Image Processing and the Study of Manuscript Textual Traditions

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I n the study of textual traditions, image processing can play a significant rôle not only as an ancillary aid to the visualizing of manuscripts in the process of transcription, but also as a central element in providing a new form of representation of most of the empirical evidence relevant to the edition.

Availability of digital images from manuscript sources is almost at hand for historians and manuscript editors. It is often argued that in a few years digital imaging will replace microfilm reproduction, as currently applied to the conservation of archival document collections (Thaller 1992a, 42). And, in fact, the Bodleian Library, the major library of the University of Oxford, has already announced substantial moves toward digitizing large microform collections of images from medieval manuscripts (Gartner 1993). The arguments for digital imaging are well known: even though microfilms deteriorate slowly, they do so in an unforeseeable way, whereas the quality of digital images remains constant or, at least, can be kept constant by automatic double-record comparison; copies of microfilms suffer inevitably from loss of quality, whereas copies of digital images do not. Moreover, digital images are more user-friendly and can be stored in a more compact way. Digital images, then, have an advantage over microfilms in archival value, and their production and storage is no longer avoided on economic grounds (Thaller 1992a, 1995).

But how would digital imaging actually affect scholarly and editorial work on manuscript sources? A digital image offers a visualization of a manuscript source on a computer. Printed editions are sometimes supplied with illustrations, a circumstance that proves a point. A printed edition usually appears in a form that hardly shows any external resemblance to the original document. Illustrations are often supplied to convey a closer idea of the nature of the source. Simple illustrations, though, do not suffice if information not provided by the printed edition is to be gained from the original in a more systematic way. Diplomatic editions are produced also for that purpose. But the example shown in figure 1, which is taken from one of the printed and classically produced critical editions (Heidegger 1991, xii-xiii) proves an additional point. No diplomatic transcript can convey as much information as a picture of the original. To be more specific, in the case of "drafts" or outlines with alternative readings, the very placing and spatial arrangement of different portions of the text become very important; as it has been observed, "the process of becoming a textual structure is there fixed in the spatial relations of chronologically different, but structurally equivalent textual units" (Kraft 1990, 110-11).[1] The transcript in this example helps to decipher Heidegger's handwriting, which may not be familiar to many readers, but the diacritics with which the transcription is interspersed—), ', [, ', and so forth—are not immediately understandable to readers not yet conversant with the editorial conventions (in this particular case, not altogether consistent either); they become obvious, and their ambiguities disappear only by comparison with the original, or with its reproduction, a fact that once more calls for the need to show the original.

But the same fact does not support reasons for the uselessness of the diplomatic transcript either. The diplomatic transcript, like any form of transcription, is a form of analysis; it analyzes the information contained in the source. It is an assertive *statement* that *extracts* information from the document. The image is a *source* (or at least a close reproduction of it), a kind of quarry whence information can be extracted; the transcription is a statement conveying that information to an interested reader. Now what have com-

FIGURE 1
Reproduction and Transcription of a Manuscript

REPRODUCTION

FIGURE 1 *(Continued)*

TRANSCRIPTION

In dem Handexemplar der ersten Auflage dieses Buches fand
sich auf der Titelblattseite eingelegt ein Zettel, der, nach der
Handschrift zu schließen, aus der Mitte der dreißiger Jahre
stammt. Der Text lautet:

Kantbuch.

Mit S. u. Z. („Sein und Zeit") allein —; bald
deutlich, daß man nicht einging
auf die eigentl(iche) Frage [vgl. I 3. T.[1] u(nd) Destr(uktion)[2]]

eine Zuflucht — unterwegs u(nd)
                nicht neue Entdeckungen
                zur K(ant) Philologie. —

[S(ein)] Seiendheit — Gegenständlichkeit
                u(nd) „Zeit"
                   Schematismus

aber zugl(eich): der eigene Weg versperrt
                u(nd) mißdeutbar gemacht
vgl. IV. Absch(nitt)[3]
Beiträge[4] — Anfang zu neuem Anfang — | Refl. bgr. (Reflexions-
begriffe)

[1] gemeint ist der I. Teil, 3. Abschnitt von „Sein und Zeit".
[2] die Destruktion der Geschichte der Ontologie des zweiten Teiles von
„Sein und Zeit".
[3] der vierte Abschnitt des Kantbuches.
[4] „Beiträge zur Philosophie" (Gesamtausgabe Band 65).

puters to do with all that? A computer treats both the source and its transcription as data to be processed; therefore, from a conceptual point of view, it changes their very nature and purpose and brings about remarkable methodological consequences on most historical disciplines. The image is no longer regarded as a mere illustration, and the chief purpose of the transcript ceases to be that of *reproducing* the source: on a computer, the image can be processed to obtain additional information, and the transcription aims at producing data for further processing. It becomes an activity of data modeling and encoding in order to elicit as much information as possible from the manuscript and to infer new analytical results. From this point of view, both the image and the transcript are not regarded as physical reproductions referring *back* to the original document but rather as analytical data pointing *toward* a new logical representation of the source. Computers enable new forms of representation, which can have a considerable impact on the methodology of textual scholarship.

An edition, in fact, can be thought of as a form of textual representation, whose classical printed model presents rather obvious limitations in a number of cases. The case of incomplete handwritten drafts left over by the author in a fragmentary state has already been mentioned. The problems they pose to textual criticism have long been debated in scholarly literature (Kraft 1990, 107–24). The solutions are not altogether clear and show the inadequacies of the classical type of edition. The very notion of a "variant," on which that model is based, does not seem to be applicable in the case under discussion.

> Those instances where scholars have spoken about "completed posthumous texts" with "alternative variants," (Woesler 1981, 50) are in fact to be dealt with as *incomplete posthumous texts with multi-valued functional positions* (Kraft 1990, 107).

If the distinction remains unheeded, "philological errors result" of necessity (Kraft 1990, 107). But how shall one reproduce in a printed edition the fragmentary nature of the text that shows itself "in the language of his spatial semantics" (Kraft 1990, 111)? We ask whether equivalent textual units belong in the same functional position. Editors have indeed regarded as the "highest goal" (Backmann 1931, 14) of their efforts "the reconstructibility of the manuscript by the user of the apparatus" (Backmann 1924, 641), but "in the age of reproducibility, the attempts to represent manuscripts through description or special signs are simply an anachronism, if not a caricature of philology" (Kraft 1990, 150). More recently, facsimiles have substituted for diacritic marks, and "the demand for a reconstructibility of the manuscripts" has been met "by reproducing them" (Thurmair 1980–81, 372). The very appearance of facsimile editions shows the advantages of digital imaging. Digital images can be handled as data and not as mere illustrations. It should be remembered that the mere showing of an image

does not supersede a transcription, not even to say an apparatus. The distinction already mentioned between physical and logical representation of a document, or between its mere reproduction and its analysis, must be carefully kept in mind. The claim that even "a second-rate reproduction affords a more evident and concrete discernibility than the most perfect apparatus" (Weidl 1975, 197) must be considered with discrimination, for "it is only through the apparatus," that is to say, through a logical representation or a due analysis, "that the facsimile—and finally the very manuscript itself—becomes capable of asserting" its information content (Kraft 1990, 157). "Editing a manuscript remains categorically different from simply reproducing it" (Kraft 1990, 111), a point to which we shall come back later.

Another example is provided by the textual tradition of twelfth- and thirteenth-century romance literature. Our idea of text is very much at odds with the kind of textual canonicity dominant in medieval times. As has been observed, "most of us almost automatically equate texts with printed books" (Uitti 1993a, 157). And the now-prevailing model imposes an idea of textuality that does not comply with the medieval practice. In the case under discussion, the medieval idea of textual canonicity "includes *both* the notion of 'authorship' *and* a variable textuality reflecting scribal 'creativity' and refashioning" (Uitti 1993b).[2] The medieval text is "fluid and dynamic," for "fidelity to an author's work generally involves what we would call changing what the author wrote." But the textual ideal conveyed by "the artifact we call the printed book" (Uitti 1993a, 157-58) has also worked on the principles assumed by the major schools of textual editing, which all strive, although in opposition to one another,[3] for "closeness to a lost authorial original" (Uitti 1993b, 1). As reproduced in a printed book, text is fixed and immutable; it allows, as in the case of fragmentary drafts, "only a single 'right answer,'" which confers privilege on "the 'final' work of an 'author.'" The form of representation is mistaken for the form of what is to be represented. So printed book editions do not, nor can they, make allowance for the kind of scribal creativity we find in this type of medieval literary text. Textual variety is judged by necessity "undesirable" and confined to "an apparatus of discarded 'variants'" (Uitti 1993a, 157).

Can computers and digital imaging help in avoiding the "distortion" (Uitti 1993a, 159) that is produced by assuming that the representation that takes the form of the printed book (or any other form) is the ideal representation of the text? Producing a computer representation already helps remove the prejudice that assumes the printed-book representation to be an absolute one. However, it also produces a new form of representation commendable in its own right. In a project carried out at Princeton University, the study of the Old French manuscript tradition pertaining to Chrétien de Troyes' romance *Chevalier de la Charrette* (Lancelot) has been approached through the creation of a database including an encoded diplomatic transcription of all the

extant manuscripts. The database representation of the entire textual tradition of Chrétien's romance is remarkably akin to the varied and diversified nature of the reality to be studied. It enables a better approximation of a significant textual corpus and affords access "to *real* (i.e., surviving ms.) material rather than to an inevitably 'artificial' modern editorial reconstruction" (Greco 1993, 159).

However, it is not only for reasons of flexibility and quantity for allowing a closer and more comprehensive reproduction of the source materials that a computer representation can "provide access to realities that could not have been approached" otherwise. The "organizing power" of a database representation is able "to augment the resources open to scholars" because it increases their options "in regard to analysis" (Uitti 1993a, 157–58). Again, the methodological significance of a computer representation is not so much inherent in its mimetic as in its structural and logical features, which make sources available as data for further processing and analysis. A database representation is able to "translate" encoded textual features documented by the corpus into "structures" readily accessible "for the purposes of analysis and comparison." Structuring textual materials as a database "provides" more "resources for dealing with problems ranging from the orthographic through the morphological and grammatical to the interpretive," than "a simple string search mechanism does" (Paff 1993,

It is worth insisting on these conceptual features of a database representation of textual features, which have been consciously and deliberately emphasized, because they hold quite as much for digitized images of manuscripts. A digital image can be regarded not only as a bitmapped reproduction of a document, but also as a logical data type, just as much as a textual phrase can be regarded as a logical object of a certain kind, rather than a meaningless string of characters. But it is often more difficult to regard images as logically structured data than it is to think of them as sheer reproductions of a real physical object. The "Charrette" database, as valuable as it is, does not avail itself of digitized images: the effort of trying to "devise a graphic program in order to reproduce ornamental initials and even miniatures" (Greco 1993, 159), for example, mimics more than anything the old-fashioned attempts to reconstruct the manuscript through the apparatus and still mistakes transcription as a form of analysis for transcription as a form of reproduction.[4] Whereas, indeed, it would be worth studying "'variants,' or 'variant readings' as they appear in their context" (Greco 1993, 160) not only by means of a text, but also by means of an image database. In spite of it, however, the "Charrette" database allows for a variety of scholarly applications, such as research on the text's reception and on the poetical and rhetorical features affected by the mobility of its tradition that can only speak for its outstanding value.

The "Gentile" database offers another opportunity to understand the role of computers "to provide a more accu-

rate representative of the actual fluidity of the text" (Buzzetti and Tabarroni 1991, 193; Buzzetti, Pari, and Tabarroni 1992). The text referred to is a commentary on Porphyry's *Isagoge* written in the first decade of the fourteenth century by the Bolognese master Gentilis de Cingulo. It is a typical teaching book produced in the faculty or, more accurately, in the "university" of arts and medicine of Bologna in the fourteenth century. This text, and all others like it,

> are indeed such peculiar witnesses of the university teaching techniques, that both their tradition and physical production turn out to be deeply affected by their scholastic origin.

> A typical figure in the Bolognese school tradition was in fact the *repetitor*, a young master who acted as a teaching assistant for the master appointed to the ordinary course, with the special duty to "repeat" to the students in the evening the lecture given by the master in the morning.[5] Traces of the activity of these lesser historical figures are preserved in the manuscripts, mainly under the form of major accidents occurring in the textual tradition of the works of the masters from Bologna, such as anonymous marginal glosses or even long passages interpolated within the text, but reported only by few or even one copy (Maier 1955, 308).

> As a result, the works of the Bolognese masters of philosophy and medicine in the 14th century are often characterized by a complex textual tradition, providing evidence for a gradual process of composition through the different interventions of the master himself and of his *repetitores*. Hence, these texts also usually exhibit a sort of "fluidity," affected as they are by a great number of alternative readings, scattered through the different manuscript copies, and by glosses and additions which can even be peculiar to each copy.[6] (Buzzetti, Pari, and Tabarroni 163–64)

For these kinds of sources, "the traditional goal of assessing the text in the most reliable way," that is, through a critical edition based on the canonical printed book model, "could be neither feasible nor desirable." For

> it is often not easy to decide whether a gloss or an addition stem from a later intervention by the author himself or by a *repetitor* (and, in the latter case, whether the *repetitor* is merely repeating his master's doctrines or is speaking on his own authority). The very concept of "the" author of the text becomes questionable in such cases. Moreover, for the purposes of our research project, which is focussed on the early institutional framework of the study of arts and philosophy in Bologna, all the different versions of a text are of the same historical relevance. (Buzzetti, Pari, and Tabarroni 1992, 166)

From the point of view of an adequate reconstruction of the text, the case of our teaching text is very much akin to those previously mentioned, where alternative readings cannot be debased to lower-rank variants. In all these cases, we impose an editorial policy that treats all alternatives as equally valid variant texts (see Kraft 1990, 110).

Four manuscript copies of the "Gentile" text exist, each exhibiting major discrepancies, such as glosses and interpolations, that do not characterize different redactions, how-

ever. The entire tradition of this text can be represented by a database of images and transcriptions. I have argued elsewhere that such a database is a new form of electronic edition, where the computer permits new means of organizing textual data (Buzzetti and Tabarroni 1991, 193). The resources on which this organizational task are based are contained in an electronic archive of transcriptions of the different representations of the text. The critical issues raised by the text can thus be approached by having access to all the information in all the variants.

Thus "all the information conveyed by each witness" of the text could be "organized in a form more apt at solving the critical problems raised by the textual tradition" (Buzzetti and Tabarroni 1991, 193).

How was the "Gentile" database designed and what use was made of digital imaging? The κλειω (kleio) database management system was chosen because it can administer images as a data type, together with other more conventional data types such as full-text and structured alphanumerical data, all in the same processing environment (Jaritz 1993, Woollard and Denley 1993, Thaller 1994, and Thaller forthcoming). Within the system, images can be connected to textual descriptions and/or transcriptions organized as structured elements of a database. The transcriptions were arranged accordingly in a kind of hierarchical database, following the internal structure of the text. The commentary is divided into a *principium* (lacking ms. S) and seventeen sections corresponding to an equal number of lemmata of Porphyry's text in the Boethian translation. Each lemma of the literal commentary comprises a *divisio textus* and a brief exposition of the *sententia auctoris*, followed by the discussion of *notabilia* and *dubitationes* (Buzzetti and Tabarroni 1991, 190). We therefore obtained,

for the first *lectio*, the following (simplified) structure (see figure 2). Because the structure is the same for each of the four manuscripts (F, M, C, S), we obtained the following (simplified) matrix (see figure 3).

Every portion of the text in each of its four manuscript variants was then defined as the value of a structural element of the database, thus enabling us to connect it with a relevant image. The main image files are bitmaps of a manuscript page, recto and verso of a manuscript folio, respectively. By means of the image-processing facilities of the system, we could obtain from each image relevant cuttings for each portion of the text. The resulting structure for each sequence of textual units within a given manuscript can be represented by two independent tree structures built from these primitive units, very much the same as in an ODA (ISO 1986)[8] conformant model (see figures 4 and 5).

Images of parallel sections of the text can all be displayed on the screen, together with the relevant transcriptions. The editor can then assess parallel readings of different manuscript variants in their actual context, displaying as much factual information as is needed. But is the database representation just an aid to the critical reconstruction of the text, or can it be considered a step toward a new form of edition? Indeed, one has to say that it serves both purposes. By means of a database management system (DBMS), information can be both processed and represented. Precisely for that reason a computer-based edition can be "open-ended" (Uitti 1993a, 157; Greco 1993, 159) and "dynamic" (Thaller 1992b, 5–7), both of which we shall again insist upon. Thaller's κλειω is a tool for processing information (in our case, for retrieving evidence, both textual and visual) and inferring analytical results (in our case, for making editorial decisions), as well as a means to represent both the data and the result of their processing (in our case, an entry in the

FIGURE 2
Subdivisions of a Text
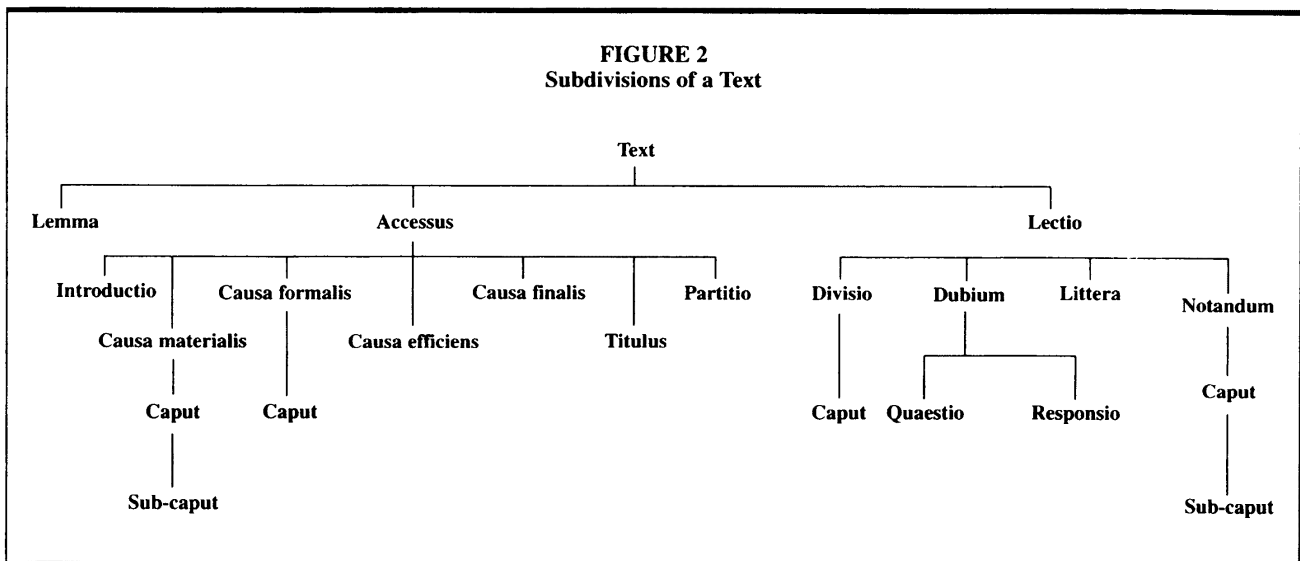
FIGURE 3
Structure of a Textual Database

	F	M	C	S
Lemma				
Accessus				
Introductio				
Causa materialis				
Caput				
Sub-caput				
Causa formalis				
Caput				
Causa efficiens				
Causa finalis				
Titulus				
Partitio				
Lectio				
Divisio				
Dubium				
Quaestio				
Responsio				
Littera				
Notandum				
Caput				
Sub-caput				

apparatus and a reconstructed text). The enormous advantages afforded by κλειω's image-processing facilities to improve readability and assess unclear manuscript evidence are hardly to be underestimated; but it is its power in representing and organizing both evidence and results (in our case, the very process of documenting and reconstructing a text) that better suits the purpose of producing an edition.

So why should a textual scholar still "stress," indeed undeniably, that a database "is **not** an edition" (Uitti 1993b, 15)? It is a claim that has to be accepted, if a database is only thought of as a form of "replicating" a manuscript tradition (Uitti 1993a, 157). There is a point in rejecting the notion of "a new type of edition" (Kraft 1990, 15) a so-called archive edition, whose task would comprise the "archival survey of all sources, and thus of all variants, both in the composition and transmission of the text," a sort of "inventory," conceived "primarily" and "in the sense of mod-
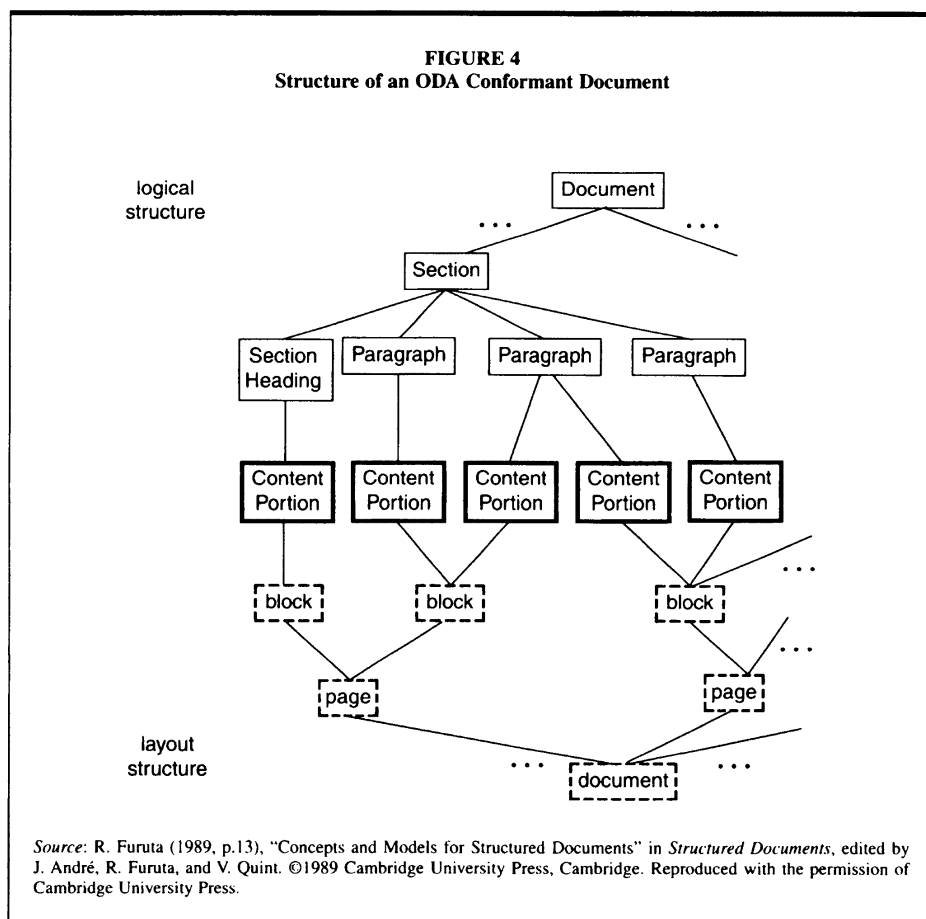
ern information theory," as "an information bearer" (Kanzog 1970, 19) that would "substitute for the originals under consideration" (Kanzog 1970, 40-41). In addition, an image is only the best *logical* approximation to a document and not a substitute for it. So a database is by no means an edition as long as it is thought of as a sheer duplicate of its source material. A database, however, had better be thought of as a structured *logical* representation of the sources. An information bearer, whichever it may be, cannot just replicate the original: the problem is to put its *logical* features to a good use. But for the sake of producing an "edition" exactly how can that be done? The most plausible answer appears to be to *organize a database as an apparatus*. For that seems to be precisely what makes an edition—not just an archive—out of anything. Represented in database form "with commentary" (Uitti 1993a, 157), a textual tradition is already, as it has been emphasized, *translating* encoded tex-

tual features *into structures* (Paff 1993, 161). And that could possibly be done just for the sake of documenting one or another reconstruction of the text, precisely the purpose for which the apparatus has been created. It is also the problem our "Gentile" database has to face: its claim to be a step toward a sound "critical edition in electronic form" (Buzzetti and Tabarroni 1991, 193) very much depends on its solution to this problem.
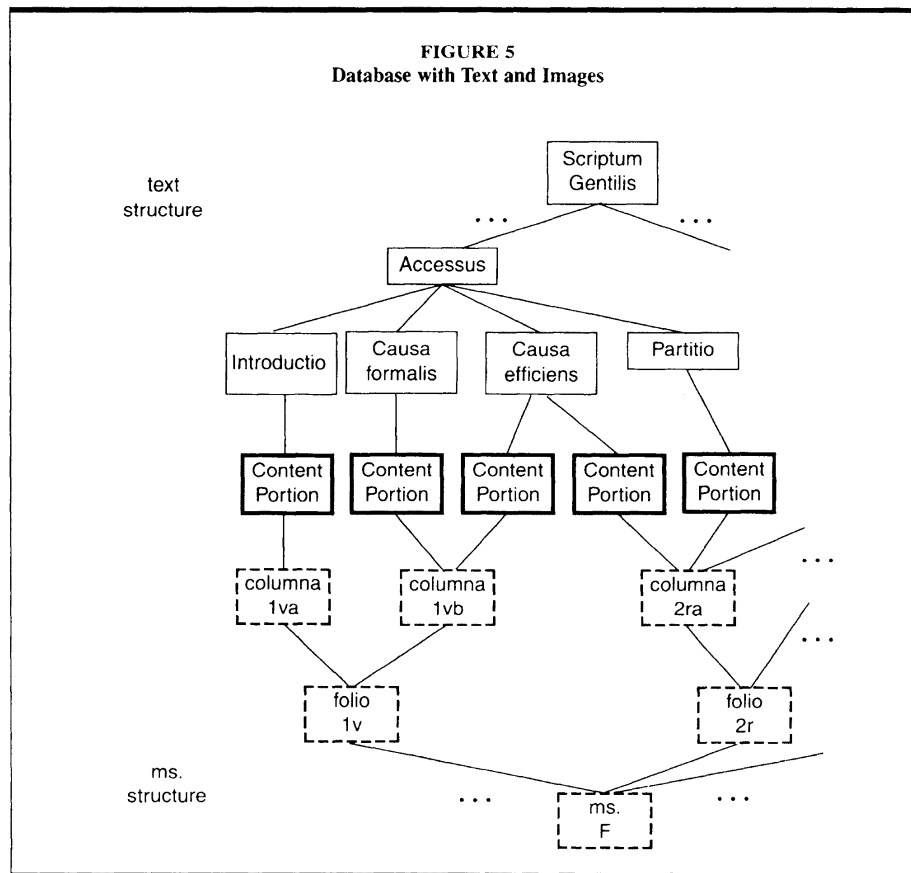
To allow selections and new arrangements of textual material, the primary task of the "Gentile" database is to provide for alternative structural representations. Effective processing procedures should be devised to organize retrieved textual and visual information so as to enable both the reconstruction and the representation of an edited text. New tools should then be implemented to allow editorial choices and to organize reconstructed text, referring all the relevant information to it in a systematic way. At this stage, our database can make provision for a kind of fully "exploded" apparatus, which would still require suitable rearrangements for movable and revisable textual reconstructions. Because an editor has to make choices, evaluating and discarding irrelevant factual information, an edition cannot simply comprise a comprehensive, all-inclusive archive.

Additional binding facilities, not only for structured elements of a database as is now the case, but also for smaller components, are now going to be implemented in κλειω. Through the creation of overlapping hierarchies, alternative structural representations will then be available within the database, and editors will be able to create devices for "filtering" redundant textual evidence and retain only relevant items as entries of a functional apparatus. An "exploded" all-inclusive apparatus could then be "imploded" into an exclusive one: an apparatus serving only one possible edition, relying on the editor's decision, may be only a "virtual" one still to be tested on wider, possibly external grounds.

Making the database, or some of its parts, publicly available is another major requirement for shaping it into an edition. Electronic information can be published as such. It can be distributed on magnetic or optical support. It can also be made accessible via data networks: it all comes to institutionalizing a copy for networked distribution. Circulation and authentication are easily ensured. The problem is the format. Standards are needed to interchange structured information. The self-documenting image file (SDIF) format (Thaller 1995) appears to meet the aims and requirements of a suitable edition of manuscript materials. What makes

FIGURE 4
Structure of an ODA Conformant Document

Source: R. Furuta (1989, p.13), "Concepts and Models for Structured Documents" in *Structured Documents*, edited by J. André, R. Furuta, and V. Quint. ©1989 Cambridge University Press, Cambridge. Reproduced with the permission of Cambridge University Press.

FIGURE 5
Database with Text and Images

an image file useful to other users is its logical description—in our case, the transcript of its source. The content information of an image file is usually logically structured through textual descriptions stored and administered by a database in independent files. Under such conditions, exchange of data is possible only between databases of the same structure and design. Opportunities for merging database transcripts and descriptions to permit "electronic 'editing'" to be "open-ended" and "continuous" (Greco 1993, 159) are seriously hampered. Devised precisely to afford optimal extraction and integration of materials from one database to another, the SDIF format should contain, in a single file, a bitmapped image, a logical description of its content (e.g., a transcription with editorial annotations), and information for an external program to interpret it and to enable integration through mutual export-import operations. SDIFs should then allow a further substantial step toward the edition of image-based materials. Databases could, like an edition, be easily "quoted" and referred to within one another. To be quoted and improved, textual reconstructions would not need to wait for their completion and assume the "monumental" (Uitti 1993a, 157) stillness of an immutable printed edition. In a nutshell: "before an edition," a printed one, "is completed, nobody can use it;

and once it is finished, it cannot be modified any further." Printed "editions are therefore absolutely static" (Thaller 1992b, 5). Electronic editions, on the contrary, would be "immediately available" and could be "immediately and effectively improved" at any stage. For a "static printed edition" they would substitute a "dynamic form of representation mirroring the advancement of research" (Thaller 1992b, 7). The production of electronic editions comprising digitized images of manuscript materials cannot be reduced to sheer technological renewal. Such production undoubtedly affords new forms of representation that can effectively cope with the startling vagaries of many a textual tradition.

NOTES

1. This particular remark was brought to my attention by Claus Huitfeldt in discussions at the Wittgenstein Archives in Bergen.
2. I am grateful to the author for supplying me with a complete draft copy of his paper.
3. "The 'common error' Lachmanians" on one side and "the 'best manuscript' Bédierists" on the other (Uitti 1993b, 1; 1993a. 157).
4. The level of technology available for this database "limits" the system's "abilities to deal with graphic images" (Paff 1993, 161).
5. On the problem of *repetitiones* in Bologna, see Maier (1949, 251-78, esp. 255-56); Alichniewicz (1986, 21-25); and esp. Maier (1989, 268-70, 274-77, and 285).
6. See also Buzzetti and Tabarroni (1991); on the notion of "fluidity" for

a textual tradition, see Del Punta (1982, 53).

7. Mss. Firenze, Biblioteca Nazionale, C.S., J.X.30 (=F); C.S., F.4.49 (=M); C.S., A.4.48 (=C); Salamanca, Biblioteca Universitaria, M.2878 (=S). For a brief account of the peculiarities shown by the textual tradition of this work, see Buzzetti and Tabarroni (1991, 190–92).

8. On representation problems of structured documents, see Joloboff (1989).

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