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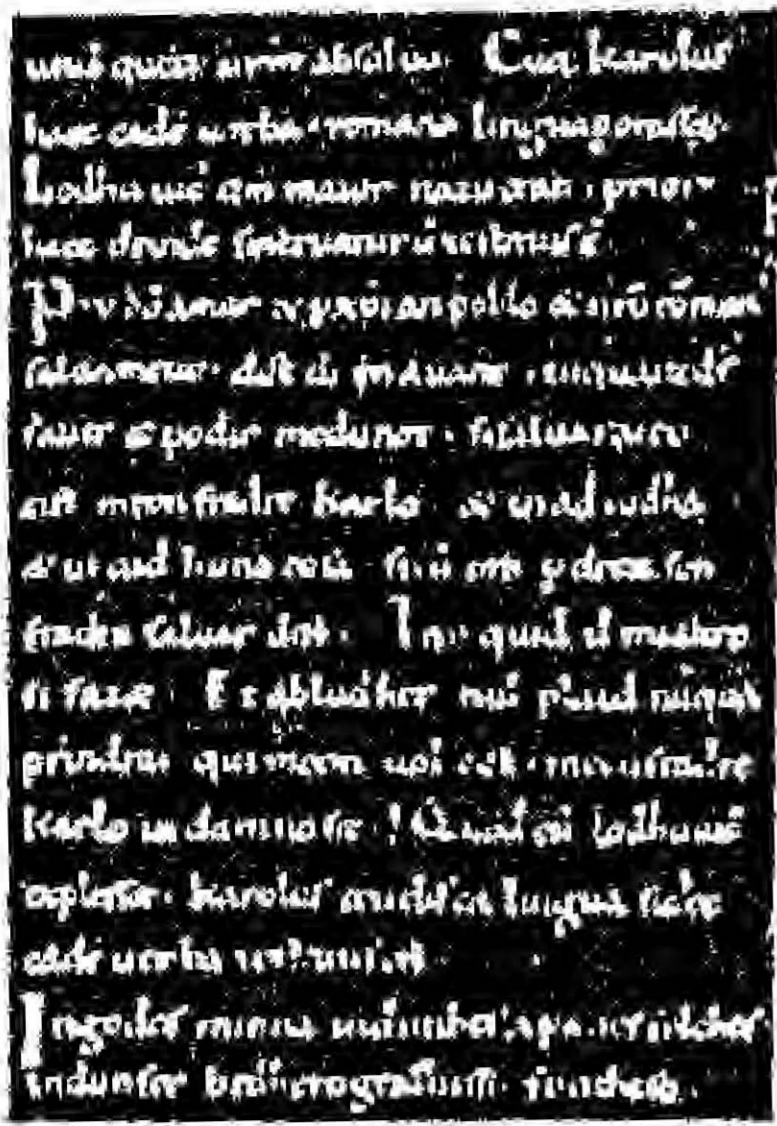Romance Philology, 45(1)

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Textual Criticism in the 21st Century

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The decisive change between the current practice of textual criticism and that of the 21st century will be the use of the computer to produce machine-readable critical editions. To date most computerized textual criticism has conceived of the computer primarily as a tool to facilitate the production of printed texts both by automating the procedures of textual criticism, as well as by permitting a much greater consistency in the application of editorial criteria. The goal of the process is still the printed text itself, the material object to be placed in the hands of the linguist and the literary critic (cf. Logan et al. 1986:318); as a byproduct, but only as a byproduct, the computer also produces an electronic version of the text.

The next logical step is to deliver that electronic version as the end product itself. A number of scholars (among them, Burton 1981–82:214, Eisenberg 1989:11, citing Lowry 1979) have pointed out the similarities between this process and the evolution from manuscript to print. The early printers were simply trying to automate the process of manuscript production. It was not until near the end of the 15th century that they began to understand that the printed book was qualitatively as well as quantitatively different from the manuscript. It was not necessary, for example, to leave blank spaces for the insertion of illuminated initials; in fact, such a feature defeated two of the primary goals and consequences of printing: lowering the cost of the individual volume and speeding up its dissemination. The actual printing of a critical edition has precisely the same effect today, but there are other consequences as well. The insistence on viewing the printed text as the end product means

that we must forgo one of the major advantages of computerized texts, their *non-linearity*.

Indeed, from the very beginning of electronic text processing, non-linearity has been the goal of most of its practitioners. Texts are normally *read* sequentially, syntagmatically, from beginning to end, even though the stories that they recount may begin *in medias res* and although some recent texts—one thinks of Julio Cortázar's *Rayuela*—have attempted to provide alternatives. They are *studied*, however, paradigmatically, by seeking similarities of many different kinds at widely separated points in the text: all instances of a given lexeme or morpheme, a given syntactical structure or image. Such paradigms can be sought within a given work or among a series of works. At the intratextual level they describe the workings of that text; at the intertextual level, the workings of the system as a whole, be it linguistic, literary, or cultural. The discovery of paradigms has been one of the chief occupations of literary and linguistic scholars, and these discoveries have been made the old-fashioned way, by reading texts and recording the resultant observations in notebooks and card files. But *ars longa vita brevis*. To read systematically through an entire text or corpus in search of examples of a given paradigm is not necessarily an efficient way to proceed, and scholars have long sought to produce aids which would obviate this necessity, chief among them concordances and indices, reference tools which present a text not sequentially but paradigmatically. Cardinal Hugh of St. Cher (1230) produced a word list for the Bible in response to the needs of both scholastic theologians and preachers; around 1250 three English Dominicans expanded this list into a true Key Word In Context (KWIC) concordance (see Mangenot 1912:895a–b). It is probably no accident that these compilations were concurrent with the development of the thematic sermon, which takes its name from the technique of structuring the sermon around a Biblical passage, usually the text for a given day of the liturgical year, and then seeking verbal parallels in other biblical passages (the prose introduction to the *Libro de buen amor* is a parodic example of the technique).

Manually produced concordances proliferated in the second half of the 19th and first half of the 20th century, despite the work they required: "Throughout the history of concordance-making, the procedure has been the same: to analyze the text into its individual words, to attach to each word its location and some context, and to list those words in an ordered sequence, usually alphabetical" (Burton 1981–82:139). The process is tedious in the extreme. James Strong's concordance to the Authorized Version of the Bible, for example, required thirty years to complete (Burton 1981–82:7). Even though linguists and literary scholars of all persuasions found concordances enormously useful, the huge investment of labor required to produce them meant that only the most important authors were treated: Dante (1888), Shakespeare (1894), Milton (1894), Wordsworth (1911), Petrarch (1912), Chaucer (1927) (see Ingram 1974:273; Hanon 1977:292).

Immediately after World War II, Father Roberto Busa began to explore the possibility of mechanical data-processing equipment—key punches and card sorters—to automate the preparation of an index to the works of Saint Thomas Aquinas (Busa 1951).[1] In the fifties, with the increasing availability of electronic computers—by 1957 there were forty on college campuses in the U.S.—, other scholars began to work on the problems of adapting them to the production of concordances and indices, rightly foreseeing the possibility of reducing by several orders of magnitude the time needed to produce such works. The first major concordances prepared with computers were published in 1957: Ellison's *Nelson's Complete Concordances of the Revised Standard Version Bible*, and Montgomery & Hubbard's *Word Index to John Dryden*. Ellison's biblical concordance required some 1200 to 1300 hours of time on a Univac computer (Burton 1981–82:7). Between the mid-sixties and early seventies, centers for literary and linguistic computing had begun to spring up all over Europe and North America (Gallarate, Besançon, Nancy, Manchester, Cambridge, London [Birkbeck College], Edinburgh, Utrecht, Göteborg, Lund, Liège, Pisa, Leiden, Louvain, Marburg, Florence, Oxford, Tübingen; Cornell, Colorado, Dartmouth, Univ. of California, Irvine, Brigham Young, Duke, Univ. of Wisconsin, Madison, Queens College, Waterloo, Toronto, Montréal; cf. Kock 1970). Of the early centers, two were particularly important for Romance linguistics: the one at Utrecht established by Mario Alinei for the production of the *Spogli Elettronici dell'Italiano delle Origini e del Duecento* (SEIOD), and the Centro Nazionale Universitario di Calcolo Elettronico (CNUCE), founded by Antonio Zampolli in Pisa (Burton 1981–82:89, 92). As a byproduct of the *Spogli* Alinei had, by 1962, a complete concordance to the *Divina commedia*, although he declined to publish it in favor of the selective, manually produced concordance which the Dante Society of America had been preparing since 1960. Compiled with the aid of 118 scholars, the Dante Society's concordance was intended to replace that of Edward Allen Fay (1888), also prepared under the auspices of the Society. Eventually the Society's partial concordance (Wilkins & Bergin 1965) was published—in the same year as Carlo Tagliavini's complete concordance, produced electronically with the aid of CNUCE (Burton 1981–82:90, 92). Since then CNUCE has published a large number of concordances to medieval Italian texts (e.g., Accademia della Crusca 1968, 1971; Barbina 1969). The first two electronic concordances in French were published, oddly enough, in the same year (1965) and treated the same text, Baudelaire's *Fleurs de Mal* (Cargo 1965, Quemada & Menemencioglu 1965). The first Spanish concordance, of the works of the Cuban poet Eugenio Florit, appeared two years later (Pollin 1967).

By the beginning of the seventies, production of computer-assisted con-

1. Burton (1981–82) provides an enormously useful survey of the development of literary and linguistic data processing techniques from the forties to the late seventies. Busa (1971) and Howard-Hill (1979) provide definitions and practical information.

cordances had become a thriving cottage industry. In some cases concordances were conceived of as ends in themselves, in others, as byproducts of other projects. An example of the former is the *Concordanze della lingua poetica italiana delle origini,* under the direction of d'Arco Silvio Avalle (Forthcoming), an ambitious project designed to produce a concordance to the entire corpus of Italian poetry to 1300. More traditional, but still conceived as independent tools, are the concordances to Old French texts produced at the Institut de Lexicologie Française of the University of Liège (e.g., Dubois et al. 1973?, Dubois-Stasse & Fontaine-Lauve 197?, Lavis & Stasse 1979, Lavis & Jansen 1979, Stasse 1979). The Medieval Spanish Seminary of the University of Wisconsin, under the direction of Lloyd Kasten and John Nitti, offers perhaps the best example of the concordance as byproduct: in the process of preparing the *Dictionary of the Old Spanish Language* (see Keill 1988), the Seminary has produced over 70 concordances of medieval Spanish texts which will be used as primary source material for the dictionary. Of these the most important are Kasten & Nitti 1978, 1982. (For a complete listing of Spanish-language concordances to 1987, along with other Hispanic lexical tools, see Billick & Dworkin 1987; for reflections on the utility of concordances to Romance philology, see Hanon 1977.)

Such a proliferation suggests that these materials are of considerable interest and utility to scholars, even in relatively awkward printed or microfiche form. The Madison concordances to the royal scriptorium MSS of Alfonso X (Kasten & Nitti 1978) have provided the raw materials for a number of lexical studies which would otherwise have been impossible undertakings (e.g., Craddock 1985, Penny 1987; see also Craddock 1986a).

Machine-readable texts. One of the byproducts of the electronically produced concordance was a machine-readable copy of the text. With the earlier concordances the machine-readable text was incidental, merely the means to an end, and of no practical use either to the compiler or to anyone else. With the ready availability of interactive text editors on main-frame computers in the seventies and then, in the eighties, of word-processing programs on microcomputers, the electronic text began to assume an importance of its own. The search capabilities of such programs—the ease with which one can locate all instances of any given word or any part of a word—immediately solved the problem of looking at texts paradigmatically rather than syntagmatically. It was now possible to search systematically for features of linguistic or literary interest; this in turn made possible much more detailed and objective studies of certain kinds of problems, such as syntactic or stylistic co-occurrence patterns which do not necessarily show up in either alphabetical or reverse concordances. It may be only a mild exaggeration to state that the word processor alone has been responsible for much of the growing interest in and development of corpus-based linguistics.

Such capabilities did not long escape the notice of far-sighted scholars; even in the sixties projects were under way to establish large text corpora,

generally limited to a given language, country, or period. Thus CNUCE has collected Italian texts, the Centre de Traitement Electronique des Documents (CETEDOC) at Louvain-la-Neuve, medieval Latin ones; but perhaps the most successful project has been the *Thesaurus Linguae Graecae* (TLG). Headed by Theodore F. Brunner and located at the University of California, Irvine, the *TLG* contains machine-readable versions of all texts in Greek to 600 A.D. (Brunner 1987, 1988; Hughes 1987; Helgerson 1988). Of particular interest to Romance scholars are CNUCE, mentioned above, and the *Trésor de la Langue Française* (TLF), based at Nancy, with U.S. collaborators (ARTFL: American and French Research on the Treasury of the French Language) at the University of Chicago. The TLF, with over 1700 texts, has so far concentrated on the period from the 18th century on, although it also includes over 200 texts from earlier periods (McLean et al. 1987, Dendien et al. 1988). The *Archivo Digital de Manuscritos y Textos Españoles* (ADMYTE), while based on these models, will go beyond them in incorporating extratextual materials along with the texts themselves. Thus the archive will contain: (1) a union catalogue of the primary sources of medieval Spanish literature, the *Bibliography of Old Spanish Texts* (BOOST; see Faulhaber et al. 1984), to provide all of the basic information needed to place a text within its chronological, geographical, and intellectual context; (2) a rigorously paleographical transcription (using norms set forth in Mackenzie 1986) of the best MS of each text; (3) TACT, a text-retrieval program written by John Bradley and Lidio Presutti and distributed by the University of Toronto's Centre for Computing in the Humanities, which will be used to locate materials of interest within the corpus; (4) Marcos's *UNITE* program, to collate and collect variants from two or more copies of the same text (Marcos-Marín 1991); and (5) digitized facsimiles of the MSS and printed editions upon which the transcriptions are based (Faulhaber & Marcos-Marín 1990).[2] At a later date it may prove possible to incorporate the electronic version of the *Dictionary of the Old Spanish Language.*[3]

In addition to a collection of data of various kinds, both textual and visual, ADMYTE will include software for manipulating that data and navigat-

2. ADMYTE, intended as a contribution to the quincentennial celebration of the voyages of Columbus, is a collaborative effort among the Univ. of California, Berkeley, the Univ. of Wisconsin, Madison, the Univ. Complutense and Univ. Autónoma of Madrid, and Madrid's Biblioteca Nacional. It will consist of a series of CD-ROM disks, the first of which will contain the software and the largest possible collection of machine-readable medieval Spanish texts; later disks will contain approximately 5000 pp. each of machine-readable texts and digitized images of the original MSS or printed editions from which the machine-readable texts were transcribed. Updated versions will be made available online via RLIN, the Research Library Information Network of the Research Library Group.

3. In addition to corpora focussed on a particular language, there has also been interest in general electronic text archives. Of these the earliest and still the best known is the Oxford Text Archive. A joint Princeton-Rutgers project under the direction of Marianne Gaunt (Rutgers Univ. Library) and Robert Hollander (Princeton) has begun planning for a U.S.-based counterpart.

ing through it, for finding specific kinds of information within the data collections as a whole. In the formulation of Ian Lancashire (1989), ADMYTE constitutes a "dynamic text." Each text in the collection will be linked to its corresponding bibliographical description in *BOOST*, which provides information on authorship, dates, and subject matter—as well as a great deal of additional data not offered in traditional bibliographies. Its entries will in fact be the entry ports for gaining access to the texts. Once a text or set of texts has been chosen for study, TACT will allow the scholar to look at a given word or set of words or associated sets of words. ADMYTE will provide, in short, a first approximation to the electronic equivalent of the best-manuscript edition for all of the texts which it contains, as well as software designed specifically to interact with those texts.

The essential difference between ADMYTE and an electronic critical edition lies in its scope and the kind of ancillary information it provides. ADMYTE focusses on a text corpus rather than on a single text, and information about its texts is limited principally to external factors: authorship, dates, subject matter, description of MSS and/or editions, persons related to the text in some fashion. A true electronic critical edition would have to provide all of the information currently provided in print editions—but in a form both easier to use and more powerful—as well as all of the information provided by ADMYTE, and more. In an electronic critical edition the critical text will be the locus of a set of data connected to it by various kinds of links, some established specifically by the editor, others established automatically by software tools. The critical text will not exist as a self-sufficient isolate but rather as part of a rich environment which will enable users to study the text's internal structure—graphemic, phonological, morphological, lexical, semantic, syntactic, discursive—as well as its relationship to its genre, to its linguistic and literary tradition, to the interpretive tradition which surrounds it, to its historical moment, to its society, and, eventually, to significant aspects of its culture, understood in anthropological as well as artistic terms.

Hypertext. Models for an electronic critical edition already exist in hypertext, a term defined by its inventor, Ted Nelson, as "non-sequential writing" (1987, chap. 1:17).[4] Hypertext allows users to establish connections (links) between individual sections (nodes) in two or more computer files using software tools designed for this purpose. Once such connections

4. Nelson's conception of hypertext is far richer and more sophisticated than one might think from that definition. He views it as a total data system, global in scope, to which authors would contribute texts and from which they would receive royalties to the extent to which those texts are read and used by others. One key device is the "quote link," whereby quoted material is not incorporated bodily into the new text, creating a second copy of it, but is rather connected to it by means of a link to the original text. Thus a scholarly article would no longer require the author to transcribe cited material but merely to establish a link to the passage in question. In turn, when someone else cites the second text, the first one is carried along with it, and both authors receive royalties in proportion to the amount of text cited from each. For a good historical overview and account of current hypertext systems accompanied by an annotated bibliography see Nielsen (1990).
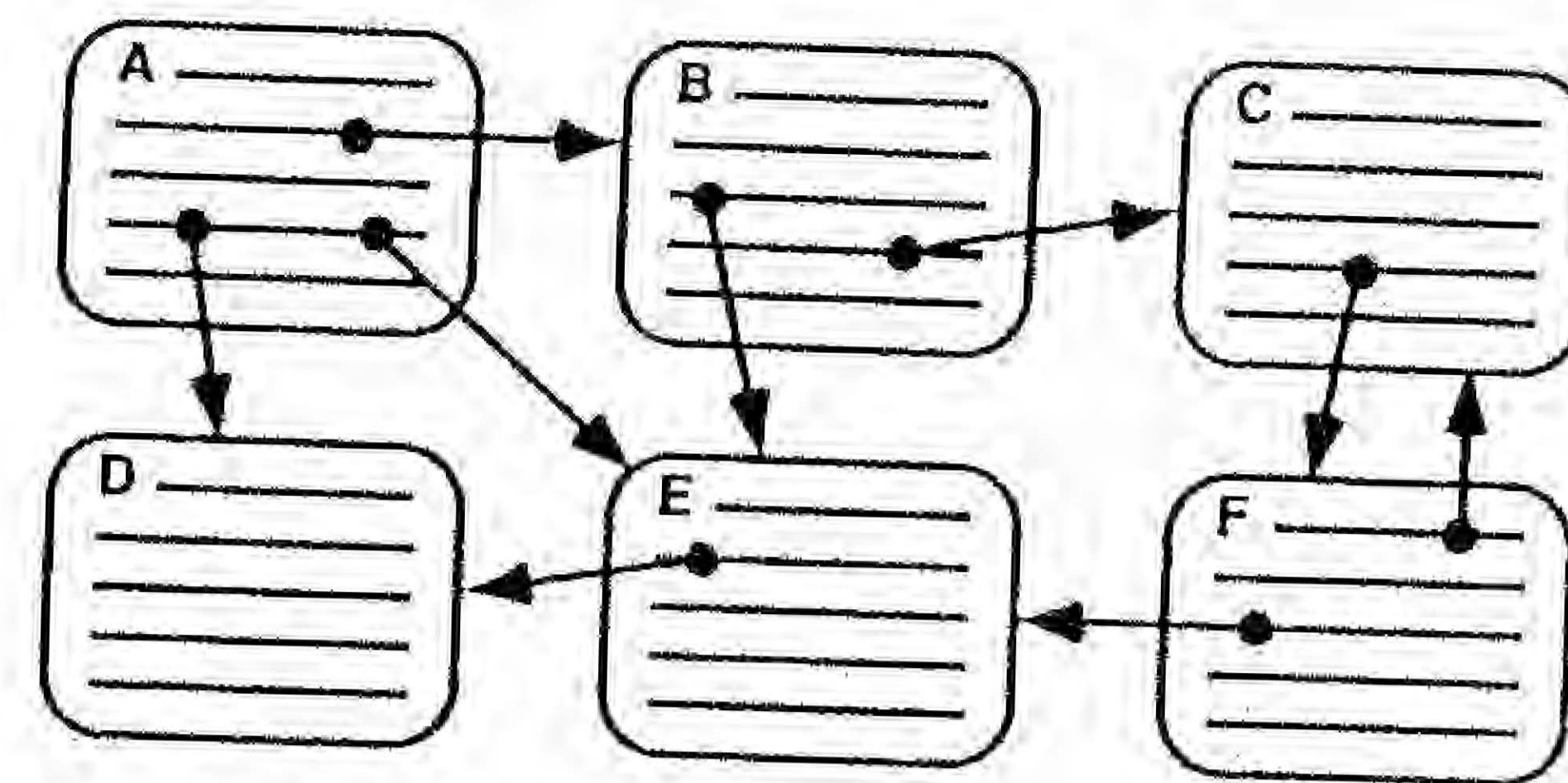
Figure 1. Simplified view of a small hypertext structure having six nodes and nine links. (Reprinted with permission from Nielsen 1990)

have been established, users can move at the touch of a key from one of these sections to another, each appearing in its own window on the computer screen as connections are followed from section to section. Thus "links allow movement from one node to another, following a conceptual path. Hypertext can be used to embed additional text, such as a glossary or commentary, into an existing text. It can also be used to link related parts of a single text or multiple texts, providing a visual cue to the reader that there is related material at the other end of the link" (Stigleman 1990:15). A typical use in an electronic critical edition would be to establish a link between a passage in the text and the note explaining that passage. The note in turn might be linked to a parallel passage in another text, and so on. (See fig. 1 for an example of a hypertext file system.)

A "hypertext document system allows authors or groups of authors to *link* information together, create paths through a *corpus* of related material, *annotate* existing texts, and create notes that point readers to either bibliographic data or the body of the referenced text" (Yankelovich et al. 1985:18). But hypertext systems need not be limited to text. They can "include linking together discrete *blocks* (e.g., word, paragraph, text document, graphical object, spreadsheet cell, and video frame) to form *webs* of information, following different paths through the information webs, and attaching annotations (special types of links) to any block of information" (Yankelovich et al. 1985:19). Once links have been established, users can travel along them in either direction, from source text to destination, or vice versa. Essentially, links allow sophisticated cross-referencing capabilities within and between electronic documents as well as immediate access to the cross-referenced materials.

Hypertext software, then, allows the author to establish such links so that, in turn, users can follow them in order to explore the various relationships between the nodes or pieces of data (a text, an image, a sound) or examine the same slice of information within various contexts: "hypertext

emphasizes connections and relations, and in so doing, it changes the way the texts exist and the way we read them" (Landow 1989:174).

The importance of nodes and links, basic to hypertext, can be traced back to the first formulation of the concept by Vannevar Bush (1945). Nodes contain the raw data, while links are the structuring devices that hold it together, that give it shape and form. Conklin (1987:3) sums up the properties or functions of links:

> They can connect a document reference to the document itself.
> They can connect a comment or annotation to the text about which it is written.
> They can provide organizational information (for instance, establish the relationship between two pieces of text or between a table of contents entry and its section).
> They can connect two successive pieces of text, or a piece of text and all of its immediate successors.
> They can connect entries in a table or figure to longer descriptions, or to other tables or figures.

But connections and relations are only one of the functions of a hypertext system. Hypertext is not merely a collection of data of various kinds, but also the software with which to manipulate it. For Yankelovich et al. (1985:18):

> the minimal set of capabilities incorporated into an electronic document system should include tools for
> (1) promoting connectivity,
> (2) promoting audiovisualization,
> (3) creating and revising documents,
> (4) browsing, searching, customizing, and retrieving information, and
> (5) preserving the historical integrity of information.

Item (5) follows from the fact that electronic text is infinitely malleable, a characteristic that is both an advantage and a danger for textual criticism: it allows editors to build on their own previous work or successive editors to build on that of their predecessors;[5] on the other hand, scholarly progress will *not* be enhanced if, between the time an author cites a particular hypertext edition (= hyperedition) and the time the reader sees that citation, the text is updated by the editor. There must be a way to cite, maintain, and recover successive versions of a hyperedition, a problem whose ramifications are discussed in some detail by Nelson (1987, chap. 2:14–22, 25, 43, 45–46).

Finally, the scale and organization of the hypertext system itself has a direct bearing on the utility of the hyperedition developed under it. Without going into a detailed analysis of the various types, suffice it to say that the model here postulated is document-based, a large universal library "documverse" along the lines of Nelson's Project Xanadu (cf. Fiderio 1988:242).

Standard Generalized Markup Language (SGML) and the Text Encoding Initiative (TEI). Hypertext systems to date have been closed universes which require that all data conform to predetermined conventions (see Meyrowitz 1989). This means that in most cases there is no easy way to import or export information from one such system to another; consequently, it is difficult if not impossible to build on previous hypertext work. The need for a sophisticated interchange standard for encoding machine-readable texts has long been recognized in the scholarly world. SGML is intended to provide such a standard.[6] Based on IBM's Generalized Markup Language (GML), SGML was originally designed as a tool in the publishing and information industries to standardize the description of documents of all sorts, but its properties allow it to be used to specify any characteristic of a text explicitly and unambiguously so that that characteristic can in turn be transmitted from one document processing (or hypertext) system to another, isolated for analysis, or formatted for typesetting. It is a *declarative* rather than a procedural language, i.e., instead of telling the computer what to do in order to indent a paragraph at the top of a page (e.g., set page length at 11", set page width at 8", begin new page, skip .75" of vertical space, set type size to 12 pts., indent 5 picas, etc.), SGML simply declares the beginning of a paragraph with an agreed-upon tag: <par>. That tag and everything else relevant to the structure of the document are set forth in a style sheet or "document type definition" (DTD) placed at the head of the document. In turn the DTD is defined in accordance with SGML conventions which allow for the precise description and enumeration of the document's logical and semantic structure. Within those basic conventions, many different markup schemes can be implemented, but in general they all stipulate that each element of the document's structure be delimited by a set of tags. When the document is formatted for a specific printer or display device, each of those tags can then be mapped or translated into the set of instructions required to produce the desired result.

For example, tags at the beginning of a structural element may be inserted within <>; ending tags, within </> (as in some of the more widely used SGML systems). Thus the title page of a book might be coded as follows (adapted from Sperberg-McQueen & Burnard 1990:74):

```
<title.page>
<doc.author>Ernest    Hatch    Wilkins    and    Thomas    Goddard    Bergin
</doc.author>
<doc.title>A    Concordance    to    the    Divine    Comedy    of    Dante    Alighieri
</doc.title>
<doc.imprint>
<doc.publ>The Belknap Press of Harvard University Press </doc.publ>
```

5. The series of microfiche transcriptions and subsequent printed editions published by the Hispanic Seminary of Medieval Studies illustrates the advantages of electronic text, even if the ultimate product involves the print medium (e.g., Cooper & Waltman 1985 and 1989, Corfis 1985 and 1986, and Capuano 1987 and 1990).

6. My description of SGML and the TEI is drawn from Coombs et al. (1988), Smith (1987), Barnard et al. (1988), and especially Sperberg-McQueen & Burnard (1990). There is now an international standard for SGML, ISO 8879 (see Smith & Stutely 1988). For a comprehensive bibliography on structured text see Cover et al. (1990).

```
<doc.city>Cambridge</doc.city>
<doc.date>1965</doc.date>
</doc.imprint>
</title.page>
```

The physical appearance of the resulting title page depends upon the book designer, who specifies in the DTD the point size and font type for each data element as well as its location on the page.

For literary scholars, SGML provides a way of keeping track of information which would be lost in a procedural language. For instance, in conventional printed editions, foreign words, resolved abbreviations, and interpolations might all be indicated through the use of italics. In an SGML-based edition, each of these three categories would be tagged separately and could be searched separately, even though their physical representation on the computer screen or in print might still be indicated by italics (example from Barnard et al. 1988:82).

The **Text Encoding Initiative** (TEI), co-sponsored by the Association for Literary and Linguistic Computing, the Association for Computing in the Humanities, and the Association for Computational Linguistics, is an attempt to apply the principles and syntax of SGML to the preparation of machine-readable texts for scholarly purposes. Organized in 1987 with support from the National Endowment for the Humanities, the TEI has "two closely related goals: to define a format for text interchange and to recommend specific practices in the encoding of new texts. The format and recommendations may be used for interchange, for local processing of any texts, or for creation of new texts" (Sperberg-McQueen & Burnard 1990, "Summary," 1). The TEI is an essential first step in the process of preparing machine-readable critical editions, which will require a consistent and standardized set of tags so that each new critical edition will be able to build upon previous work and, more importantly, take advantage of existing software rather than require a completely new set of analytical programs, written *ad hoc*, to deal with that edition. In order to develop software tools which can be broadly applied to many kinds of texts and in a wide range of languages from ancient to modern times, those texts must be encoded in a standardized format. Thus the TEI must specify, among many other particulars, coding practices for features ranging from the physical layout of the original MS or printed edition containing the text (foliation, rubrics, word division, punctuation, typography, scribal emendations and suppressions, interpolations, glosses, commentaries, quotations, etc.), to the logical structure of the text itself (titles, chapters, stanzas, cantos, acts, scenes, sentences), to features commonly associated with analysis and interpretation (phonology, morphology, syntax, semantics, stylistics, metrics, pragmatics, discourse structure).

Hypertext and SGML critical editions. The utility of hypertext-like systems for the presentation of editions was obvious early on. In 1981 Ross

had already suggested thinking about a textual data base "as the 'front end' for a document retrieval system . . . the kind of information in the data base could be displayed to the scholar working at a terminal, where passages from all sources could be called up" (1981:161). At the time he was writing, the technology to provide such a system simply did not exist. Logan et al. (1986:318) describe a project "to offer a prototypal example of this kind of [machine-readable] book, a computer-based version of a critical edition of Thomas More's *Utopia*." The essential features of Logan's edition are: (1) the ability to view simultaneously, in coordinated windows on the computer screen, text, translation, and commentary files (scrolling in one will scroll the others as well); (2) the use of text-retrieval software to find features in other parts of the files; (3) the ability to annotate passages by opening a window at any point in the text file. Eisenberg (1989) describes the problems that need to be solved and suggests a possible architecture based on the hierarchical file structure of the MS-DOS operating system. Both proposals are limited by the fact that they are conceived for particular computing environments, although Logan's program is the more powerful because of the inherent superiority of UNIX's multi-tasking software over MS-DOS. Eisenberg is unduly concerned with the physical representation of the text on the screen and does not pay enough attention to the software which must underlie the set of files he posits (although he does understand the need for audiovisual materials [1989:18]).[7] Bernard Cerquiglini (1989:112–16) is enthusiastic about the possibilities of hypereditions as a means of seizing hold of "ce jeu de la redite et du retour, de la reprise et du changement qu'est l'écriture médiévale" (114), but appears to have little understanding of the very difficult technical and conceptual problems involved.

Nevertheless, rather than a discussion of those technical problems,[8] or a detailed blueprint for the creation of hypereditions, what is needed at this juncture is a conceptual overview of three basic aspects of hypereditions: content, creation, and use. Consensus must be reached on two problems: (1) the kinds of materials and software tools which should be included; (2) standards and norms. Of the two, the latter is by far the more critical and more difficult. It will be relatively easy to agree on what ought to be included in an hyperedition and what sorts of software tools ought to be available to editor and reader; it is far more difficult, especially in an era of rapidly-changing technical capabilities, to specify how those materials should be represented and connected one to another.

Content of a hyperedition. Creation and use of a hyperedition will be conditioned by content; for the latter we can turn to printed editions cur-

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7. Dees (1988) gives a very generalized account of the use of the computer in the editorial process as a prolegomenon to an explanation of his own methodology for establishing a stemma.

8. For an overview of some of these technical problems in text-based research computing, see Batke (1989).

rently available as a first approximation, even though opinions still vary on the contents of an ideal printed edition of a medieval text. At a minimum it would include:

1. Introduction.
   a. Statement concerning the work to be edited: authorship, date, literary and social context, sources and parallels, style.
   b. Codicological or bibliographical description of witnesses used in the establishment of the text.
   c. Description of the relationship of the witnesses (*stemma codicum*), including the methodology used to arrive at that relationship.
   d. Linguistic study: graphies, phonology, morphology, lexis, syntax; identification of dialect, and basis of that identification.
   e. Literary study: in particular, metrics and stylistics since they are instrumental in the establishment of the critical text.
   f. Intertextual study: sources, parallel texts, translations, and later texts based on the one being edited (again, materials useful for the establishment of the critical text).
   g. Editorial criteria: basis for establishment of text (i.e., relationship of critical text to stemma); treatment of orthography, punctuation, textual divisions, capitalization.
   h. Bibliography.
2. Facsimile edition of base text; facsimiles of selected leaves of other texts.
3. Paleographic edition of base text.
4. Critical edition of text with tri-level apparatus of notes and commentary.
   a. Positive critical apparatus of rejected variants and paleographic commentary on the base MS.
   b. Sources and parallels.
   c. Explanatory commentary to justify critical text.
5. Glossary.
6. Concordances.

One can readily think of other materials that could be included (e.g., a biography of the author or a study of the text's *Überlieferungsgeschichte*), but these will depend on the tastes, interests, and abilities of the editor; the primary task is the establishment of the text itself and its linguistic and methodological justification. Obviously, given publication costs these days, to include all these materials for lengthy texts is prohibitively expensive; in practice most editors content themselves with a good ideal less, omitting the facsimile and paleographic editions (particularly if there are numerous witnesses) and the concordances. Glossaries tend to be selective rather than comprehensive, and the introduction generally concerns itself only with the question of the establishment of the text.

At first blush, one might expect to find precisely the same materials in a hyperedition, even though their presentation might differ considerably. But if we compare the two more closely, we find substantial differences. The most significant feature which separates a critical edition from, say, a school text or popularizing edition, is the apparatus itself, which contains the basis for the editor's choices as well as his attempt to represent the most significant aspects of the various witnesses upon which the edition is based. However, the criti-

cal apparatus, as it has evolved, is merely an uneasy compromise between the editor's and the users' desire for completeness, the limitations of print technology, and the financial realities of publishing. One does not want a selection of the "significant" variants from the witnesses but rather *all* of them. Hypertext provides just that capability. In the first place, it gives us "layers" of text, each in its own window, with the reader having the ability to focus his attention on any one of those layers. The top layer is the critical text itself, but underlying that (the metaphor is spatial purely for the sake of clarity) are the paleographical transcriptions of all witnesses, in turn underlain by the digitized facsimiles of the MSS themselves. As in the system of Logan et al. (1986), this set of texts must be synchronized so that at any given point in one representation of the text the reader can gain access to the corresponding points of the others. Thus the need for a critical apparatus of variants virtually disappears. It can be reduced to the identification of the substantive variants selected for the constitution of the critical text, as in modern biblical editions, leaving the function of documenting all other readings to the full-text transcriptions and appropriate software which can call up the entire set of readings for a given passage as needed.

In the same manner, software tools take the place of the glossary and the concordances. The editor need not—and should not—provide information manually if tools can provide it algorithmically, following Lancashire's concept of the "dynamic text" (1989), the combination of text *and* software. Thus instead of concordances, a sophisticated text-retrieval program will allow users to locate all instances of a given word or word form, while an on-line dictionary will provide the lexicographical resources for its proper interpretation. If concordances are desired for a comprehensive view of a text's vocabulary, complete or partial, they can be generated with the same program.

Similar mechanisms will give access to other aspects of the electronic critical apparatus. Sources, parallel texts, paraphrases, translations of the text, and other texts based on it will also be available, not merely as citations or with snippets of selected passages, but in their entirety, either through specific links established by the editor or through software tools which will give access to other texts in the electronic library. Finally, the editor's notes—or the entire corpus of scholarly commentary—on the text will also be synchronized with the critical text. Beyond that, one might wish to include the complete texts of secondary literature cited in introduction and notes: we are rapidly approaching the textual universe implicit in Nelson's Project Xanadu.

The list of the contents of the ideal printed edition set forth above suggests also that those editions are organized hierarchically: the introduction precedes the edition; the notes and commentary are found beneath the text or at its end. Any hypertext system for critical editions would have to allow for such hierarchical structuring, with an appropriate set of cueing devices, as well as for the much more common cross-reference linkages.

There are other advantages to a hyperedition. Consider the introduction,

which would appear to be the aspect of a critical edition most resistant to electronic innovation: typically the editor will cite numerous passages from the text itself, or from its sources or parallels to show (1) how the text was composed, (2) the relationships among the various witnesses which will allow the reconstruction of the stemma codicum, and (3) examples of significant linguistic or literary features. In a hyperedition these citations will not be included physically in the introduction; rather, to use Nelson's terminology (1987, chap. 2:32–40), they will be "quote-linked": the editor will simply establish a link from the introduction to the relevant portion of the critical text, of the underlying MS versions, or of a particular source. One consequence is that if, in the course of establishing the text, the cited passage is changed, it will *also* change in the introduction, automatically; thus the introduction will always reflect the latest state of the critical text. The process would be precisely like the "hot links" found in some integrated word processing/spreadsheet packages, whereby a change in the figures of a particular spreadsheet file is automatically propagated to the text file linked to it. Another consequence is that links from the section of text quote-linked to other elements in the system (e.g., sources, commentary) are carried along with the quote-linked text, thus making them available at the point of the linkage.

Thus hypertext does for text what relational and hierarchical systems did for data bases and what spread sheets did for calculators: they propagate, instantaneously, changes in one element (a cell in a spread sheet, a field in a data base, a node in hypertext) into all elements linked to it. In hypertext such links can be manual (explicitly coded relationships established by the editor) or automatic (implicit relationships actualized by the use of an appropriate search mechanism). Thus the links between all tokens of a given word type remain latent until they are activated by use of a text-retrieval program, which establishes the connections between them on the basis of indices. If one of the tokens is changed, e.g., through correction of a transcriptional error, it automatically enters into a new latent relationship with its word type. The software tools which must become part of any electronic critical edition constitute yet another dimension of that edition.

However, the contents of a hyperedition need not be limited to textual materials or software tools. Once one moves beyond a hypertext system to a hypermedia system, which would allow for the incorporation of graphics, video, sound, and animation, we have far outgrown the traditional conception of a critical text. And yet, why not? The *Cantigas de Santa María* of Alfonso the Learned cannot and should not be studied simply as literary texts. Each of them is accompanied (in Escorial MS T.I.1) by full page illuminations and musical notation. Ideally the student of the text should be able to read the text, look at the illuminations, and listen to the music simultaneously. In order to visualize the cultural context, it would be desirable to have, let us say, photographs of the cathedral of Toledo and other medieval architectural monuments. Dramatic texts could be accompanied by videotaped

productions. Project Perseus, now under development, will provide precisely that kind of hypermedia environment for the study of ancient Greece (Crane 1990). The contrast with current print and audiovisual technology could not be greater. Even when all of these elements exist separately (as in the case of the *Cantigas*), assembling them is a laborious logistical exercise which can only be carried out in a large and extremely well-appointed research library.

Creation of a hyperedition. The contents of a hyperedition determine its creation, which will require one set of tools; use will require another set, although there will be some overlap. The primary tool for creation is, obviously, the hypertext/hypermedia system itself; however, that system must include standard utilities such as a text editor, spread sheet, graphics program, a timeline generator, image and text scanners, image processing programs, and facilities for integrating and editing sound and video. Of these, by far the most important for computerized textual criticism is the text scanner, designed to read printed or MS materials and convert them directly into machine-readable form. The text scanner is so important because one of the major bottlenecks for computerized textual criticism is the sheer drudgery involved in transcribing materials. For even the largest single-MS text, this is a manageable problem; for lengthy texts which exist in multiple copies, transcription represents a very large portion of the total effort involved, since every single witness must be transcribed in its entirety.[9] Current text-scanning packages may include hardware and software (Kurzweil, Palantir) or software only (OmniPage, AccuText). Their accuracy for modern machine-printed texts is excellent (95% +), but drops dramatically when dealing with early hand-printed materials; and scanners are, as yet, useless for MSS. In their absence, users have no option but to transcribe texts manually; and while a great deal of manually transcribed material is already available in the medieval Romance languages (see p. 126), it is an infinitesimal percentage of the total.

Less common utilities—at least at present—would include an SGML parser/encoder, a semi-automatic lemmatizer, and an image processing program specifically adapted to the needs of manuscript research. The former is necessary to alleviate the difficulty of manually marking up machine-readable text with SGML tags. Ideally it should be possible to generate some of these tags automatically on the basis of identifiable features of the text or its physical layout and to use function keys or menus to obviate the necessity of typing others. "A parser for SGML is required to ensure that type definitions conform to the ISO standard, to ensure that individual documents conform to

9. Transcription of each witness is the only practical way to preserve completely all textual peculiarities, including punctuation and orthography. Systems which take a base text as a template and then create subsidiary texts on the basis of lists of variants transcribed manually from each of the other witnesses (cf. Tombeur 1979:167–68) can only do so by filtering out orthographic variation. To attempt to reproduce the orthography of each individual MS in such a system would entail more work than manual transcription of each one.

the type definitions, and to produce a consistent internal representation that replaces tags omitted in markup minimization" (Barnard et al. 1988:30). If all word forms found in a given text are keyed to the appropriate head word in an electronic dictionary (e.g., *dizes* as an inflected form of *dezir*), then a lemmatizer would not be necessary; in the vast majority of cases, however, forms will have to be keyed to an existing electronic dictionary through some sort of lemmatizing process, either because they are hapax legomena or because they have not yet been documented in the existing dictionary. Image-processing software for paleographical and codicographical analysis is another desideratum. Frequently MSS have suffered damage of various sorts. A sophisticated image-processing program will allow the recovery of text not visible to the naked eye (see Benton et al. 1979). Other programs, such as *Paleographer*, developed by Timothy W. Seid of Brown University (1989), are designed to help identify peculiarities of medieval scripts, to differentiate on the basis of different types of script as well as to differentiate different hands within the same type. Such programs allow users to trace the typical *ductus* of a given script, the proportions of letters (height vs. width), the angles of juncture of the various strokes, etc. MorphoSys, developed for the purpose of recording and analyzing the shapes of leaves by Thomas Duncan (1988), a botanist at UC Berkeley, could also be adapted readily to the analysis of letter forms or of the entire text page.

Of more direct relevance to the process of textual criticism itself are programs specifically designed to automate the process of creation of critical texts. A sophisticated program like UNITE, capable of collating textual witnesses for substantive as well as accidental (e.g., orthographic) variation, and of producing lists of variants as well as the text of the presumed archetype, is an absolute necessity. As Marcos-Marín points out (1991:103), one of the great advantages of such a program is that it allows explicit and detailed specification of the principles used in the creation of the critical text and then follows those principles without deviation. However, in order to be useful for the entire spectrum of textual traditions (and as Speer [1991a:25] opportunely reminds us, each textual tradition presents its own peculiar problems), such a program needs an arsenal of algorithms to allow the editor to examine the tradition, quickly and easily, from a multiplicity of viewpoints. Thus, UNITE allows users to choose the archetypal reading on the basis of unanimity among all the witnesses—a completely uncontroversial procedure but one which leaves a large residue of variants, since the witnesses to medieval texts frequently diverge—or on the basis of plurality or majority readings, a proceeding which may be of extraordinary value as a heuristic device for grouping similar MSS together in order to discover their relationships, but one which is quite unsuitable for the reconstruction of the archetypal text. In a two-branch tradition, for example, with one MS in branch *a* and 50 MSS in branch *b*, the single witness of *a* has exactly as much weight as all 50 witness/of *b*, and any reconstructional algorithm must take this into account.

One could readily conceive of an Artificial Intelligence (AI) inference engine (a set of rules with instructions for processing those rules) working on the data provided by the collation. Consider a tradition with three witnesses, *S*, *G*, and *T*, where *S* represents one branch and *GT* represent the second (Hispanists will recognize the sigla of the major MSS of the *Libro de buen amor*). The first rule might be "if *S* and *GT* agree, then their agreement represents the archetypal text"; the second, "if *S* agrees with either *G* or *T*, then that agreement represents the archetypal text." Of course, such a system presupposes the prior creation of a stemma following classical Lachmannian principles. This is the task of a stemma generator, taking as input the list of variants presented by a program like UNITE. Again, a variety of algorithms should be available, ranging from genealogical ones based on Lachmannian common error and cladistics to statistical methodologies like Dom Quentin's (1926) and W. W. Greg's (1927) calculus of variants, cluster analysis, and mathematical models based on, e.g., lattice or graph theory (see Irigoin & Zarri 1979). The goal, however, is *not* to produce a critical text through mechanistic means but rather to present the editor with as much usable evidence as possible in order to allow human judgment to operate as efficiently as possible—a point made eloquently by Marcos-Marín in this issue (103).

Both explicit and implicit links will be necessary in a hyperedition, although current hypertext environments only allow for the former. Explicit links are obviously required in order to connect a particular passage with an editorial comment, but they also provide the hypertext equivalent of the *apparatus criticus*, to specify the relationship between the various textual witnesses and the critical text. For example, a passage in the critical text may be omitted in a given witness, an omission which in the editor's judgment is a significant variant for the establishment of the text. To indicate the relationship, a "lacuna" link would be created between the witness and the critical-text, anchored at each end of the omitted passage in the critical text and at the spot of the lacuna in the witness. It will be necessary to create a taxonomy of legal link types for the apparatus along the lines suggested in Vidmanová (1979:63) and Sperberg-McQueen & Burnard (1990:121).

In current hypertext systems, users are limited to following the patterns of associations set up by the author, thus navigating through the environment according to a pre-established map.[10] For the novice this is probably the best way to approach a text, following the guidance provided by the editor's expertise; it also allows the editor easily to impose a particular reading strategy or interpretation. A more sophisticated or independent-minded reader requires more freedom, that is, the ability to find and follow associations not explicitly established by the editor. Concretely, *all* textual materials in the hyperedition must be searchable, not just the critical text itself. Alschu-

10. In systems like Intermedia (see Landow 1989) the user can add links to the environment, thus enriching it for future users. But the situation remains the same: the links must be explicitly established by someone.

ler (1989), reviewing three hypertext implementations of the same set of documents, demonstrates that automated search strategies were much more efficient than manually created links for moving around in those documents and retrieving information. The same paper also highlights another shortcoming of current hypertext systems: the necessity of dividing texts into screen-sized fragments, a process which facilitates the "horizontal" or paradigmatic node/link relationship, but obscures the "vertical" or syntagmatic continuity of the text itself: "Texts often contain ideas that are not confined to discrete fragments. For example, Hamlet's indecisiveness is a theme based on a set of actions, some explicit, some only alluded to, and some conspicuous by their absence. Making these actions explicit is a highly subjective process; moreover, it involves a radical departure from the nature of the text" (Raymond & Tompa 1988:873).

The manual creation of all explicit links is yet another problem which must be solved: "They will become a limiting factor, ultimately to be rejected, in generating large hypertext systems" (Kibby & Mayes 1989:164–65). To the extent possible, the creation of explicit links must be automated, using techniques such as those suggested by Fahmy & Barnard (forthcoming), just as the encoding of textual elements must be automated in order to make encoding feasible at all, given the range and number of elements that potentially can be encoded. Barnard et al. (1988:29), in discussing the encoding of large text corpora, suggest three categories of elements which can be encoded: (1) "of general importance and . . . objectively determinable," (2) "of less general importance but [still] objective," (3) "not objectively determinable." Although they provide examples of only the first category, it seems clear that editorial encoding of even the "objectively determinable" aspects of a text would entail an immense amount of work. The requirement for such massive editorial encoding would mean that, as in the case of manually produced concordances, only the most important texts—as defined by the current critical climate—would be edited, while, on the other hand, much of that encoding would be of little or no use to the vast majority of users. Thus, rather than limit users to what the editor has already done, or require the editor to do work whose usefulness is out of all proportion to its cost, the proper strategy is to provide software tools which will enable users to modify the text for their own purposes. Only time and experience will establish the proper demarcation of editorial and user encoding, but on both sides many tasks must be carried out automatically in order to make hypereditions feasible.

Aside from purely technical problems, many of which must await the development of faster processors and denser storage devices, there are other areas which require exploration. What is the proper way to represent relationships within and among a set of texts? For example, we can embed editorial commentary in a text by enclosing it in SGML <com> </com> tags, or we can maintain a separate file for commentary and connect text and com-

mentary file with hypertext links (although, strictly speaking, even the hypertext links can be encoded in SGML syntax)—"in-line encoding" vs. "external representation" (Sperberg-McQueen & Burnard 1990:109). Here the rule-of-thumb is simple: in-line encoding should be used to delimit elements occurring *in* the text; external representation should be used to link the text to any extratextual material. Hence, in the example given (editorial comments), external representation would be the more appropriate mechanism. A more difficult problem is that of synchronizing parallel texts for analysis or display, crucial for the kind of system presented here.[11] At first glance it would seem possible to solve the problem through software, using sophisticated string matching algorithms to keep texts in step. This method breaks down, however, if we have to deal with more than one language. In Prince (1990) it was necessary to compare Castilian, French, and Catalan versions of Brunetto Latini's *Livres dou tresor* in order to establish the Aragonese text. Here the solution was simply to invoke the canonical text divisions originally established by Carmody (1948). A similar solution would work easily for verse texts, which at a minimum have canonical line numbering; however, such systems may not be sufficiently fine-meshed for prose texts.

Use of the hyperedition. Once the hyperedition has left the hands of its editor, a new set of tools becomes necessary in order for it to be useful to and usable by the reader. They must provide for "the integration of colossal volumes of information to make them readily accessible via a simple and consistent interface" (Conklin 1987:21).

For literary and linguistic scholars, the most important tool would be a sophisticated text retrieval system, capable of operating on any single text, the corpus as a whole, or any subset, along the lines of the one described in Choueka (forthcoming). Such a system must be able to locate a broad variety of textual objects:

1. It must be capable of searching for a specified word or phrase, or a series of words or phrases, within a given context, using normal boolean operators (X *and* Y, X *or* Y, X *but not* Y, etc.). The context must be specifiable both in very simple terms (e.g., number of words which separate the items sought) as well as more complex ones (within a given sentence, paragraph, scene, act, stanza, depending on the genre and structure of the text).

2. The use of "wild cards" and truncation symbols allows for the construction of complex queries or pattern matches without having to specify manually all of the possibilities. Typically a wild card is used to indicate a match with any single character (e.g., *l?s* matches both *las* and *los*), or any number of occurrences of any character (*m*n* matches *man, men, moon, moan, mien, mean, mourn, modern, moisten,* etc.). A truncation symbol allows the match of words beginning or ending with any character(s): Thus *habl** matches, in Spanish, *hablo, hablas,*

11. Cover (1990) and Sperberg-McQueen & Burnard (1990:122–23) discuss this problem in some detail and offer four solutions to it, including the one selected here. The other three require massive amounts of encoding and therefore may not be suitable for lengthy texts.

habla, hablamos, habláis, hablan, hablador, habladurías . . . A special category of truncation symbol would allow for the searching of a defined list of affixes, inflectional or derivational. Thus *imita#*, specifying derivational suffixes, would find *imita-ble, imita-bilidad, imita-do, imita-nte, imita-dor, imita-ción, imita-tivo, imita-torio*, but not *imita-r, imita-n, imita-s*, etc. (example from Alvar & Pottier 1983:404).

3. Morphological searching permits users to find all and only those word forms belonging to a given lemma. It assumes the prior construction of a morphological dictionary of the language in question, with each word form assigned to a lemma. A search for *decir* would thus retrieve *digo, dices, diciendo, decimos, dije, dijera* . . . The same morphological dictionary would allow for normalized searching of unnormalized text, e.g., since in Old Spanish u/v and i/j/y are orthographically interchangeable, *vivir* can be spelled in many different ways: *uiuir, uiujr, ujujr, vivir, vivjr, vjvjr, viuir, viujr, viuyr* . . . It would be possible to search for all of these forms using an algorithm which would simply seek all permutations of u/v and i/j/y or to devise complex pattern matches (uv/ijy/uv/ijy/r), but the possibilities are so various, especially when dialect forms must be taken into account, that the establishment of a morphological dictionary is essential.

4. Lacking a true thesaurus—which, even if it existed for a medieval language, would not solve the needs of all scholars—, users must be able to define thesaurus groups at will, e.g., all terms dealing with 'death'. Such groups should be capable of being nested or collocated, e.g., under 'existence' the subgroups of 'life' and 'death'. Again, the mechanism must be as general as possible in order to meet the broadest possible variety of user needs.

5. Short-context delimiters allow users to specify that an ambiguous term (e.g., Sp. *fue* corresponds either to *ser* 'to be' or to *ir* 'to go') be accompanied by the word either immediately preceding or immediately following in order to disambiguate it.

6. Feedback and seed documents permit refinement of an initial search by incorporating its results into further searches, broader or narrower. Feedback strategies look at a user-defined context for the term sought (sentence, paragraph, page, document) to find other words relevant to the search, which can then be incorporated using the thesaurus mechanism described above. A seed document, identified either beforehand or in the course of a search because it clearly reflects what the user is looking for, serves as a template for the search; the system returns other documents or passages which share its peculiar configuration of search terms (Stanfill & Kahle 1986:1235–38).

7. Filters, both negative and positive, allow users systematically to exclude or include certain kinds of material before running a search. In a play, for example, one could filter all of the speeches by a given character; in narrative, all of the examples of direct address. The use of such filters, of course, implies the existence of an SGML parser/encoder for tagging particular segments of the text in order for the filter to be able to locate them. Filters also allow users to view only those portions of the text of current interest, or to view the entire text in any desired mode, starting with the raw machine-readable file with all markup tags visible and ending with a completely formatted text indistinguishable from what one might see in a current printed edition. The hypertext version of the *Oxford English Dictionary* uses similar mechanisms to allow the reader to see a dictionary entry as it was printed, to focus on the definitions, suppressing the illustrative citations, or, conversely, to present the citations without the definitions (Raymond & Tompa 1988:875).

Other user tools (adapted from Yankelovich et al. 1985:22) will supplement this text retrieval software: Paths, standard in all current hypertext environments, provide another search mechanism. Instead of merely giving users a set of powerful tools for analysis, the editor might wish to structure the reader's view of the text by means of a named set of links, as is done in a printed edition through the annotations and commentaries.

A map or graphical browser is desirable so that users can, at any time, establish the relationship of the particular node being examined to the system as a whole. One of the basic problems that developers of hypertext systems have encountered is that of orienting the user within the labyrinth of paths which transect the document (Conklin 1987:38–39). With the ability to layer one node on top of another, and to establish numerous connections from and to any single node, users easily can become lost in hyperspace. Some mechanism is needed to orient the reader, for instance, a graphical map of the nodes and the links that have been established between them, with the user's path highlighted in some way—Ariadne's thread for a modern Theseus.

While such a map would be useful in a hyperedition, it is not critical: The text itself stands at the center of the universe, and all roads lead from it and to it. Nevertheless, it would be helpful, particularly for novices or scholars interested primarily in the text rather than its establishment, to have their attention directed toward those elements of most relevance in the text through links to appropriate entries elsewhere—in the glossary, in an atlas, in a historical dictionary. Such links would replace or supplement traditional footnotes and endnotes, and it is the task of the editor to provide them. Thus, in a hyperedition of Chrétien's *Perceval*, the editor might wish to lead the reader through a set of bibliographical references to the bleeding lance in a specific order so as to make a particular point about its religious overtones. At the same time, more sophisticated users require a powerful set of software tools to allow the construction of their own itineraries, the pursuit of their own interests.

Any hyperedition must provide facilities to allow users to annotate the text by attaching commentaries to it, commentaries which might form the basis for an article or a class discussion, or merely contain a query concerning a puzzling feature of the text. In turn it must be possible to filter out these commentaries on the basis of the author, their date of composition, or their subject matter.

Beyond this set of user tools, there are others which are of interest specifically within the realm of critical editions: In addition to allowing users to look at the critical text and the transcriptions on which it is based in parallel windows, it should also be possible to select a single line and display all of the witnesses one below the other. For texts with dozens of witnesses this is the only practical method of studying them in detail. Similarly, users should be able to print out a serial collation of all witnesses.

Just as the editor requires a stemma generator/collation program, like UNITE, in order to prepare the critical text, users need the same tool in order to be able to verify the accuracy of that text on the one hand, and, on the

other, to establish the text of hyparchetypes, i.e., of subfamilies of a given text. The latter is particularly important in the case of texts which have come down to us in a large number of witnesses and where there may be radical differences among the various families as a function of time or geography, or between the critical text and the vulgate. To return to a point made in the introduction to this volume, current scholarship is at least as interested in the text which was known to a particular set of readers as in that which left the hand of the author. The two are not necessarily the same: The short version of the *Libro de buen amor* was by far the most widely circulated during the Middle Ages. Represented by MSS *G* and *T,* a sophisticated program like UNITE should allow reconstruction of the version they represent even if the editor of the critical text has not seen fit to do so. The ability to take advantage of new evidence is also implicit in the existence of such tools. Should a new witness be discovered, it can be transcribed by running it through the text scanner, and collated with the other witnesses to seek significant errors, which in turn can be analyzed by the stemma generator to find out where the new witness fits in the stemma and whether it changes the textual reconstruction.

Where do these tools reside? Are they—as I have been implying—an integral part of the critical edition itself, or are they separate? The answer depends very much on the degree of standardization achieved. To the extent that all texts are encoded to the same standard, the software tools can be generic and therefore external to the critical edition. In turn they must be standardized among themselves, with a consistent user interface and a seamlessly integrated design so that both editor and user can move effortlessly and smoothly from the text scanner to the collation program to the stemma generator to the text analysis program—all within the overall shell of hypertext.

Prototypes. Various commercial implementations of hypertext currently exist (e.g., Apple HyperCard for the Macintosh, ToolBook for MS-DOS, OWL International's Guide for both Macintosh and MS-DOS systems), as well as some academic prototypes (Intermedia at Brown, HyperTIES at the Univ. of Maryland). None of them currently includes all of the tools mentioned above; they tend to be wanting particularly in full-text search mechanisms and in the capability of allowing users to move at will through the textual universe rather than following prescribed links. ToolBook and Hyper-Card explicitly allow for the incorporation of graphics, sound, and video, although the current limitations on storage technology still make the creation of hypermedia products difficult. In the educational environment, hypermedia have been used chiefly as tools for the creation of instructional software. The Intermedia Project at Brown, for example, has developed hypertext data bases for the study of 19th-c. English literature and plant cell biology (Landow 1989).

I am aware of no true hyperedition in the sense I have described, but there are several prototypes: The Dartmouth Dante project under Robert Hollander has made steady progress in transcribing all of the commentaries on the *Divina commedia* and making them available interactively via the several national networks. Users can call up a specific passage in the text to see what commentators have said about it or, conversely, look for a specific word or set of words (using standard Boolean procedures) throughout the corpus of the commentaries (Hollander 1990). Desmond O'Brien (Univ. of Glasgow), using OWL Guide, has produced a prototype of a hyperedition of *Piers Plowman* (demonstrated at the Dynamic Text conference held at the Univ. of Toronto in June, 1989); and, in the Romance field, Peter Batke (Johns Hopkins) and Frank Domínguez (U. of North Carolina), have been working on a hyperedition of Jorge Manrique's *Coplas por la muerte de su padre,* using ToolBook (personal communications), while Karl Uitti (Princeton) has under way the electronic edition of the corpus of Chrétien de Troyes, technically a less sophisticated project, although with a well-thought-out scheme for encoding literary and manuscript features (Forthcoming).

Cost. The preparation of large text data bases or hypermedia projects is not cheap. Brunner (1987:7) calculates that, over the life of the *TLG,* the project has cost approximately $6,000,000; Crane (1990:35) estimates that between 1987 and 1993 the Perseus Project will cost some $3,000,000. The Dictionary of the Old Spanish Language has received approximately $2,000,000 from the National Endowment for the Humanities since 1972 (John Nitti, personal communication), even though some of the basic work of transcription has been carried out by volunteer labor. While much of the cost of these projects was devoted to data collection (e.g., transcription of texts, scanning of images), a large ~~operation~~ has been due to the fact that the software tools had to be written *ad hoc,* designed specifically for the requirement of each project.

It is obvious that hypereditions will never come into being if they require financial support of this order. It must be possible for editors to work as they have always done, in the lonely watches of the night, by themselves, without massive external support. Paradoxically, in order to do so, they must rely more than ever on cooperation with their peers and with specialists from other disciplines, particularly computing and information science. Far more than in the traditional print environment, advances in electronic scholarship will depend on enlightened collaboration among specialists in widely separated fields. Standardized and relatively easy-to-use software tools which, as Meyrowitz has pointed out (1989), will allow the importation and exportation of all kinds of data among widely differing computing environments must be widely available. Existing and projected large text data bases must be disseminated with as few legal impediments, i.e., copyright, as possible, so that editors can take advantage of work already done, of texts already transcribed. Access to large scale electronic tools—an on-line dictionary, a data base of mythology, a biographical dictionary, an atlas, a historical dictionary, an encyclopedia, or an image data base—is highly desirable, but such tools

are clearly beyond the means of any one scholar and, in any case, are only tangentially related to the establishment of the critical text.

Textual criticism in the nineties. Where do we go from here? One could conceive of world-wide centers for research on specific texts or linguistic traditions:

> One of the most interesting possibilities that the electronic edition opens up . . . is that of maintaining a fluid, on-line copy, to which corrections and additions by the editors, or suggested to them by other . . . scholars, could continually be appended, with their source and date indicated. The application would seem to entail a partially new conception of the function of critical editions. . . . An on-line version . . . holds out the prospect of an edition that will form a centre of a much more useful kind: a central copy, available to all scholars, that is continually updated. The on-line copy could thus become a continuing focus and clearing-house for scholarship. (Logan et al. 1986:325)

This is essentially the model offered by the Dartmouth Dante Project. The *TLG*, the TLF project at Nancy, CETEDOC at Louvain, the *Dictionary of the Old Spanish Language* at Madison, and CNUCE in Pisa also illustrate the possibilities of organizing collaboration by language, period, or both.

In view of the costs of preparing electronic texts and hypermedia materials, and the futility of starting *ab ovo* every time a new edition or tool is desired, the collaborative creation of a scholarly electronic environment which would organize the efforts of many different scholars within a coherent whole, along the lines of the projects just mentioned, makes obvious sense. Thus, one would edit the text of the *Libro de buen amor* not as an independent project, but within the context of the resources of ADMYTE or its successor, making the resultant edition available as part of ADMYTE. Nelson's "docuverse" (see above, p. 126) is a logical consequence of such a model, an integrated system, global in scope.

It is premature to expect the profession to move immediately toward systems like the ones described. In fact, it would probably be disastrous. Instead, those who are exploring these problems actively—in consultation with like-minded brethren in other fields who face the same problem of reconstructing authoritative texts from (primarily) manuscript evidence—should begin to set forth their desiderata jointly and to inquire in some detail into the possibilities opened up by technological advances. The Text Encoding Initiative is an essential first stage in this process.

While these problems are under discussion, there are several specific, albeit modest steps which should be taken by prospective editors. The first, of course, is to ensure that at some point in the editorial process, preferably in the transcription of the base manuscript(s), an electronic version is produced. Not to do so, given the widespread availability of computers and sophisticated word-processing software, borders on dereliction of duty. In order to avoid problems of compatibility, the text should be transcribed in a least-common-denominator format, either the lower ASCII (American Standard

Code for Information Interchange) set of 128 characters (now ANSI standard X3.4-1986) or the ISO (International Standards Organization) 646 (ISO 7-bit Coded Character Set for Information Interchange) set of 82 characters (upper and lower case English alphabet a–z A–Z, the numerals 0–9, and the following punctuation marks: "%&'()* +,-./:;<=>?_), which is recommended by the TEI guidelines (Sperberg-McQueen & Burnard 1990: 45–46). Primary features of interest—minimally, the physical representation of the text (resolved abbreviations, interlinear and marginal glosses, rubrics, foliation, catchwords)—should be marked in some systematic fashion. Widespread among editors of medieval Spanish texts are the norms set forth in Mackenzie (1986), which have proved broadly satisfactory for the transcription both of manuscripts and early printed texts in Spanish. Robinson (1990) offers another set of norms for MS transcription along with Macintosh programs for their implementation. Although quite sophisticated, they represent in some respects a step backward, since they presuppose the Macintosh version of the upper ASCII character set. I am not aware of such norms for the other Romance languages. As the TEI draft standards become more widely known, however, machine-readable texts should be encoded to them, and translators should be written to map from previous standards into SGML and vice versa. The development of large corpora of machine-readable texts, all conforming to the TEI guidelines, will measurably enhance our ability to combine these corpora within a hypertext or hypermedia system.

Theoretical implications. It is far too soon to speculate upon the theoretical or practical implications of hypereditions, either for textual criticism or literary theory. The vision adumbrated here, which requires the complete transcription of each primary witness as an essential first step, obviously facilitates the goals of Bédierist-style best manuscript editions or, even more conservatively, simple diplomatic transcriptions. When combined with digitized facsimiles, it allows a focus on the manuscript as the object of textual research, as Cerquiglini (1989) advocates. But tools like UNITE will just as easily support Lachmannian-style reconstructions. In this respect, the system is, in principle, neutral. What it quite plainly will do is to provide a much higher level of precision for all editors, whatever their theoretical persuasions. Does it mean the abandonment of all previous efforts and the wholesale creation of new editions for all medieval literary works? No. The edition of a medieval text will still depend heavily on previous scholarly tradition, and for the foreseeable future we will be engaged in a massive effort to convert printed and MS materials, both primary and secondary, into usable machine-readable form.

In terms of literary theory and analysis, the combination of tools and data should provide a much-needed dose of pragmatism by allowing (and forcing) critics and theoreticians to treat large quantities of data with great precision. All too frequently, excessively broad generalizations are based on microanalyses of small slices of data, or upon haphazardly collected instances

of a given phenomenon. With hypereditions it will be much easier to take into account the entire corpus of relevant data. Given the conceptual fit between hypertext and intertextuality (see Havholm & Stewart 1990, Landow 1989:184), it seems likely that hypereditions will promote research along intertextual lines as well as provide a means for testing its assertions. They will also help us to assess and/or implement deconstructionist theories of textual indeterminacy or instability. Finally, the increasing availability of extra-textual evidence concerning the society which created and consumed literature, in the form of sophisticated prosopographical and codicological data bases such as Faulhaber et al. (1984) and its electronic descendant, the *Biblioteca Española de Textos Antiguos* (see Faulhaber & Marcos-Marín 1990), is likely to promote criticism based on the new historicism.

Of one thing I am sure: until we are actually able to work with hypereditions, we will not fully understand their implications, nor will we truly be able to see how they will change our profession—but change it they will.

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Abbreviations

ACH	Association for Computers and the Humanities
ACM	Association for Computing Machinery
AION-SR	*Annali Istituto Universitario Orientale, Napoli, Sezione Romanza*
ASNSP	*Annali della Scuola Normale Superiore di Pisa: Classe di Lettere e Filosofia*
BAE	Biblioteca de Autores Españoles
BESXV	Biblioteca española del siglo xv
BOOST	*Bibliography of Old Spanish Texts*
BRAE	*Boletín de le Real Academia Española*
CCM	*Cahiers de Civilisation Médiévale*
CFMA	Classiques Français du Moyen Age
CHum	*Computers and the Humanities*
CLHM	*Cahiers de linguistique hispanique médiévale*
CN	*Cultura Neolatina*
CNRS	Centre National de la Recherche Scientifique
CRAL	Centre de Recherches et d'Applications Linguistiques
CSIC	Consejo Superior de Investigaciones Científicas
DCEC	*Diccionario crítico etimológico castellano e hispánico*
DOSL	*Dictionary of the Old Spanish Language*
ECr	*L'Esprit Créateur*
GRLMA	*Grundriß der romanischen Literaturen des Mittelalters*
GSLI	*Giornale Storico della Letteratura Italiana*
HR	*Hispanic Review*
HSMS	Hispanic Seminary of Medieval Studies
Lba	*Libro de buen amor*
LLC	*Literary and Linguistic Computing*
MedR	*Medioevo Romanzo*
NRCF	*Nouveau Recueil Complet des Fabliaux*
PILFUL	Publications de l'Institut de Lexicologie Française de l'Université de Liège

PPU   Promociones y Publicaciones Universitarias
PUF   Presses Universitaires de France
RFE   *Revista de filología española*
RPh   *Romance Philology*
SATF   Société des Anciens Textes Français
SB   *Studies in Bibliography: Papers of the Bibliographical Society of the University of Virginia*
SBoc   *Studi sul Boccaccio*
SD   *Studi Danteschi*
SFI   *Studi di Filologia Italiana: Bollettino Annuale dell'Accademia della Crusca*
SMed   *Studi Medievali*
SMV   *Studi mediolatini e volgari*
SPCT   *Studi e Problemi di Critica Testuale*
TLF   Textes Littéraires Français
UTET   Unione tipografico-editrice torinese
ZRPh   *Zeitschrift für romanische Philologie*

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