiles in their negotiations for retrieving their lands. These lands had been taken away from the exiles by the subsequently overthrown despotic government, and the study of rhetoric was intended to improve their persuasiveness in negotiations.

These first rudiments of rhetoric were later developed into serious intellectual issues, in Athens. The early teachers of rhetoric in Athens were known as Sophists. To them, rhetoric did not simply consist of methods of argumentation; rather, they offered rhetoric as a central educational discipline. The Sophists became very powerful and influential due to the the growth of Athenian democracy and higher education.

Aristotle, in his Rhetorics, both recorded contemporary practice and, being fond of categorizing, sought a reform by fitting rhetoric into its proper category among the arts. One of his teachings is that rhetoric itself is not a productive art of making but is an art of doing, with an inherent power which is employed in certain kinds of speaking.

The previously mentioned doctrine of the Sophists that rhetoric should be a central discipline in education had a long history, but it rose to its ultimate heights in the writings of Quintilian in Rome in the 1st century AD. Cato the Elder had had a great impact on the Roman esteem of rhetoric, and through the writing of Cicero, Cato’s doctrines spread in the Western world for centuries. The most exhaustive collection of rhetoric techniques and principles, however, was Quintilian’s Institutio oratoria. In the next section, we will present a specific part of classical rhetoric according to Quintilian.

2.2 Ornatus in verbis singularis

“Die Ganze Stärke und Geschicklichkeit des Redners ferner lasse sich in folgende fünf Teile zerlegen: Zuerst müsse er erfinden, was
er sagen wolle; zweitens, das Erfundene nicht allein nach einer äußerlichen Reihenfolge, sondern nach dem inneren Gewicht und nach richtiger Abschätzung verteilen und zusammenstellen; drittens, dieses vermittelst der Rede einkleden und ausschmücken; hierauf es im Gedächtnis aufbewahren; zuletzt es mit Würde und Anmut vortragen”

(Cicero: De oratore, 1,31,142; corr. Quintilian: Institutio oratoria, 3,3,1; quoted from [25] (my emphasis))

This quote well summarizes what was regarded as essential qualities of a speaker in Rome by the 1st century AD, and it is not hard to agree that they are still in our time as valid. These qualities or constituents can be summarized as follows.

**inventio** – to find the ideas and possibilities offered by a certain theme or question

**dispositio** – to arrange the contents in a proper way

**eloquium** – to express the contents in language

**memoria** – to memorize the speech along with thoughts and their linguistic expression

**actio** – to realize the speech in voice, gesture and action

To this list may be added another ‘technique’ that is also regarded as part of the rhetoric [25], namely exercitatio or the practicing of reading, writing and speaking.

Of the items listed above, we will concern ourselves only with eloquium, or the techniques of expressing ideas in language. This linguistic expression, in its turn, can be subdivided in many parts, including, among others, style, grammar, expressivity and ornatus, or the ornaments of language.

The term “ornatus” in itself reflects the Aristotelian view of regarding, for instance, the metaphor not as an instrument of thought but as an adornment that at best serves the functions of clarity and vividness. This is a view that has been argued in many contexts, as we will see in chapters 3 and 4.

The category of “language ornamentation” is further decomposed into several subcategories, of which one is the focus of our interest. This is the ornatus in verbis singularis, or the language ornaments in single words. According to Quintilian, this subcategory is characterized by substitution in order to find the right word among all words with equal or similar meaning. The “right” word may be either one that sounds good (verba vocaliora) or one that best conveys the intended meaning (verba nitidiora). In this paper, we will be concerned only with the latter kind of substitution.

Cicero states three ways to substitute the simple word with an expressive ornament: to use an unusual expression, to create a new word (an onomatopoeism, for instance) or to use an expression out of its usual meaning. This last case is summarized in the concept trope. Quintilian defines a trope as
“the beatifully performed change of an expression from its usual meaning to another meaning.” [25]

In the *Institutio oratoria*, Quintilian then gives the following list of tropes:

metaphor – the metaphor will be discussed specifically in the next chapter.

synecdoche – to substitute one expression for another: from general to specific or vice versa, from raw material to product or vice versa (like Schiller uses “grape juice” for “wine”), or from singular to plural or vice versa.

metonymy – to use another expression that is not similar, as in the metaphor, but related through causality, containment, or possession. When Plato writes: “He then passed Socrates the cup”, he uses a metonymy where “cup” is to be read “poison”. Metonymy is closely related to the synecdoche.

antonomasy – to replace a personal name with something else, either an epithet or a paraphrase. In the Bible, God is often referred to as the “Almighty”.

onomatopoeia – to represent a concept by an expression whose sound alludes to the concept.

catachresis – to invent a new expression for something that has no common name.

allegory – to express a condition that is a token of the intended meaning. The allegory does not strictly belong to the *ornatus in verbis singularis*, since it is often used in a larger scope.

irony – to indicate something by stating its opposite.

paraphrase – a circumscription, by which something is stated in more words than needed. It is debated whether the paraphrase belongs to the tropes, and it might as well be included in the *figures*.

hyperbaton – to manipulate the word order and hence the emphasis on certain words.

hyperbole – a deliberate exaggeration of the truth, by stating more than has actually happened.

It is arguable whether the last five items given above belong to the *ornatus in verbis singularis* since their scope is normally larger than single words. This is also discussed by Quintilian.

From this list of tropes recognized in the classical rhetoric, the *metaphor* will be the basis for the rest of the paper. In the next chapter, the metaphor is investigated and further surveyed from the standpoints of rhetoric and cognitive psychology.
Chapter 3

The metaphor

In this chapter, we will examine in some detail the metaphor and the role and interpretation of the metaphor in rhetoric from ancient Greece to our days. We will also touch upon cognitive psychology in discussing how human beings detect, understand and use the metaphor.

3.1 Classical definition

In order to examine the phenomenon of metaphor in rhetoric over the ages, we need a starting point. This section gives two definitions by the two major contributors to classical rhetoric: Aristotle and Quintilian. The quotes in this section are from [15].

In the Poetics, XXI, 7–14, Aristotle writes:

Metaphor is the application of a strange term either transferred from the genus and applied to the species or from the species and applied to the genus, or from one species to another or else by analogy. An example of transference from species to genus is “Indeed ten thousand noble things Odysseus did,” for ten thousand, which is a species of many, is here used instead of the word “many”. An example of transference from one species to another is “Drawing off his life with the bronze” and “Severing with the tireless bronze,” where “drawing off” is used for “severing” and “severing” for “drawing off,” both being species of “removing”.

Metaphor by analogy means this: when B is to A as D is to C, then instead of B the poet will say D and B instead of D. . . .

In the Institutio oratoria, VIII, 9–10, Quintilian writes:

Metaphors fall into four classes. In the first we substitute one living thing for another, as in the passage where the poet, speaking of a charioteer, says, “The steersman then/With mighty effort wrenched his charger around,” or when Livy says that Scipio was continually barked at by Cato. Secondly, inanimate things may be substituted for inanimate, as in the Virgilian, “And gave his fleet the rein,” or inanimate may be substituted for animate, as in “Did the Argive bulwark fall by sword of fate?”, or animate for inanimate as in the following lines: “The shepherd sits unknowing on the height/Listening the roar from some far mountain brow.”
Schlüter [21] adds to the Aristotelian metaphor concept the figure of *synesthesia*, or the use of transfer from one modality to another. We speak, for instance, of a "warm" color or a "dark" note.

### 3.2 From word to sentence to discourse

As pointed out in [15], the taxonomies of Aristotle and Quintilian are apparently incongruent. We will be concerned primarily with the Aristotelian definition, since the notion of species and genus is more interesting for our purposes than the distinction of animate and inanimate.

Aristotle undoubtedly connects metaphor to noun or word and not to the entire discourse. This, in the words of Ricoeur [20], had the effect that "the destiny of metaphor [was] sealed for centuries to come: henceforth it [was] connected to poetry and rhetoric, not at the level of discourse, but at the level of a segment of discourse, the name or noun." The metaphor was thus regarded as a case of *deviant denomination* that occurred solely at the level of words or perhaps simple expressions.

According to Ricoeur [20], the study of rhetoric (at least in Europe) decayed in the 18th century into something he calls "tropology". This is to be understood as a purely normative approach to study, with an emphasis on classification and enumeration of tropes or word figures. Since this taxonomic viewpoint is not sufficient for explaining the production of meaning as such, there was a need to differentiate the semantic from the rhetoric in the study of metaphor.

The Aristotelian ideas of metaphor is nowadays known as the *substitution theory*. All versions of this theory share the conviction that metaphor is a way of saying what could as well be said literally. This is where the new school of semantically oriented studies disagree. For these new theories (known as *Gestalt* theories), it is fundamental that what is expressed by metaphor can be expressed in no other way.

One of the pioneers of modern study of metaphor is I. A. Richards, who in his *The Philosophy of Rhetoric*, written in 1965, originated what is now known as the *interaction* view of metaphor. A basic assumption for Richards is that the meaning of a sentence is not the result of the meaning of the words; rather, the latter meaning proceeds from breaking down the sentence and isolating one of its parts. Within this framework, the meaning of metaphor is regarded as given by an interaction between two different thoughts of different things. A metaphor is not a substitution of terms but, in his phrase, the "interanimation of words" (quote from [16]). The notion that two thoughts interact is at the root of his distinction between *tenor* and *vehicle*; the tenor is the underlying subject of the metaphor and the vehicle is the terms which present it. An example is this quotation used by Richards:

- A stubborn and unconquerable flame
  Creeps in his veins and drinks the streams of life.

The tenor is the fever from which the man is suffering, and the vehicle is the flame that drinks his life\(^1\). We talk about fever by using the word "flame" and

\(^1\)It is important to note that what we might call the primary subject, "fever", is never explicitly mentioned in the passage and yet we understand it easily.
its associations determine what we mean by so doing. The use of the term "flame" enables us to say things about fever different from those we could say by using the word "fever". This supports Richards' contention that it is thoughts (associated commonplaces) and not words that interact.

When studying semantics (as in the sentence-level metaphor view above), one ultimately has to be concerned with semantic innovation, and thus a transition from the semantical level to the hermeneutical level. Ricoeur attempts to show that this transition corresponds to a change of level that moves from the sentence to discourse (poem, narrative, essay, etc.). So the issue is no longer the form of the metaphor, nor even just the sense of the metaphor, but the reference of the metaphorical statement as the power to "redescribê" reality. Thus, metaphor is closely related to model, and the relationship is one on a heuristic level. This view has been formalized by, for instance, De-dre Gentner [10], who states that metaphors and models can be viewed as structure-mappings between domains. It seems that this view is mainly concerned with the function of metaphor, namely to explain something unfamiliar in terms of another, more familiar, domain.

We will in the following refer to this kind of discourse level metaphors as referential metaphors.

3.3 Metaphors and cognition

This section will briefly discuss cognitive aspects on metaphors. By way of introduction, let us for a moment return to Aristotle. Being a philosopher, he was interested in the definition of metaphor: What is a metaphor and how is it different from literal language and other figurative devices? But being an aesthetician, he was also interested in the question of why some metaphors are striking and others not; and he was also interested in how metaphors work.

Cognitive psychologists have been interested in metaphors mainly for two reasons:

- Language is universally regarded as an issue of concern to psychologists, since it is such a central psychological process and since it is implicated in so many other psychological processes as well. Metaphors clearly provide an important test case for any psychological theory of language. This linguistic interest has given rise to one main question about metaphors: How are metaphors recognized?

- The other reason for psychologists’ attraction to metaphor is that metaphor promises to reveal so much about cognitive structure. It seems that metaphor comprehension can tell us very much about how our ideas are organized and how one idea relates to another. The main question here is How are metaphors interpreted?

As to the third concern of Aristotle, not much work seems to have gone into analyzing what characterizes a good metaphor. Let us dwell for a moment on the two questions mentioned above.

3.3.1 Metaphor recognition

The most common proposal is that we recognize a metaphor when some sort of anomaly occurs [22]. This anomaly may typically be semantic (a debate
can, for example, not be "heated" in a literal sense) but there are also many examples of metaphors where a literal reading may be semantically correct. For example, "My love is a tree" could be a literal statement, but it would in this case indicate a most unusual amorous preference. Other metaphors do not require such bizarre literal readings, merely irrelevant ones.

It seems to be a hard task to formulate tests to detect metaphors, although of course many have tried. All of the tests proposed capture most cases, and nearly all of the clear ones. But there does not seem to be one set of criteria able to detect all metaphors. Tourangeau [22] notes that all metaphors involve two subjects, systems often drawn from different domains. He further proposes that

The most general test for a metaphor may be the joining of two separate subjects; the presence of certain semantic or pragmatic anomalies may simply be ways in which this general criterion is sometimes met, manifesting an underlying domain incongruence.

3.3.2 Metaphor interpretation

According to Tourangeau, most authors dealing with metaphor comprehension accept what is known as the two-step model of the process. Metaphors, according to this model, are interpreted twice — the first time they are read literally, the second time figuratively. This should mean that metaphors, on the average, ought to take a longer time to understand. This hypothesis has not been unanimously proven experimentally [22].

The interesting part of metaphor comprehension begins with the second step, the figurative reading. The attempts to explain how a metaphor is understood generally belong to two traditions: associationism and transformational linguistics.

Associationism proposes that words are associated with an array of elemental ideas, images or concepts. Sentence meaning is some kind of composite of the associations of constituent elements. One option is to view the topic and the vehicle of the metaphor as having common associates; comprehension involves activating the common associates.

In transformational linguistics, metaphors are viewed as semantic violations which have to be handled by inserting special cases in the grammar descriptions of language. Psychologists have made sharp distinctions between normal and deviant sentences, and contrasted the processing of "rule-governed" language with that of "anomalous" language.

Verbrugge and McCarrell [26] criticize the approaches above on the grounds that metaphors have been exclusively treated as imprecise and illogical, and that the characterization of grounds (in terms of common features and common associations) has been purely attributive. They claim instead that this characterization must be made in terms of structural resemblance, abstract relations. They attempt to show experimentally by means of prompted recall that this model of characterization might be more appropriate for explaining metaphor comprehension.

The theory of metaphor comprehension has been further elaborated in the context of information systems. We will return to this subject in section 4.4.
Chapter 4

Metaphors in information systems

In this chapter, we are going to leave classical rhetoric and instead investigate what is known as “metaphors” in information systems. The first parts present an overview of “metaphor” usage and try to explain what is meant by “metaphor” in this context. After this, we move on to examine the motivations and the attempts to formalize the introduced concepts.

4.1 Definition

When we speak of metaphors in information systems, we generally mean something like this:

An information system may be designed to convey to the user an analogical model [11] of the task and system domain. This analogical model is then said to be a metaphor of the information system.

The purpose of this metaphor is generally to explain the concepts of the task and system domain in terms of the (more familiar) concepts of the analogical model. According to the discussion in chapter 3, in rhetorical terms this would be a discourse level metaphor\(^1\) or a referential metaphor. We might also refer to this kind of analogy model as a metaphor theme, which is a term from the discussion of metaphors in science. According to Hoffman [13], Black coined the term in 1962 to refer to the case where the universe of discourse of a scientific theory is compared en masse to another domain.

One interesting issue, related to the definition above, is the difference between metaphor and simile. It is true that they are very closely related in that they both exploit some resemblance between objects or concepts from different domains, but there have been many attempts to formalize the distinction that is intuitively felt. Quintilian’s school taught that the metaphor is an abbreviated simile, while Aristotle saw things quite differently. To him, a simile is developed further than the metaphor, and in fact he subordinates the simile to the metaphor in several places. This Aristotelian view is shared

\(^{1}\)It is amusing to note that many authors rely on Aristotle for definitions and opening quotes, considering Aristotle’s view of metaphor as a phenomenon within the scope of a word.
by Ricoeur, who writes [20]: "...simile explicitly displays the moment of resemblance that operates implicitly in metaphor." Aristotle also points out that this explicit elaboration makes the simile less aesthetically pleasing. The interactionist view of metaphor (refer to chapter 3) states that while metaphor involves interaction of thoughts, the simile is just a simple function of comparison [16]. Levine [15] suggests that the simile is used to assist the reader (or, in the context of information systems, the user) in making his phenomenological interpretation. With this kind of observations and suggestions at hand, it might be stated that the definition given above applies to similes rather than to metaphors. Our view is that we are dealing with a more or less continuous spectrum of the use of resemblance, with metaphor on one extreme (totally implicit) and models on the other (totally explicit). The simile would be placed somewhere between these two extremes.

In the context of information systems, this distinction does not seem to be treated as being very important. The term "metaphor" is used in the literature to denote the whole spectrum mentioned above. In the rest of the paper, we shall conform to the modern usage of the term "metaphor" in its broader sense.

4.2 Use of metaphors

The concept of metaphor in information systems apparently originated in the late 70s, when Xerox created an experimental word processing system called Alto. This was the birth of the well-known "desk-top metaphor". Results from the Alto experiment were then used in the design of the Star Information System in 1981 [23]. This is an office system combining document processing, data processing and filing, mailing, and printing. The screen represents a "desk-top" with documents, folders etc. lying on top of it. These objects can be directly manipulated with a pointing device, and acted upon in a way similar to the operations available in a real office. Another, perhaps better known, office system employing the same basic metaphor is the Apple Macintosh [1]. The purpose of the desk-top metaphor is obviously intended to present to the user familiar concepts such as documents and copy operations instead of a totally abstract and unfamiliar command language and cryptic file system. Another important part of making the user feel "on safe ground" is the WYSIWYG\(^2\) principle, which means that a working document, for instance, is presented on the screen in the same way as it will eventually appear on the paper, including fonts, page breaks etc.

It is easy to see that a large-scale metaphor like the desk-top includes several metaphors on a somewhat lower level. The text-editing function of the office system, for instance, may be compared to a typewriter. This may suffice for introductory purposes, but it poses problems due to functional fixedness, i.e. the interference of prior knowledge. On a typewriter, the space bar is used for moving rightwards along a line, but on a text editor an attempt to do this will either erase the text or push it to the right [4].

To continue with our examples, metaphors have been employed in many areas apart from office information systems. In [18], Nievergelt and Weydert report on a system that uses a spatial metaphor to help the user navigate

\(^2\)Which means "What You See Is What You Get".
through data and command structures. ARK, a system created by Randall Smith [6], uses a real-world metaphor for the user to experiment with gravitation and other properties of objects in the physical world. Carroll, Mack and Kellogg [6] give an overview of many systems illustrating key metaphors, including chalkboard, outline, business forms and many other metaphors.

4.3 Metaphors and learning

A user of an information system learns about the system prior to and in the course of using it. In this section, we will examine how metaphors in the design of the information systems affects the user's learning of the system.

For a start, let us establish that people tend to make use of their past knowledge in trying to learn something new. A specific instance of this phenomenon is the metaphoric extension from one structured domain to another. The familiar domain, from which the metaphor is drawn, can vary depending on the previous competence of the user. For example, a professional programmer might learn a new system by metaphorizing at least initially from what he already knows about another system. More casual or naive users might rely on metaphors drawn from more distant domains of knowledge, e.g. use what they already know about typewriters in order to learn a text editor [7].

This proposal implicates a simple and direct suggestion. If people employ metaphors in learning about information systems, then the designers of those systems should try to anticipate and support metaphorical constructions likely to enhance the learning and use of the system. Also, it is important that the designers seek to provide guidance to new users who may otherwise rely upon inappropriate metaphors. Carroll and Thomas [7] provide some ad hoc recommendations for designers of information systems: (the first five points are intended mainly for designing systems for naive users, the last three are oriented towards more experienced users)

- Find and use appropriate metaphors in teaching the naive user a computer system.
  
  Given the precondition that people use old knowledge in acquiring new, it should be fairly obvious that it is an advantage to give the user hints as to what old knowledge is appropriate to use for his learning task.

- Given a choice between two metaphors, choose the one which is most congruent with the way the system really works. The more aspects of the system that can be "covered" by a single metaphor, the better.
  
  Perhaps the best example of non-congruence in the metaphors presented to a naive user is error messages. Imagine an unskilled user who has been implicitly led to believe through the use of words like "retrieve," "store," and "file" that they are dealing with something like the office filing system he is used to. The user specifies that he wants to store a file, whereupon he is given a message such as %%ERR-MSG-42 without additional comment. Suddenly the close-to-comprehensible world of office files is gone.

- Take care to ensure that the emotional tone of the metaphor is conducive to the desired emotional attitude of the user.
A metaphor may involve a fairly isomorphic comparison at a rational level between some concrete object or series of events and a system. If the emotional tone is wrong, the metaphor is anyway likely to prove ineffective or worse.

- When it is necessary to use more than one metaphor for a system, choose metaphors drawn from a single real-world task domain (i.e., similar enough) but do not choose objects or procedures that are too similar.

- Consider the probable consequences to users and system designers of each metaphor used.

Consider the usage of the frequent term “man-machine communication.” This may be a very powerful and misleading metaphor, in that the naive user might expect the machine to communicate with him in the human sense of the word. It is not unusual to see unskilled users type in “What?”, “?” or “STOP THAT!” to which the system frequently responds UNKNOWN COMMAND.

- When introducing a metaphor, explicitly point out to the user that it is not a perfect representation of the underlying system.

This is necessary because the metaphor used is, by definition, an imperfect mapping to the real system.

- Keep in mind from the beginning that any metaphor presented to the user is provided to give an overview of the system and that there may be a time that the metaphor is no longer useful.

- Provide the user with exciting metaphors for routine work.

The importance of choosing metaphors carefully is illustrated by Hayes in [12]. The same underlying problem was presented to a number of subjects in two slightly different representations, chosen so that one representation was easy to imagine while the other was rather “unnatural”. It turned out that the more natural representation made it much easier to solve the problem, and also that the subjects solved the (basically isomorphic) problem in different ways depending on the representation they had been given.

Another issue that is most important to consider is what happens when the metaphor breaks down, i.e., when the user steps outside the boundary of the metaphor he is currently regarding as perfectly valid. As Carroll has pointed out [3], this mismatch is not necessarily a problem but can be an efficacious learning tool, provided that it occurs in an obviously consistent context. Carroll gives an example of an inexperienced user of the Lisa system who was prompted to “tear off paper” in the context of an icon representing a pad of paper. The user took the prompt quite literally and tried to devise some action of “tearing” by sweeping the cursor across the desktop and the icon representing the pad of paper. The metaphor in this case was a mismatch since actions applied to objects like files must be selected from menus. However, the metaphor was not a failure. To quote [3], “The experience provided a key insight — not only into how to select actions in this interface, but about the boundary conditions for the interface metaphor.”

Lisa is a system from Apple, introduced in 1983. It was the predecessor of the Macintosh, with a user interface based on direct manipulation and the metaphor of a desk-top.
To summarize this section, it is important for learning as well as for using information systems that the systems are designed from the fact that people use old knowledge in learning new things. This is where the metaphors of information systems play an important part.

4.4 Theoretical approaches

Within the context of information systems, and the understanding of metaphor as defined in section 4.1, metaphors have been theoretically studied mainly from a cognitive science point of view. Three main directions of study can be identified: the operational approach, which focusses on the manifest effects of suggesting metaphoric comparisons to the learners, the structural approach, which more formally tries to resolve the question of how prior knowledge organizes new learning, and the pragmatic analyses that consider how possible metaphor mappings are constrained in actual use by contexts and goals. The short survey of these directions that follows is built mainly upon work by John Carroll and his colleagues [5] [6].

4.4.1 The operational approach

Educators have often observed that providing students with comparisons can help them learn. The operational approach to metaphor observes that many metaphors can help people learn about information systems in many ways. In demonstrating learning efficacies, the question is raised of precisely how metaphor operates in the mind to achieve such effects. The operational analyses offer examples of “good” metaphors, and sometimes of “bad” metaphors, but they offer no principles that could predict these properties extensibly. There is not even a principled definition of what a metaphor really is. This definition may be found in the structural analyses.

4.4.2 The structural approach

The structural analyses attempt to define metaphor in structural terms by developing representational descriptions and specifying mechanisms for constructing and evaluating these descriptions. The structure-mapping theory of Gentner (refer to chapter 3) can be ordered into this category of analyses. The contributions of structural theories are mainly that they provide an analytical framework that clarifies what metaphors are and enable more precise questions to be asked, for example, the nature of similarity and dissimilarity between source and target domains. On the other hand, structural theories do not address contextual factors such as the goal and motivation of the person facing the metaphor, or what domain knowledge is relevant for constraining the relations appropriate to the mapping. Purely structural approaches must avoid the question of which relations constitute the mapping, and the consequences metaphors can have for learning and experience are also considered irrelevant. To address these questions, a pragmatic approach is necessary.

4.4.3 The pragmatic approach

The focus of the pragmatic studies of metaphor is the context in which metaphors occur — including both the goals associated with using a metaphor and
characteristics of metaphors beyond their pure similarity basis (i.e. their incompleteness, mismatches and involvement in composition). In the pragmatic approach, information system metaphors are seen as tools. They are deliberately invoked in the service of specific user goals. They directly describe aspects of the target domain, but they also inherently fail to describe, or even misdescribe, other aspects. The point is that resolving these failures enhances a conceptual understanding of the target domain.

4.4.4 A unified framework

The relationship of the three approaches mentioned above seems to suggest a need for and a possibility of an integrated theory of metaphor use. In [6], we can also find a proposal by Carroll et al to satisfy this need. What they propose is an overall pragmatic framework of metaphor use based on different types of cognitive activity, within which the roles of structure-mapping and pragmatic constraints can find their place. This framework defines three stages in metaphorical reasoning: instantiation, elaboration, and consolidation.

- **Instantiation** is an automatic activation process that provides a metaphor comparison and maintains it for elaboration. Instantiation of the metaphor is frequently based on the basis of surface similarities, but may also be based on similarity of tasks and goals.

- The second stage, **elaboration**, is a more detailed analysis of an instantiated comparison. It is a pragmatically guided structure mapping, identifying the predicates to get defined and mapped. The process is directed by the user’s goals, by the type of explanation or understanding sought in the target domain. If a mismatch is detected, this can stimulate the elaboration mechanism to construct a new understanding. Elaboration is also the mechanism by which the problem solver capitalizes on prior knowledge of the source domain.

- The **consolidation** stage provides a control structure for the other two stages. The instantiation and elaboration stages will in the course of time produce partial structure mappings for a variety of metaphors. Consolidation integrates these partial mappings into an integrated understanding of the target domain, a mental model.

To summarize, we may recognize that the ultimate problem that the user must solve is to develop an understanding of the target domain itself — a mental model. This implicates that interface metaphors must be viewed as tools offered to the user for articulating mental models.

For information systems purposes, this implies that successful system design (and user interface design in particular) will need to take into account observations of users’ previous exposure to other metaphoric interfaces, the knowledge that users can be expected to gain through metaphoric comparison as well as the consequences of the metaphor for the user-as-learner.

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4The basic distinction between models and metaphors is that while models are designed to represent some target domain as faithfully as possible, metaphors are chosen or designed to invite comparisons and implications which are not literally true.
4.4.5 Connections to other disciplines

This theory by Carroll, presented in the previous section, seems to be well-founded in the tradition of cognitive psychology. It can be viewed as an extension to the structural approach reviewed earlier.

If we compare with rhetoric, there are certain similarities: the theory seems to be along the line of changing the focus of attention from word through sentence to discourse. But the deviations are just as obvious:

- The concept of metaphor has shifted from the truly verbal domain to a visual domain.
- What is today known as metaphor would, in terms of classical rhetoric, rather have been classified as allegory or simile, due to its wider scope.
- The product of rhetoric (i.e. the speech) was a sequential structure, and above all it was temporary. Metaphors in information systems are used in a more permanent way. Consequentially, the purpose of metaphor in rhetoric was to adorn, illustrate, and impress, while the purpose of metaphor in information systems is more of instruction and aid to learning.

The conclusion and summary of this chapter must be that the study of metaphor in information systems have developed from a rather ad hoc discipline into a framework based upon cognitive psychology and learning theory. The concept of metaphor in classical rhetoric does not have much in common with information systems metaphors.
Chapter 5

Metaphors in office information systems

In this chapter, we specifically consider metaphors in office information systems. The current paradigms in office information system design are examined, we discuss the important issue of fidelity (how true the metaphor should be to the real office world) and finally try to indicate a possible direction for the future.

5.1 Where we are today

In the office information systems of today, we can find a wide range of key metaphors. Carroll et al [6] give as examples the typewriter metaphor for text processing, the desktop for the operating environment, the business forms for form-based business applications and so on. A general observation is that the designers of office information systems seem to be striving towards a metaphor that is as similar to the real office as possible. Of course, the purpose of these attempts is praiseworthy; the users will probably be more prone to accept a new system if they are able to draw upon their previous knowledge of the working situation. A reasonable question to ask, however, is how far the office information systems should try to simulate the real office. In the following section we will examine this question in some detail.

5.1.1 How faithful should the simulation be?

The naive answer to this question would be "in as much detail as the system allows, to take maximum advantage of the user's previous knowledge of the real office." As Johnson has pointed out [14], this answer is wrong for several reasons. First, it fails to recognize the fact that the user is not so dexterous in manipulating simulated objects on a computer screen as he is in the physical world. Second, it often results in unnecessary system development effort and poor performance. Third, and perhaps most important, it limits the functionality of the system to that provided by its physical counterpart. A good example of overly ambitious simulation is the simulated calculator that is often available as a "desktop accessory" in office information systems. This calculator is operated just as a real one: the user presses number and function buttons by using the mouse. The number display is also just like the display of a real calculator: small. Real calculators are not easy to use: among other
user interface problems, they make it easy to lose track of what one is doing and it is hard to correct errors. In this case, familiarity is not sufficient reason to simulate them on personal computers and workstations instead of providing a calculating function free from the problems that go with the calculator.

Let us continue by examining the desktop metaphor more closely. When is it appropriate to deviate from the exact simulation of the office? We can identify three cases where this deviation is justified.

Functionality missing in the office

There are obvious reasons for deviating from the desktop metaphor when the computer can provide useful functions that are not available in the real office. For example, on the Xerox Star and its successor, the Viewpoint system, file drawers can present their contents sorted according to any of several different criteria. This is a deviation from the functionality provided by physical file drawers, and it has to be paid for in additional time required in training the users to use the sorting functions, but generally it is well worth the investment.

Another non-physical aspect of the Star user interface is that folders can be nested to any depth, that is, folders can contain folders. This is obviously not possible in the case of physical folders, but it is nevertheless a valuable function since it becomes easier for the users to maintain a structure among their files.

When deviating from the physical-office metaphor in this way, it is most important to make clear to the users the boundaries of the metaphor. This is consistent with the recommendation of Carroll and Thomas in section 4.3. To continue from the last example above, it should be pointed out in some way that the file system of the Star is not “just like” a physical file cabinet. Otherwise, users may be misled into believing that the limitations of the physical folders (all of the same size, so they can not be fit into each other) apply also to the system.

Functionality not needed in a computer system

Deviations from the physical office occur also when a function provided by some aspect of the physical office is simply not needed in the computer-based information system. Usually, the users do not even notice this kind of deviations; have you ever missed the stapler and the paper clips on your electronic desktop? Probably not, because the unit in an office information system is the document rather than the page and thus the document does not fall apart when left unstapled. To keep documents together, the folder is used instead of the paper clip.

Enhancement of the user interface

Finally, another reason for deviating from the desktop metaphor is to enhance the user interface. For instance, real objects on real desktops do not shrink to small, schematic representations of themselves when not in use. The use of icons is prescribed by the relatively small size of the display screen, as compared to the physical desktop. A user interface where documents would retain their full size even when not in use would quickly become impossible to use as the number of documents grew.
A related reason for deviating from the faithful simulation of the office is to provide a user interface that makes certain tasks easier to perform in the system than they are in reality. An example of this is file listings. In Star/Viewpoint, you access a file by opening a file drawer or a folder, looking for the file you want, selecting it, and performing some action on it. Now consider the case that there are hundreds of files in the file drawer, and you already know the name of the file you want. In a system that simulates the physical office, you would still have to page through the whole directory listing until the file appears so that you can select it. Instead of this tedious procedure, a reasonable deviation is here that you are allowed to directly type the name of the file and have the system find it.

5.2 Where to go?

In the previous section, we saw a few examples of the metaphors prevailing today in the design of office information systems. In this section, we are now about to sketch some possible metaphors of future systems.

In 1983, Clanton [8] gave an intuitive classification of metaphors in information systems. He distinguishes between functional, operational, organizing, and integrating metaphors. This classification may be a suitable starting point for a discussion of metaphors in the office information systems of tomorrow.

5.2.1 Functional metaphors

A functional metaphor is intended to make the function of a machine more compatible with the user's view of the task. A good example of this kind of metaphor is the computer-based spreadsheet systems. For appropriate tasks, they generally provide a very strong metaphor that closely matches the user's knowledge of the task. The match is of course not perfect, but the electronic spreadsheet contains much useful functionality that is not present in a paper-based spreadsheet. For example, a spreadsheet calculation on paper would not automatically recompute the desired result when a value is changed that affects the result. The computer-based spreadsheet is a good example of the extension of functionality discussed in section 5.1.1.

As to the future, it is possible that this kind of functional metaphor in a system providing extended, useful functionality will change the way people regards the corresponding task. It might be the case that people's expectations and perceptions are going to shift gradually from the task domain to the extended functionality, system, domain.

5.2.2 Operational metaphors

The operational metaphor unifies sets of operations, so that the users form expectations about what operations are available and how to use those operations. The desktop metaphor is mainly operational: by presenting a desktop, the users are induced to expect the availability of the operations that are commonly associated with the desktop.
5.2.3 Organizing metaphors

The commonly used desktop metaphor has proven very appropriate for integrating a cohesive set of functions, but it is generally less successful in modeling the user's personal organization of work. There is more to personal organization than long-term storage of documents in folders in file cabinets. Malone [17] has by empirical studies and interviews found that one of the most salient features of the way people organize their offices is that some information is stored in files and some in piles. Offices that include many piles appear to be messy and also tend to be less useful to their occupants. The reasons that piles are created are, according to Malone:

- The mechanical difficulty of creating labeled file folders, binders, and so forth.
- The cognitive difficulty of creating appropriate categories classifying information in a way that will be easily retrievable.
- The desire to be reminded of tasks to accomplish.
- The desire to have frequently used information accessible.

These reasons can be self-defeating, since as more and more information is stored in piles, it becomes harder and harder to find things, and items that were placed visible as reminders become covered and no longer serve their purpose. An office information system might help with these problems by providing an appropriate organizing metaphor. More specifically:

- The system would make the mechanical process of creating classification systems very easy.
- The trouble with classifying information could in an office information system be overcome in several ways:

  - *Multiple classification.* Allowing the document in question to be easily put in several categories is quite feasible in a computer system, but very hard to accomplish in a physical storage.

  - *Deferred classification.* Another way to simplify classification is to allow users to defer classification in the same way as they do on desktops, by storing the information in some location without having to classify it explicitly. These "electronic piles" should make the use of computer-based systems more natural. In general, the use of *spatial location* for accessing information, instead of logical classification, is an important part of human organization ability. This might profitably be incorporated into computer-based office information systems.

  - *Automatic classification.* Still another way to simplify classification is to do as much as possible automatically. For example, electronic mail and forms contain explicit fields for information like author, subject, and so forth. This information can be used to automatically classify the documents, with no effort on the user's part.

- The retrieval of information can be much alleviated by being able to specify several retrieval keys simultaneously.
• The system should be designed explicitly in order to facilitate reminding. The users could, for example, be allowed to classify things they want to be reminded of in terms of priority, date (e.g., a deadline), and by event (e.g., things to remember on seeing a certain person).

In this discussion on organizing metaphors, it is interesting to imagine a future setting where all of the office work is performed within the office information system because only then can all the advantages offered by the system be exploited in full. The reminding function discussed above, for instance, is of best use only when the user uses the system every day.

5.2.4 Integrating metaphors

The metaphors of current office information systems are generally founded on the level of abstraction of the individual worker (the desktop metaphor is in this sense typical). Although the technology needed for intra-office communication of information is readily available, the large-scale integration of information in a holistic office information system is still awaited. But this integration has to come, if the ancient human burden of transporting information is finally to be lifted.

The integrating metaphor needed to describe a whole office would be something in the spirit of an office model. In the literature, many proposed office models can be found (see [9] for a survey) and there are also many classification schemes for these models. Bracchi and Pernici [2], for example, give the following four categories of office models: data-based models, process-based models, agent-based models, and mixed models. In this discussion, it is important to remember the distinction between a model and a metaphor: while a model is devised to represent the target domain as true as possible, the metaphor is chosen or designed to invite comparisons and implications that are not literally true. A model of the whole office would be the same to every employee in the office (since the model is an attempt to represent an objective reality), but the metaphor is different. Since metaphoric reasoning draws upon previous knowledge, and persons in different positions in the office know different things about the office as a whole, this implies that the integrating metaphor should be different for different persons in the office. As an example, consider the administration ("the office") of a software manufacturing company. The programming team is to the personnel department a collection of entities with characteristics like salary and years with the company, while to the project managers the same programming team may be a function that accepts specifications as input and produces application systems.

This observation may interpreted in the following way: a total office information system may have to built upon an objective model of the office (for implementation reasons, if nothing else), but the integrating metaphors on top of the model could (in fact, should) be different for each user of the system.

5.2.5 Future implications

The above discussion on office information systems in the future can perhaps be summarized in the following way:

• The metaphors of future office information systems will be based on higher levels of abstraction. The office model will be the foundation,
rather than the desktop. These *integrated* metaphors may very well be different for different users.

- The metaphors will provide an environment that allows the users to *organize* their work in a convenient and familiar way, thus encouraging the transfer from paper-based to computer-based information management.
Bibliography


In this paper, we discuss the concept of metaphor within rhetoric, philosophy, cognitive psychology and computer science. The history of rhetoric and metaphor is surveyed, the state of the art in the computer science sense of metaphor is examined, and we try to show that the study of metaphor in information systems has proceeded from ad hoc approaches to theories that eventually establish a connection back to the studies of metaphor within other disciplines. Finally, we discuss the implications of the metaphor concept for the office information systems of the future.
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