

Philosophical Studies and Hypertext

Michela Galati
John J. Leggett

Hypermedia Research Lab

SEPTEMBER 1993
TAMU-HRL 93-010

Table of Contents

1. INTRODUCTION	1
2. BUILDING THE <i>Philosophical Dictionary of the Seventeenth and Eighteenth Centuries</i>	2
3. EVALUATION OF HYPERTEXT FOR PHILOSOPHICAL STUDIES	6
1600	10
4. CONCLUSIONS	12

1. INTRODUCTION

The field of philosophical studies involves a systematic investigation of a very complex set of documents whose primary sources, the philosophical texts in Greek, Latin and national languages, have been read and studied for many centuries. The Lessico Intellettuale Europeo (LIE) established as a CNR (national research council) Institute in Italy has developed its work on the analysis of philosophical and scientific texts using lexicographic methods. Work at the LIE concentrates mainly on the seventeenth and eighteenth centuries, these constituting the departure point of modern culture as regards both central lines of thought and conceptual and doctrinal developments. The work also concerns the lexical aspects of the Latin language and its vitality as the language of several disciplines and technical dictionaries, and its continuous interaction with the national languages established in Europe at that time. The relationship between Latin and the different national languages is a point of great importance in any research involved in the intellectual terminology of the seventeenth and eighteenth centuries. This relationship provides a dead-line moment between the use of Latin as a technical language and the emergence of the national languages. The *Thesaurus Mediae et Recentioris Latinitatis* is a research project underlying the continuity and vitality of medieval Latin and the Romance languages. The goal of the project is to collect and make available to scholars and students, as a database, some of the Latin terms not present in the well-known dictionaries of classical and medieval Latin (Thesaurus Linguae Latinae, Oxford Latin Dictionary, the Blaise Dictionnaire), with particular emphasis on the words derived from the Greco-Latin translation area and the translations of Aristotle [24].

The major product of this research consists of an evolving philosophical dictionary and a number of publications, indices, concordances and lexicons. The *Philosophical Dictionary of the Seventeenth and Eighteenth Centuries* is a multilingual dictionary (Latin, English, French, German, Italian and Spanish) of entries organized in alphabetical order, taken from the major philosophical and scientific works of these two centuries, from Charron's *Sagesse* (1601) to the death of Kant (1804). The Latin section has 55 works of 24 different authors, including Galilei, Descartes, Leibniz, Kant and many others. This dictionary is a 'lexicon' that presents philosophical and scientific theory through the language and terminology used by the philosophers in their books. It provides entries organized under different lemmas according to different languages (see Figure 1). The lemmas are defined by their contexts, arranged in chronological order and followed by a

grammatical classification to help distinguish homographs. Currently, a full-text information retrieval system provides a thesaurus of word forms (70,000 units) and a lemmary-thesaurus (9,000 units) covering the Latin area of the philosophical dictionary. In publishing new indices, concordances and lexicons the starting point is the database which provides the lemmatised concordances and contexts of the dictionary.

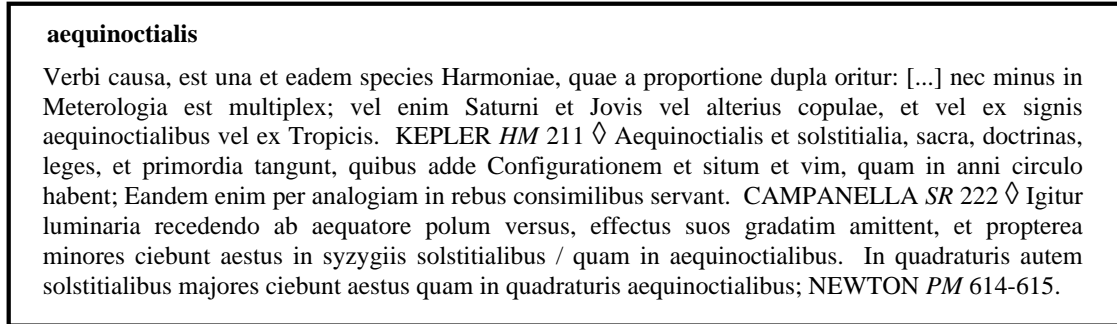


Figure 1. Entry from the *Philosophical Dictionary of the Seventeenth and Eighteenth Centuries*.

The goal of this paper is to give insight into problems that philosophical studies pose for hypermedia systems. The vehicle used to achieve this goal is the analysis of a typical philosophical studies intellectual task embedded in two popular hypermedia systems. In particular, we evaluate the capabilities of Intermedia [12, 28] and KMS [1] for the representation and analysis of the ‘Orazioni inaugurali’ of Giambattista Vico [26]. Section 2 describes the particular context and procedures used in this intellectual work, why the existing information systems approach is lacking and why hypermedia systems can be beneficial. In Section 3, we present and discuss the evaluation of the two hypermedia systems for this application. Section 4 concludes by discussing the two most important missing features of hypermedia systems for this application domain.

2. **BUILDING THE** *Philosophical Dictionary of the Seventeenth and Eighteenth Centuries*

The complexity of this work requires a set of procedures that can best be explained as follows.

- a. The original writing (usually a book) is inserted in the database. The writing is divided into documents, each having a tripartite format (see Figure 2): a bibliographic reference area, a natural text area (unformatted) and a lemma area (formatted) containing the terms which constitute keys.

All three areas are pre-edited and descriptive codes inserted indicating capital letters, italics, the presence of languages other than Latin, etc. The full-text information retrieval system operates on different parts of the documents with different commands. Boolean queries are used to search and retrieve interesting documents.

b. The researcher, through continuous interaction with the database, composes the entries for the philosophical dictionary by retrieving and studying keywords in context from the natural text and/or lemma areas of the document. During this phase many factors are considered, including the list of all instances of the keyword, ascending or descending order of keyword frequency, the combination of the keyword with other significant keywords, concordance techniques for natural language pattern recognition and suffix and prefix analysis. Suffix and prefix analysis is particularly important for the Latin and Greek languages since the classical languages are built with a different syntax and semantics than the modern European languages. For example, in these languages, the suffixes ‘ae’, ‘as’ and ‘am’ can change the ‘context’ of the keyword.

c. The ‘lexicon’ evolves primarily through additions to the lemma area. The lemmas do not have a single definition, but are ‘defined’ by the **contexts** (found in procedure b) grouped under each lemma.

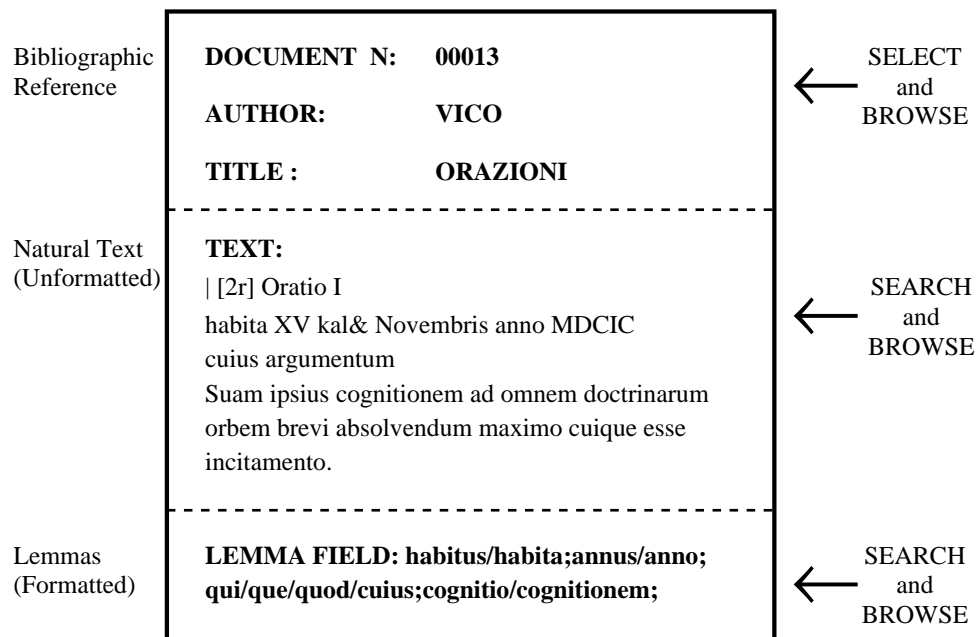


Figure 2. Document in Stairs.

A practical example is the entry of the word ‘astronomy’. This constitutes one of the keywords of modern science. In the past its meaning was not completely separated from the semantic of ‘physics’. The line of changes followed diachronic and synchronic paths and the Latin semantic varied in different geographical areas. Considering its confluence in the national languages, the word ‘astronomy’ used in Galilei does not have the same meaning as in Newton. Also, ‘astronomia’ and ‘astronomiae’, even with the same semantic, could have different contexts; the first being a subject or an ablative; the second, a plural subject or related with a complement depending on other ‘contexts’. To decide when astronomy developed its own autonomy and the word acquired the meaning of modern science is one of the goals (and daily jobs) of philosophical research. Since it is clearly impossible to define one specific lemma for astronomy, this goal is accomplished by building a series of meaningful ‘contexts’. The complexity of all these factors (language, geographical area, social and cultural life, development of the modern science and terminology) serves to make philosophical studies a very challenging task domain and places difficult requirements on information systems that support this intellectual work.

2.1 Traditional information retrieval alone doesn’t work

The full-text information retrieval system currently in use at the LIE is IBM’s STAIRS (STorage And Information Retrieval System) [13]. After five years of daily use we have determined that this system is inappropriate for this complex intellectual work. Although it has full-text indexing and boolean search, the retrieval effectiveness is unacceptably low [2, 3, 19]. In addition, for our task domain, we have observed the following problems:

Workspace. The addition of materials becomes very difficult when we have a large collection of documents (e.g. over 12,000).

Editing. Editing operations are not available as part of the system and, over the years, this has become a major problem. Inserting a book manually or mechanically involves many typographic mistakes. The revision of documents outside the system is a complicated, time-consuming and expensive procedure.

Merging. Merging operations fail for more than 50 documents. Considering that the number of documents and updates are in the thousands, this limitation causes serious problems.

Interface. The interface is quite poor. The on-line help is so poor that a small book of procedures had to be written for the researchers of the LIE.

Search and retrieval. Search and retrieval is accomplished by boolean query. This method of retrieval is difficult for many people. In fact, STAIRS is not directly used by most of the researchers at the LIE. All searches are usually made by one or two researchers (agrees with Blair and Maron's observations [2]).

2.2 Forging a new relationship

Forging a relationship between the fields of philosophical studies and hypertext is useful and theoretically sound. Philosophical studies require continuous personal decision making over the contexts in which interesting terms appear. The researcher must be able to see faithful reproductions of the documents, navigate among the documents, associate contexts, annotate anywhere in the corpora and communicate with other scholars. It must also be possible to update the information by correcting (typographical) mistakes and adding new documents, lemmas and contexts. In addition, it must be possible to insert educational materials of many forms including dictionaries, maps and pictures. Obviously, this vast corpora of sources form a highly interconnected network.

The complexity of this lexicographic task requires much more than can be offered by state-of-the-art, full-text information retrieval systems. The large number of documents involved and the interrelations of their connections also pose problems for hypermedia systems. Management of an immense storage of documents and maintenance and continuous update of this storage imposes requirements like those of the most advanced database, information retrieval and data repository systems. But it is the personal, highly interactive nature of this intellectual task that requires a hypermedia system approach.

Why are there so few examples [6, 7, 8, 9, 18] of an application of hypermedia systems in classical studies? First, it is harder in the humanities than in the more technical fields to approach new techniques that necessarily require a new methodology and perspective. Second, students, scholars and professors do not have access to the new technological instruments necessary to verify new techniques. Third, scholars in the humanities do not have access to specific courses on the combination of this new technology and their respective fields. Steven DeRose [8] underscores the

problems within Classics and the Religious Studies by showing that the complexity of documents in this field, with more than one structure and more than one version, requires multiple inheritance and sophisticated search, retrieval and annotation tools. If we are to forge new relationships, we must make these tools and the underlying technology readily available to all scholars.

3. EVALUATION OF HYPERTEXT FOR PHILOSOPHICAL STUDIES

A major goal for this evaluation was to provide as realistic a setting as we could, given the constraints of the situation. This work was carried out over a six-month period while the first author was a visiting scholar in the Hypermedia Research Laboratory at Texas A&M University. An in situ longitudinal study was chosen over a single experimental setting to provide a more reliable assessment. We used the same procedures as those used at the LIE: insertion of the writing in the database, analysis of the existing corpora and extension of the corpora through the building of a 'lexicon'. The daily work activities of the philosophical researcher remained essentially the same but of necessity the size of the corpora was significantly smaller. For this pilot study, a typical writing from the eighteenth century was chosen for analysis in two of the more full-featured hypertext systems.

3.1 The 'Orazioni inaugurali' of Giambattista Vico

The 'Orazioni inaugurali' of Giambattista Vico are six speeches, each putting forth a particular argumentum. Each speech has an internal structure based on the division of paragraphs. Although the logical division in paragraphs was prescribed by the author in 1708, the 1982 edition used in this research has a division based upon pages [26] and recent lexicographic works have profited from this kind of structure [25]. The division of a book into pages corresponds to a metastructure imposed by the typography. For old books or manuscripts this metastructure rarely corresponds to the internal structure of the book.

3.2 Conversion to hypertext

A natural language document always presents concrete problems of virtual divisions and different structures that often cannot be represented in a hypertext as we would like [4]. The philosophical researcher is continually faced with the problem of fragmenting the writing to be as close as

possible to the logic of the original document without imposing another metastructure. In addition, it is usually important to maintain the current physical divisions of the document so researchers can find passages in existing manuscripts and books. These factors lead to the requirement that several logical structures be maintained for each document.

Fragmentation is a difficult problem in general, but for philosophical studies it is crucial since important information is usually contained in the structuring of the document itself. Context is critical to meaning, therefore, many times structure is meaning. The accurate selection of nodes and links is of utmost importance for the usability of a hypertext system in philosophical studies and constitutes a major departure point from most previous work on document conversion. In addition, the faithful reproduction of fonts and marginalia from the original documents pose very difficult representational problems for hypermedia systems.

We deliberately chose the ‘Orazioni inaugurali’ of Giambattista Vico to avoid arguments over the appropriateness of the fragmentation and we adhered to the following five principles: simplicity, clarity, consistency, brevity and connectivity. Each node contained one paragraph and as few links as possible to achieve the desired interconnectivity (simplicity, brevity, connectivity) and each node was structured and presented identically (clarity and consistency).

3.2.1 Conversion to Intermedia

Conversion to Intermedia followed the rhetoric suggested by Landow in [15]. Seven folders were generated containing the introduction to the book and the ‘Orazioni inaugurali’. Each oratio folder contains documents corresponding to the paragraphs of that oratio. Eighty-five documents were created with 165 links in the Vico web. Each document presents two links in two different anchors. The first link allows traversal to the previous or next document (paragraph) in this oratio. The second link allows traversal through the introductions to each oratio.

Since Intermedia does not provide for the building and subsequent search and retrieval of a local index and due to the problems discussed in Section 3.3 of this paper, the Intermedia hypertext was not expanded further.

3.2.2 Conversion to KMS

In KMS the ‘Orazioni inaugurali’ comprise a total of 107 frames organized in a hierarchical fashion within one frameset named ‘Oratio’. Each paragraph from the oratios is contained in one frame along with a standard set of utility links and several codings (see Figure 3). The utility links consist of three search functions, an on-line tutorial and a comment link for annotations. The search functions consist of the two KMS programs: search-tree and search-frameset and a KMS interface to the Unix ‘egrep’ command. The tutorial describes the hypertext, helps to orient the researcher and gives additional information concerning the author and period. The comment link allows the researcher to leave comments/annotations for other researchers and, in general, to share an information space for asynchronous communication/collaboration. Two major codings are contained in each frame: a coding for the physical page which enables the researcher to recall the original structure of the physical text and a coding (with the symbol ‘\$’) before the conjunction ‘que’ that, in Latin, follows a word that must be distinguished semantically from other similar syntactical forms (e.g. super\$que).

KMS allows the researcher to build an index of important terms on a frame by frame basis. We used this capability to build ‘local’ indexes in the following way: we chose the most significant and relevant words (lemmas) and created a main entry or ‘root’ for each, followed by a secondary entry containing the word physically present in the text. For example, cardo(root):cardine(entry). This type of indexing is critical to the field of philosophical lexicography because it allows search and retrieval on local indexes built by the researcher during normal daily work. This local view is very important for natural language texts in which the researcher must read the text containing a particular word to decide which contexts are more significant. Also, the consultation of an index built by a lexicographer (professor) helps the researcher (student) to realize which roots and entries are particularly important for an author.

<p>Par3/I</p> <p>[[3] Quid ipse igitur adferam vestra expectatione dignum, auditores, qui generosos huius iuventutis animos expleam, quod infra et spem vestram et istorum dignitatem non sit? quid dignum hoc sanctissimo sapientiae sacrario? quid dignum hoc amplissimo atque ornatissimo ad dicendum loco, quem nunc primum insolens co{n}scendi dicturus? Sed iste frequens consessus ve{s}ter, confertissima haec corona, isthaec vestra omnium alacritas, vultu et aspectu significata, me haerentem excitat et non reficit modo et confirmat, sed ad altiora etiam erigit et extollit, ut argumentum vobis hodie proponam, quo potissimum uno ad cuncta [3v] bonarum artium et scientiarum genera brevi perdiscenda singuli vestrum sese pares esse cognoscant ac satis super\$que sufficere; cuius argumenti, ut ita dicam, sphaera in hoc axe et cardine omnis circumrotatur: Sua ipsius cognitio ad omnem doctrinarum orbem brevi absolvendum maximo cuique est incitamento. Vos itaque, flos et soboles ingenuae iuventutis, ad quos praecipue haec mea oratio dirigitur, hoc agite et animis adeste; nam, vestra benignitate fretus, me spero effecturum, ut hodiernus dies et mihi pulcherrimi facti et vobis ingentis beneficii fructum obtulisse videatur.</p>	<p>Index:alacritas:alacritas Index:altus-a-um:altiora Index:auditor:auditores Index:axis (gr. axon):axe Index:benignitas:benignitate Index:cardo:cardine Index:circumroto:circumrotatur Index:confertus:confertissima Index:corona:corona Index:expleo:expleam Index:fretus-a-um:fretus Index:fructus:fructum Index:hodie:hodie Index:sacrarium:sacrario Index:soboles:soboles</p>
<p>Search a tree Search a frameset Unix-Search</p>	<p>Tutor-on-line Comments</p>

Figure 3. Example of Oratio paragraph in KMS with local indexes.

3.3 Analyzing the hypertext versions for use in philosophical studies

The explicit structure of the 'Orazioni inaugurali' allowed a simple conversion to the two hypertext systems. In either system, the network of nodes and links is easily understood and navigation from paragraph to paragraph and oratio to oratio is conceptually straightforward. We attempted to analyze the two systems on the following important dimensions for philosophical study: 1) navigation time in relation to volume, 2) capabilities of search and retrieval tools, 3) search and retrieval speed in relation to volume and 4) consistency and precision of results. We must say "attempted" above because neither of the hypertext systems has all of the capabilities desired.

3.3.1 Navigation time in relation to volume

Navigation in this application domain is critical because the operations needed are continuous and stressing. The philosophical studies researcher moves quickly from document to document, issuing queries and inspecting keywords in their contexts. Our daily experience with KMS showed that navigation is quick, without confusion and impervious to the volumes we were studying. Our experience with Intermedia was quite different. Over a period of two months, our daily interactions

with Intermedia led to the following observations: 1) the effort to maintain a working system requires a large percentage of the researcher's time which is subsequently not spent on philosophical studies (opening, closing, moving and resizing windows), 2) the number of documents (85) and the absence of an integrated search facility causes the lost in space problem on a continual basis and 3) Intermedia slows down progressively and after an hour or so is totally unusable.

This last observation was unexpected. We searched for a reason that could be attributed to our building of the hypertext or our use of Intermedia facilities. We found the following in the Intermedia System Administrator's Guide [14]: "After a user has been working for an hour or more, the system may get progressively slower. It may also slow down if a user has a large number of document windows (over 40) open on the screen. It is a good idea for users to get into the habit of closing document windows as they are no longer needed. If the system seems too slow, save all work and quit out of Intermedia and start the program up again. It will be much faster when restarted." Our experience shows that Intermedia becomes progressively slower independent from the number of windows open on the screen. Figure 4 shows the results of an experiment we replicated several times. We measured the time to just open and close documents in both systems. In KMS the time is linear in the number of documents, but for Intermedia the time approaches an exponential curve. In all reality, Intermedia is unusable after 20 documents have been opened and closed since it takes approximately 13 seconds each to bring forth the next ten documents.

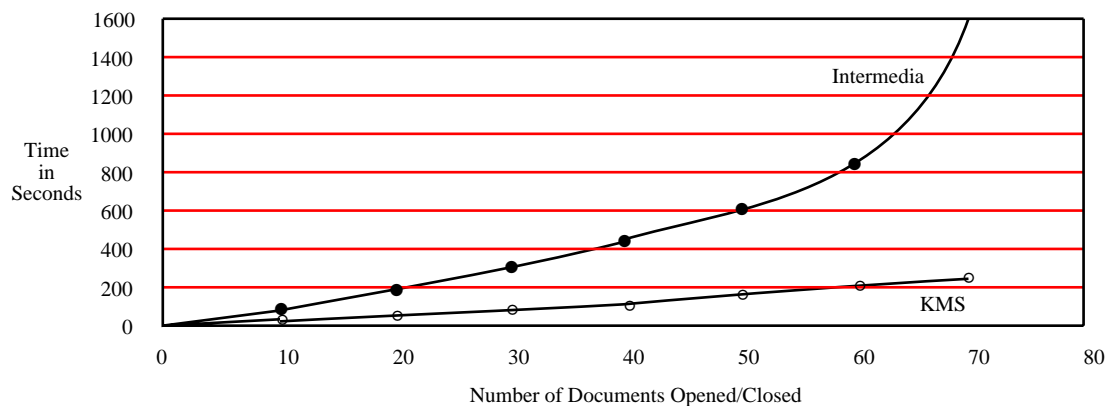


Figure 4. Time to open and close documents in KMS and Intermedia.

3.3.2 Capabilities of search and retrieval tools

The philosophical studies research methodology described in Section 2 requires a sophisticated information retrieval tool. The researcher must be able to retrieve words masked for prefix (\$mus), middle (ani\$us) and suffix (anim\$) and based on proximity and context (animus *and* natura, animus *not* natura). It must be possible to search and retrieve from local and global indexes, generate a list of the documents retrieved, treat this list as the context for the next search and merge the resulting contexts.

Neither KMS nor Intermedia have all of the required information retrieval tools for this task. Intermedia uses the standard 'find' command which provides a simple string search in one of the open windows on the workstation. In our case this allows the researcher to search one paragraph of one oratio. KMS supplies a masked string search based directly on the 'egrep' command and allows searching over the entire hypertext and local indexes. KMS also provides a list of instances found in a tree of frames which can then be used for further searching.

3.3.3 Search and retrieval speed in relation with volume

Although the searching facilities of KMS are more advanced than those of Intermedia, both systems still suffer from poor retrieval times for large volumes due to the simple linear string search algorithms employed. String searches in KMS are measured in minutes per thousand frames, whereas the normal retrieval time should be on the order of 10 to 20 seconds [2]. Both systems could benefit from a global indexing scheme and a mechanism whereby indexes become first class objects. We note that the KMS 'linear' program already generates a global index based on page numbers for paper. It should be a simple matter to extend this to a global index based on frames.

3.3.4 Consistency and precision of searching results

We have no results from the Intermedia system. The consistency and precision of searching results from KMS depended upon the complexity of the query. For simple queries over the main text or the local indexes we had very reliable and precise results; while for more complex queries, we had poor or no results. An example of a common complex query that would give poor or no results would be: "Maxima **adj4** potens animus naturam **not** (particulam societatem)". This query requests a search and retrieval of all documents containing "Maxima" and "potens animus naturam" with no

more than four words between them and not containing the words "particulam societatem". KMS also has the restriction that the search string not be longer than one line. This restriction is problematic for the field of philosophical lexicography in which the specification of search strings sometimes requires several lines.

3.4 Discussion

As expected, this longitudinal pilot study could not cover all aspects of the use of hypermedia systems for the field of philosophical studies. However, it is quite clear from trying to use these hypermedia systems for normal research work in the field of philosophical lexicography that hypertext systems are lacking fundamental components, most notably those very components that have been available for years from the information retrieval community. By the same token, the information retrieval community has been lacking those functions that are uniquely hypertext.

One could say that we chose a poor application domain for hypertext systems or that it was unfair to use the Intermedia system since it really was only meant to be a (sophisticated) prototype of what could be done in the future. We believe that the problems encountered by these two hypertext systems (prototype or commercial product) are endemic to the hypertext field. Philosophical studies is not just an isolated case, but paradigmatic for a whole range of intellectual endeavors. We think this study gives some indications as to why hypertext systems are not making headway in various fields in which we thought they would do well. The three major lessons learned were: 1) search and retrieval are very important, 2) researchers want to personalize searching (indexing) as well as information and 3) a non-intrusive interface is essential (researchers want to work on their subject matter, not the manipulation of the interface).

4. CONCLUSIONS

We have presented several (more than twenty) problems/requirements philosophical studies pose for hypermedia systems and shown that hypermedia systems have many of the required attributes for computer support of this intellectual task. We have also shown that hypermedia systems are lacking in several fundamental features/components. In this last section, we want to touch upon the two most important missing features and give recommendations to future hypermedia system designers.

The design of a hypermedia system to support this application domain must include capabilities for global and local views. These views include the normal understanding of views in hypermedia systems, but in addition imply the need for several levels of indexing and search [5, 10]. Hypermedia systems must support global views based on mechanisms such as full-text indexing, global index searching and automatic thesaurus building. These mechanisms can only supply a base-level global view. In addition, we must have the integration of a knowledge representation mechanism since the real task being accomplished is insight and understanding. Researchers need the capability for building global views based on (graphical?) abstractions of knowledge [16, 17]. Local views must be supported through fast browsing mechanisms and local indexing and search. In addition, it is of utmost importance to allow the personalization of indexing at all levels [4, 11] and to require the search engines to work with equal facility on global, local and personal indexes. This is an equivalent notion (or implementation mechanism) to 'contexts', in which the context is composed of index entries and there is one level of indirection in retrieval provided by the search engine.

The management of an immense storage of highly interconnected documents and the maintenance and continuous update of this storage requires a full-featured database system. Several researchers have recognized the general need for a hyperbase (hypertext database) component in the hypermedia system architecture [20, 21, 22, 23, 27]. For this application domain, the hyperbase will require the blending of advanced features from database, data repository and information retrieval systems. The next generation of hypermedia systems must focus on shared, distributed hyperbases and the full integration of indexing and searching engines if they are to have an impact in areas such as philosophical studies.

Acknowledgements

We would like to thank Professor Tullio Gregory, Director of LIE, for his support in this project, Dr. Marco Veneziani and Dr. Chris Bozhkov who provided helpful comments, and Dr. Ada Russo for her technical assistance. We would also like to thank the IRIS project at Brown University for supplying Intermedia (Release 3.0) and Knowledge Systems, Inc. for supplying KMS (Version 9a). We would also like to note that the current release of KMS (Version 10a) has included "Fast searches based on a full-text index." We are also most grateful for the help of Cindy Kunz in the preparation of this manuscript. Part of this work has been carried out during the first author's one-year visit at the Hypermedia Research Laboratory at Texas A&M University, sponsored by the Italian National Research Council (CNR) – grant # 203.15.2.

References

1. Akscyn, R., McCracken D., and Yoder, E. 1988. KMS: A distributed hypermedia system for managing knowledge in organizations. *Commun. ACM*, 31, 7, (July), 820-835.
2. Blair, D. C., and Maron, M. E. 1985. An evaluation of retrieval effectiveness for a full-text document-retrieval system. *Commun. ACM*, 28, 3, (March), 280-299.
3. Blair, D. C., and Maron, M. E. 1990. Full-text information retrieval: Further analysis and clarification. *Information Processing & Management*, 26, 3, 437-447.
4. Boy, G. A. 1991. Indexing hypertext documents in context. *Proceedings of the Third ACM Conference on Hypertext (Hypertext '91)*, (San Antonio, Texas, December), pp. 51-62.
5. Clifton, C., and Garcia-Molina, H. 1990. Indexing in a hypertext database. *Proceedings of the 16th Conference on Very Large Data Bases*, (Brisbane, Australia, August), pp. 36-49.
6. Crane, G. 1990. Standards for a hypermedia database: Diachronic vs. synchronic concerns. *Proceedings of the NIST Hypertext Standardization Workshop*, (Gaithersburg, MD, January), pp. 71-81.
7. Crane, G., and Mylonas, E. 1991. Ancient materials, modern media: Shaping the study of classics with hypertext. In *Hypermedia and Literary Studies*, Paul Delany and George Landow, Eds., The MIT Press, Cambridge, MA, pp. 205-220.

8. DeRose, S. J. 1989. Expanding the notion of links. *Proceedings of the Second ACM Conference on Hypertext (Hypertext '89)*, (Pittsburgh, PA, November), pp. 249-258.
9. DeRose, S. J. 1991. Biblical studies and hypertext. In *Hypermedia and Literary Studies*, Paul Delany and George Landow, Eds., The MIT Press, Cambridge, MA, pp. 185-204.
10. Frisse, M. E., and Cousins, S. B. 1989. Information retrieval from hypertext: Update on the dynamic medical handbook project. *Proceedings of the Hypertext '89 Conference*, (Pittsburgh, PA, November), pp. 199-212.
11. Frisse, M. E., Cousins, S. B., and Hassan, S. 1991. WALT: A research environment for medical hypertext (Technical Briefing). *Proceedings of the Third ACM Conference on Hypertext (Hypertext '91)*, (San Antonio, Texas, December), pp. 389-394.
12. Haan, B. J., Kahn, P., Riley, V. A., Coombs, J. H., and Meyrowitz, N.K. 1991. IRIS hypermedia services. *Comm. ACM*, 35, 1, (January), 36-51.
13. IBM. 1984. SStorage And Information Retrieval System. IBM Product Development Center, Information Development, Department 0446-Schwertstr. 58, D-7032 Sindelfingen, Germany, Program Number 5664-189, Release 1.0.
14. Intermedia. 1988. System Administrator's Guide. Institute for Research in Information and Scholarship, Brown University, Box 1946, Providence, RI 02912.
15. Landow, George. 1991. The rhetoric of hypermedia: Some rules for authors. In *Hypermedia and Literary Studies*, Paul Delany and George Landow, Eds., The MIT Press, Cambridge, MA, pp. 81-103.
16. Marshall, C. C., Halasz, F. G., Rogers, R. A., and Janssen, W. C. 1991. Aquanet: A hypertext tool to hold your knowledge in place. *Proceedings of the Third ACM Conference on Hypertext (Hypertext '91)*, (San Antonio, Texas, December), pp. 261-276.
17. Nanard, J., and Nanard, M. 1991. Using structured types to incorporate knowledge in hypertext. *Proceedings of the Third ACM Conference on Hypertext (Hypertext '91)*, (San Antonio, Texas, December), pp. 329-344.
18. Raymond, D., and Tompa, F. 1988. Hypertext and the new Oxford English dictionary. *Commun. ACM*, 31, 7, (July), 871-879.

19. Salton, G. 1986. Another look at automatic text-retrieval systems. *Comm. ACM*, 29, 7, (July), 648-656.
20. Schnase, J. L., Leggett, J. J., Hicks, D. L., and Szabo, R. L. Semantic data modeling of hypermedia associations. *ACM Trans. Inf. Systems*, accepted February 1992.
21. Schnase, J. L., Leggett, J. J., and Hicks, D. L. 1991. HB1: Initial design and implementation of a hyperbase management system. Department of Computer Science Technical Report No. TAMU 91-003, Texas A&M University, College Station, Texas.
22. Schütt, H. A., and Streitz, N. 1990. *HyperBase: A hypermedia engine based on a relational database management system*. In *Hypertext: Concepts, Systems and Applications, Proceedings of the European Conference on Hypertext*, (INRIA, France, November), A. Rizk, N. Streitz, and J. Andre, Eds., Cambridge University Press, pp. 95-108.
23. Smith, J. B., and Smith, F. D. 1991. ABC: A hypermedia system for artifact-based collaboration. *Proceedings of the Third ACM Conference on Hypertext (Hypertext '91)*, (San Antonio, Texas, December), pp. 179-192.
24. Spinosa, G. 1990. Philosophical lexicography: the LIE and the use of the computer. *Computers and the Humanities*, 24, 375-379.
25. Veneziani, M. 1991. *Indici e concordanze delle Orazioni Inaugurali di Giambattista Vico*, Edizioni dell' Ateneo, Ed., Roma.
26. Vico, G. 1982. *Le Orazioni inaugurali I-VI*, a cura di Gian GaleazzoVisconti. Il Mulino, Bologna.
27. Wiil, U. K., and Østerbye, K. 1990. Experiences with HyperBase – A multi-user back-end for hypertext applications with emphasis on collaboration support. The University of Aalborg Technical Report R-90-38, Institute for Electronic Systems, Department of Mathematics and Computer Science, Aalborg, Denmark.
28. Yankelovich, N., Haan, B., Meyrowitz, N., and Drucker, S. 1988. Intermedia: The concept and the construction of a seamless information environment. *IEEE Computer*, 21, 1, (January), 81-96.