Word and Image in Multimedia

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Rhetoric is an ancient term that is not often thought relevant to the contemporary world of electronic communication. For thousands of years, rhetoric has been defined as the art of writing or speaking persuasively, and so has been limited to verbal communication. But even in the age of printed books, effective communication has often included pictures and graphs as well as words. Computer-controlled multimedia, which is a new form of communication, goes further and includes animated graphics, sound, and video. At the technical level, standards for storing, compressing, and representing text, graphics, and video are being defined: standards such as RTF, SGML, Quicktime, JPEG, MPEG, ODA, HyTime, and MHEG. (See for example 2992, HyT92, and ODA89). But at the level of presentation and interaction in multimedia environments, a different kind of standard must be developed. For these new media we must expand our definition of rhetoric. We must define a rhetoric of multimedia: a set of design rules and practices that suggest how to create persuasive combinations of all the media mentioned above.

Together with colleagues in the School of Literature, Communication, and Culture and the Graphics, Visualization, and Usability Center at the Georgia Institute of Technology, we are working to establish the rudiments of a such rhetoric. Our goal is to explore effective configurations of old and new media. We want to learn how to draw on classical rhetorical theory and the history of writing to improve current multimedia design. And we want to see whether current theories of art, music, and literature can help us understand multimedia. (See, for example, Laurel91.) We believe that these historical and theoretical

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1 We must think beyond a rhetoric of multimedia that pertains only to the commercial applications of computer technology. We find ourselves developing an integrative theory that follows decades of work that had questioned the status of text and image. At a time when we have learned to destabilize virtually any text or image through skeptical methodologies, multimedia challenges us to ask how the critical work of the past years may come to bear on electronic technologies. The development of a rhetoric of multimedia would provide a set of critical perspectives for improving multimedia presentations. The definition of such perspectives would rely on the understanding that rhetoric, even as classically defined, is an integrative practice including the graphic and aural. Multimedia challenges us to see how flattened or two dimensional our means of communication have become. Finally, the definition and practice of a rhetoric of multimedia would depend on the integration of art history and musicology with literary theory. Colleagues in the School of Literature, Communication, and Culture at Georgia Tech who have participated in the discussions regarding the development of a rhetoric of multimedia include Professors Anne Balsamo, Charles Bazerman, Peter McGoire, and Stuart Moulthrop.
considerations can and should be combined with experience in computer graphics, human-computer interface design, and other disciplines in computer science.

In this paper we offer an example of our interdisciplinary approach to the rhetoric of multimedia. We consider the problem of integrating verbal texts into graphic environments, a problem that has received relatively little attention. Designers of multimedia applications tend to emphasize graphics and particularly video. When used at all, text is relegated to a separate space, often in a separate window. There are historical reasons for the separation of text and graphics in multimedia. Computer text processing developed earlier and in a separate tradition from computer graphics. Word processors in personal computers are about a decade old; business word processors were already common in the 1970s, and text editors for programming in time-shared mainframes date from the 1960s. The early generations of word processors were of course wholly alphanumeric. Advances in hardware and software have made possible first bitmapped graphics and then computer-generated animation and computer-controlled video and sound. These advances have led to new applications, but these new applications have little use of text beyond the obvious need to make labels. We still have largely discrete sets of applications for text (databases, word processors) and for graphics and video (image processing, multimedia presentations).

Although this division may have been appropriate in the past, a number of forces are driving us toward integration. As the hardware and software for digitizing and storing images becomes less expensive, users are expecting to be able to include graphics in their documents and presentations. Multimedia databases of archives materials (e.g. newspaper articles together with their photographs) now become thinkable. Encyclopedias (e.g. Grolier’s Electronic Encyclopedia) are beginning to include pictures and even sound. Soon video will be included in such products. In the first such applications it may just be a matter of opening a window and showing the graphic or video. But in the long run, we need to rethink how words and images can share the same visual and conceptual space in the computer.

To help in this process of rethinking, we propose to look back into the history of the printed book. Printers confronted similar issues in the first three hundred years of their technology, as they slowly learned how to arrange words spatially to convey structure and meaning and how to add graphics (woodcuts and then copper engravings) to the stream of words. The art of typography developed into a sophisticated set of practices between the 1450s and 1700. Studying these practices can help us define a new “typography” for the space provided of computer-controlled multimedia.

1. Spatial Text in Earlier Print Technology

The printing press was invented in the middle of the fifteenth century, and at first printed books were made to look very much like fifteenth-century manuscripts. The process of making the books changed, but the product remained almost the same. [Eisenstein 1979, pp. 51-52.] This similarity was natural: printers wanted to sell their books to readers who were used to manuscripts. Furthermore, printers themselves did not immediately see any need to change the form of the book: they were accustomed to the (German) manuscript’s dark pages of Gothic script. Over the next several generations, books did change. But even in the sixteenth century they retained some of the organizational and visual characteristics of the medieval manuscript. For example, as in medieval manuscripts, many older texts (particularly Greek and Latin authors and legal works) continued to be printed with commentaries, and these commentaries were sometimes laid out around the original text in layers. The printed page was divided into zones; the texts in the outer zones explained the text in the center.

A good example is provided by this standard edition of the Latin poet Ovid’s Metamorphoses, published in 1565. (See figure 1.) Ovid’s poem itself is located in the center in a large typeface. Above the beginning of the poem is a graphic depicting Ovid presumably composing his poem. (The picture is anachronistic: it shows Ovid writing in a codex or paged book, when he would have been using a papyrus roll.) Above the graphic there is a summary of the poem by Lactantius Placidus. The commentary by the Renaissance humanist Raphael Regius surrounds the text. Regius’s typeface is smaller than the typeface of Ovid, but there is still much more space devoted to the commentary than to the poem itself.

This complex page layout tended to disappear in what we might call the industrial age of printing (1800-1950). In the nineteenth century classical commentaries were still placed as notes at the bottom of the page. But most books just presented one text in a series of paragraphs. This trend continued in the twentieth century, when notes tended to be banished to the back of the book. The space of a modern printed book is quite uniform. However, the differentiated space of this sixteenth-century commentary is very informative. Regius’s comments upon specific words and phrases are located conveniently near Ovid’s text. The reader can move easily from text to commentary and back. Each textual layer conveys a different kind of information, and each requires a different kind of reading or interpretive methodology.

The editions of texts like Ovid’s Metamorphoses offered their contemporary reader a sense of control over the text that came from the accessible arrangement of information. Such editions offer us today a significant precursor to a new electronic typography. Chris Neuwirth and David Kaufman at Carnegie Mellon University have in fact directly applied the lessons of the medieval and
2. The Integration of Word and Image in Earlier Printing Technology

The illustration on the page of Ovid's poem indicates another dimension to early print technology. In the manuscript technology of the Middle Ages, there had been a great tradition of illumination: decorating letters of the text with elaborate abstract or figural designs. The earliest printed books used woodcuts to reproduce graphics; in the sixteenth century, copper engraving replaced woodcuts and allowed more precise and elaborate illustrations. With the improvement of printing technologies, the sixteenth century witnessed an explosion of graphic experimentation. These engravings could be decorative, or they could convey significant technical information (in books on anatomy and biology, in books containing maps, in technical manuals describing machinery, and so on). Graphics were also used to organize material and provide the reader with easy visual access to the subject matter. For a text such as Ovid's Metamorphoses, a large illustration at the beginning of a chapter functioned as a plan that could remind the reader of the narrative structure of the book; the picture could also reiterate the moral significance of individual passages.

In describing complex technical devices, a graphic could convey information more effectively than words, in particular because sixteenth writers had not yet developed a technical vocabulary in their own vernacular languages. Agostino Ramelli's (1588) illustration of a pulley system provides a good example. (See figure 2.)

Through detailed illustrations such as the one above, readers were able to grasp the relation between the parts of the machine and conceive how the parts fit together to achieve a specific purpose. In effect, illustrations such as this created a kind of short-hand that made scientists and technologists reluctant to depend only on written accounts ordinary language. Ramelli's illustration is clear and cogent, but the accompanying description is not (Ramelli 1588, 1857):

The mechanism of this next machine is most powerful for pulling and moving all kinds of very heavy weights. For when a man turns screw A with the crank, he thus turns worm gear B which has on the lower part of its shaft a toodled wheel marked H, and with this it turns the other two wheels on either side marked I K, together with the two drums L M set on their shafts. These drums wrap around themselves the end of the ropes that pass over the pulleys of the two tackles N O which are attached to the weight [...] Like the drums marked L M, and at the same time, the other drums likewise wrap around themselves the other two ends of the ropes that are wound around the aforesaid pulleys and turning with these movements pull the weight with great ease, but also with the help given by the rollers which support it and are on the beams that exert force against the machine which pulls the weight, as is clearly understood by studying the drawing.

[Figure 1: Illustration of Humanist commentary (Raphael Regius)]
us that the sixteenth- and seventeenth-century reader or observer expected that meaning or understanding would be supported by multiple registers. The multiple registers could be different kinds of verbal text, such as Regius's text, summary, and commentary for Ovid's *Metamorphoses*. But the multiple registers could also be different modes or media, such as Ramelli's combination of text and graphics.

Another and more elaborate example of the use of multiple modes is found in Michael Maier's *Atalanta Fugiens* (1618). (See figure 3.) Here Maier expects his reader to integrate graphic, texts, and even sound [Maier1618].

![Figure 3: Illustration of "Multimedia" Text]

This is truly a printed version of multimedia. By placing musical notation on the same pages with words and graphics, Maier is creating a multimedia event. The problem of course is that the media, particularly the music, are not self-activating. The reader must activate the text by reading the words, examining the graphics, and presumably playing and singing the music. This static combination of media is as far as the printed book could go in the direction of integration. The technology of printing achieved this level of integration as early as the seventeenth century. And, if anything, the tendency to integrate declined in the printing of the nineteenth and twentieth centuries.

[Figure 2: Illustration of Gear and Pulley System]

Ramelli's text shows the phenomenon of doubling. He says things twice, once with a graphic and once in prose. It is as if the prose were trying to catch up to the graphic. One of the most developed Renaissance interpretive practices, allegory, may also be seen as doubling the written text with a graphic: the meaning of one medium becomes reinforced by the meaning of the other. Such doubling reminds...
3. Text and Graphics in the Electronic Writing Space

These examples from the period of craft printing can provide us with a new perspective on the development of multimedia today. In that early period of printing, illustrations of technical ideas were sometimes more sophisticated than prose descriptions. We have seen how authors would repeat in prose what the graphic illustrated. The new writing space of the computer also offers possibilities for the doubling of text and graphics. A graphic may reinforce the meaning of a verbal text or vice versa. Text and graphics may interact in more complicated ways, too. This interaction has not been fully appreciated in the computer medium, perhaps because the late age of industrial printing did not exploit graphic doubling as did the earlier period of craft printing. And it is this late age of printing that directly influenced the development of word processing in the 1970s and 1980s. The task of the craft printers was both to develop an appropriate space for the written word and to explore how to combine alphabetic text with illustrations and diagrams. Developers of multimedia now face a similar task in defining an electronic space that integrates words, graphics, sound, and video.

A number of approaches are possible. Perhaps the most obvious is to deploy text in and around the graphics, as we now do with captions in printed books. This is already done, for example, with menus and labels in the standard desktop metaphor. Various objects on the desktop (files, directories, and applications) carry their textual name around with them. Techniques of deploying text in this fashion can be learned from traditional graphic design and illustration. But even here new questions arise when we add motion. With animated graphics and video, the images change over time, and so certain kinds of labels for these sequences of images also need to be time-dependent, appearing when the image is appropriate and disappearing later in the sequence. A model here, interestingly enough, could be subtitles in films, which change to reflect the current spoken dialogue.

However, there are other, more significant ways in which the symbolic role (ordinarily played by language) and the visual role (played by graphics and video) can be integrated. In some multimedia applications, the graphic elements themselves may be assigned a symbolic role: that is, they may become textual elements with a symbolic meaning. We can call this the "textualizing of the graphic space." Such textualizing is in fact already a well-established technique in the field of scientific visualization. In such applications scientists are permitted to see their data in a visually enhanced space. The space is symbolic in the sense that it is generated by setting up a coded relationship between graphic elements (such as size, color, and shape) and the (usually numerical) data.

Scientific visualization shows how one can construct a symbolic space out of numerical data. But we wish here to focus attention on verbal text rather than numbers. We propose as a research question whether verbal text could also be deployed effectively in a symbolic space—either in some form of projected 3D graphics or in Virtual Reality. In this way the text would not serve merely to label objects; it would instead be used to communicate verbal ideas, as it does now in the two-dimensional space of the printed page. A three-dimensional symbolic space could be laid out to suit the text, which might appear floating in space or attached to walls, blocks, or other objects. The goal would be to use visual cues to aid the reader/user in locating and assimilating information. We call this proposal (which is the converse of scientific visualization) "spatializing the text."

4. Spatializing the Text

There is some previous work from which we can draw for the setting out of verbal text in a graphic space. Several recent hypertext systems provide concept maps for editing or browsing; these maps are graphical representations of the structure of texts and links in the hypertext. One system that provides concept maps is Storyspace, an environment for creating and delivering small and medium-sized hypertexts. Joyce's Storyspace offers a graphic representation, in which nodes are shown as boxes and links as arrows. (See figure 4.) The map is updated to reflect structural changes as they occur, and the author can make such changes on the map itself, by grabbing and moving the boxes. Spatial relationships in Storyspace are significant: nodes can be clustered to indicate conceptual relationships.

![Figure 4: Concept map in Storyspace](image-url)
Other systems have employed a variety of techniques for visualizing the semantics of the hypertext. Jerker Andersson describes a system for hypertextual mapping elsewhere in this volume. We can also point to Sepia, developed at the Integrated Publication and Information Systems Institute in Darmstadt. [Spreitz89; Thüring91] There is the MacWeb System developed by Jocelyn and Marc Nanard. [Nanard91] There is also Acquadoc, where complex semantic relationships among the elements are expressed through spatial layout. In all these systems, alphabetic text (the names and, in some cases, even the contents of the cells) may be integrated into the graphic space.

If two-dimensional concept maps are a proven tool, it is plausible that a three-dimensional representation will make the structure clearer and easier to edit and browse. There has already been some work in this area. Semnet developed at MCC in the mid 1980s provided three-dimensional visualizations of a semantic net. [Fairchild88] More recently, researchers at Xerox Parc have created the 3D/Rooms interface, in which hierarchies of information are presented as tree structures in three dimensions called "cone trees." The cones can be rotated to facilitate viewing [Card91, Robertson91]. A three-dimensional information browser is also being developed by Hemmje at IPSI in Darmstadt. [Hemmje93] These systems suggest that textual information can be searched for and digested effectively in three dimensions. Although the 3D/Rooms and the IPSI systems are not hypertexts with arbitrary links, it also seems likely that a third dimension would help in untangling the spaghetti that sometimes results from the intersection of many links in a two-dimensional hypertextual concept map. In a three-dimensional view, the user could change his or her perspective, so that fewer links would have to intersect.

5. The Virtual Book

Arranging text in three dimensions calls for a new typography. The typography of current printed books is generally limited to a few simple visual structures. Paragraphs and headings convey local organization of the page or the opening. Larger structures are conveyed by the table of contents and indices, which are then mapped to the linear order of the pages. The design of a magazine or newspaper page makes more creative use of its visual space. The reader's eye is invited to move around the page and focus upon interesting material. In fact, contemporary magazines are really the successors of the examples of craft printing that we discussed earlier. For example, many magazines and newspapers make use of the techniques of integration (locating text in and around graphics) and doubling (using a graphic to resaturate the verbal text or vice versa). However, a printed magazine is still a layout only in two dimensions. Adding a third dimension opens

a new range of typographic possibilities. This new place in which to locate text might be called a "virtual book." It remains an open research question whether such a spatial arrangement will in fact clarify structure and make it easier to navigate through textual information. But again, it seems plausible that it would, as the following example suggests.

A traditional table of contents in a printed book shows the topics in serial order together with their appropriate page numbers. (See figure 5.) To make a three-dimensional version, we could create a block for each topic and array the topics in space. (See figure 6.) This spatial arrangement provides more information in at least two ways. First, clusters of pages (or other units) are visible at a distance, giving the user a sense of the overall structure. This sense of structure is refined as the user moves closer to particular areas of the text. Second, at certain distances and perspectives, the user will be able to see the text of several pages at once. Portions of text on these pages or units may be in large typeface and will be visible at a greater distance. As the user moves closer, more of the text becomes legible.

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On the other hand, the spatialization of the text might proceed in a direction very different from that of the abstract concept maps of hypertext systems. For example, an architectural metaphor might prove effective for conveying structure. Human beings have a great deal of experience in understanding and navigating in built environments: houses, buildings, neighborhoods, and cities. This experience of place could be given symbolic significance. For example, chapters in a book might be laid out as rooms on an architectural surface, and the architecture of the whole layout and of each room might be used to convey structure. (See figure 7.) In the center of the layout, an information kiosk (not shown here) would contain summary information and the location of each chapter. Further summary information would be located at the entrance to each room, and within each room the walls themselves would present the text in detail.

[Figure 6: Spatial layout of table of contents in Figure 5.]

In our example, the traditional layout of the table of contents gives no visual prominence to the fact that one of the sections ("College of Engineering") is much longer and more detailed than the others. The user would have to look closely at the page numbers to notice the importance of the section. However, the spatial representation makes the prominence of this section clear at a glance, because of the large number of unit markers clustering around the section.

This is only one way in which a third dimension might be added to the traditional hierarchical or linear layouts found in printed texts. Our sample space resembles a hypertextual concept map without the links, and certainly hypertextual links (as arrows) could be drawn all through this space. Color, shape, and size could also be used to discriminate among the units in a three-dimensional space. Figure 6 uses different sizes to indicate the importance of a particular block. Different colors might also indicate whether a textual block had recently been modified. Shapes could indicate different types of text. All of these techniques have already been employed in or suggested for two-dimensional hypertextual concept maps.

[Figure 7]

This metaphor too is being explored at the Zentrum für Graphische Datenverarbeitung in Darmstadt: multimedia information is being represented as located inside rooms of a house. [Hübner93] There is also a much earlier forerunner—the ancient mnemonic system called the "art of memory," used in the ancient world and in the Middle Ages. An ancient crator remembered the points of
6. Technical Limits to Spatialization

Current hardware limits what can be done with the spatialization of text. The limitations are particularly obvious for displaying text in Virtual Reality. Head-mounted displays often do not give adequate resolution for reading text. For example, a prototype system for spatializing text in VR has been constructed in the Graphics, Visualization, and Usability Center at the Georgia Institute of Technology. The system uses the conventionally available equipment, including a Virtual Research head-mounted display and a Silicon Graphics Indigo Elan workstation [VeMlnden93]. Texts in this system can be created either by drawing individual letters graphically by algorithm or by scanning pages of text and placing these scanned images in the space through texture mapping. This system is useful for experiments–it produced Figure 3 above–but it is not adequate for long reading sessions. However, texture mapping works well when displayed on higher resolution screens rather than in the helmet. And even the resolution of head-mounted displays should continue to improve. So as we develop new typographies for 3D and Virtual Reality space, we can anticipate improvements in the hardware to accommodate these developments.

7. Spatial Metaphors

It seems unlikely that a house or other conventional architecture will provide the best spatial metaphor. Our point is rather that work needs to be done to discover which spatial metaphors might be most effective. The human sense of being oriented in space is a powerful tool by which we organize information. We sometimes remember a passage in printed books merely on the basis of its position on a particular page. We place books and papers on our desk and bookshelves and rely on a sense of place to find them again. We learn to use a library by becoming acquainted with the arrangement of books and materials on various floors. The two-dimensional desktop metaphor already proves the effectiveness of the spatial arrangement of text in an computer interface. A sense of spatial organization should be even easier to engender in a three-dimensional environment.

Research on the spatialization of text can draw upon a wide variety of disciplines–some closely allied to computer science and others traditionally quite distant. As we argued in the first half of this paper, the history of typography and graphic design offers lessons that may be used in designing a new kind of virtual book. Contemporary graphic design also has much to say about combining text and images in two dimensions. For spatial metaphors, traditional architecture can help. When architects design buildings and built environments, they pay careful attention to the ways in which a human user will move through the space and will understand the structure of the environment as he or she moves. There is a related literature in perceptual psychology, on the subject of way-finding in a neighborhood, city, or any natural or synthetic environment. Finally, as we have mentioned, work on spatial layout and navigation of text can draw on existing work in hypertextual mapping and navigation.

Applications for three-dimensional text would certainly include textual and multimedia databases. The conceptual structure of a large textual database could be mapped out in three dimensions so that the user could remain oriented as he or she conducted a query. The same technique could be applied to databases that include pictures or other media. In three-dimensional space a picture or even a video could be shown on a wall together with text. Spatialization should aid in the visualization of any kind of hypertextual information. In general this technique may be a partial solution to the problem of being "lost in hyperspace." A user is lost, when he or she can no longer relate the current information to the hypertext as a whole. But if the user is surrounded by a spatial version of the hypertextual structure, then visual cues can help to maintain a sense of the whole as the user moves.

Representing text in three dimensions is therefore both a new and a traditional idea. It is new in the sense that such representations are only possible with the advent of powerful personal computers and workstations and three-dimensional graphics. It is traditional in that it draws upon a whole history of verbal-visual communication in printed books and early writing technologies.

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