The Visual Book System: A Study of the Use of Visual Rhetoric in the Design of Electronic Books

Thesis submitted for the degree of Doctor of Philosophy

by

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Abstract

This research started from the observation that the appearance of information contributes to its overall value and that because there is an almost infinite number of possible ways to represent various kinds of information, it is very important to find the one which is going to be the most effective and which conveys as much of the value of the original information.

In philosophical terms this concept could be seen as a particular instance of the Platonic vision of the universe, in his latter period, where the real world, the one we share, is only a pale and imperfect imitation of the world of ideas, the perfect one, to which every intellectual should aspire. Images as representations of ideas can help to access or at least get closer to ideas which otherwise would be too difficult to reach for human beings. Appearance has always played a key role in the learning process, as it facilitates the discovery of new concepts by allowing visual association with already familiar ones. This is why metaphors are so important in learning in general, and have therefore proved to be a valuable tool for designing new paradigms when adapting traditional tasks to changed environments.

This research has focused on paper books as traditional repositories of information and on the art of paper book design as an effective technique for presenting information that has proven its worth over centuries of use. The next step was to consider if and how to apply the positive experiences from paper book publishing to the production of electronic books.

The Visual Book is the result of the translation into electronic terms of the paper book metaphor when applied to scientific publications, with particular emphasis on the visual components of the metaphor. Where possible, the design of the Visual Book has followed the steps of the paper book production process, but it has also employed a technological component to take the new medium into account and has added additional functionalities which the computer can provide to the reader. The evaluation of the Visual Book has shown that the book metaphor has a very high impact on readers, which is particularly due to the firmly established tradition of reading information presented in that form. In this sense the Visual Book experiment has demonstrated both the importance of presentation issues when delivering information, and the value of traditional forms of publishing when defining new ones for an electronic context.

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Chapter 1: Introduction

1.1. The Context

This dissertation describes research into electronic books and publishing which has led to the design and implementation of the Visual Book system. The Visual Book is an innovative interpretation of the electronic book concept which exploits visual rhetoric to facilitate the use of information by the reader. The Visual Book was part of a more general project called *SuperLibrary* (Catenazzi and Argentesi, 1991) located at the European Joint Research Centre at Ispra, (Va), Italy. The prime aim of the SuperLibrary project was to test the validity of translating the library metaphor into an electronic environment. The idea was to demonstrate that there are useful concepts which can be derived from the principles of library organisation and which can be effectively implemented in such an electronic environment. There are currently several prototypes which, in general, place emphasis on the simulation of the library as a space where specific operations are performed following familiar and widely used search and retrieval strategies.

The common proposition behind this set of projects is that paper documentation can be organised on the basis of the translation of the concept of a library into an electronic form. It is proposed that to perform this translation effectively it is necessary to introduce an appropriate formalism which is based on the use of metaphors. Metaphors (Carroll and Mack, 1985; Carroll *et al*, 1988), are rhetorical

tools which are used for introducing and defining new concepts by using similar ones which are already familiar to the public. They have been widely used in the design of human computer interfaces (Gentner and Nielsen, 1996). A representative and familiar example is the desktop metaphor (used in both Macintosh and PC interfaces) where the work area on the screen is graphically represented as a desktop with documents and folders which are ready to be opened and used.

It is clear from this example that very often a metaphor consists of a number of interlinked metaphors and the way they look and work together is a crucial issue in determining their effectiveness. In the case of the library metaphor it is necessary to define firstly the various elements, their appearance, and their role and functionality. The entire library system therefore needs to be studied and subsequently modelled using a suitable representation for translation into electronic form. In a system oriented representation the library can be depicted as a place where two main kinds of agents - an information provider and an information user - can collaborate asynchronously. Each of them has specific roles, knowledge and needs which have to be represented in the model of the library. The physical library space has its own role and the way this is represented can influence the effectiveness of the whole metaphor.

The purpose of using metaphors which are already familiar to the user, such as the reader and the librarian, is to decrease the cognitive overhead associated with many existing information system approaches. Both document presentation and document management become more natural; in this way the computer and the human user can effectively collaborate in the production and retrieval of text. However, because there are multiple interpretations of an electronic book, it is crucial to choose the most suitable for the task to be performed before reducing the concept to metaphorical terms. Different interpretations of the concept of a library result in different views of this conceptual space and their representation in electronic form. Translating such a system, the library, implies the need to focus on its main elements, the agents (such as librarians and readers), the objects (such as the documents), and processes (such as tasks and tools). While each of these elements will be considered as part of this research the central theme is the design and production of electronic documents which will ultimately be distributed and used inside an electronic library. Electronic documents, are currently a popular topic and

the market offers a large choice of products, each of which emphasises different aspects or interpretations of the original document. The purpose of this project is to investigate a particular class of electronic documents - electronic books - and to propose a consistent and meaningful interpretation of the electronic book concept in response to the specific request of a user. Within this context it has been possible to formulate a list of hypotheses and sub-hypotheses that this study will investigate. These are elaborated in section 1.2.

1.2. Hypotheses

The main hypothesis of this research is whether:

> it is feasible and appropriate to identify and replicate the logical structure of a document by starting from the appearance of a paper document (i.e. from its layout structure) and applying a form of visual rhetoric.

This hypothesis can be expanded, in more pragmatic terms, to demonstrate that:

> it is possible to extract from the document's appearance a valid and complete representation of the logical structure of the original book and, on this basis, it is appropriate to produce the related electronic book, thus resulting in a new way to convert information which already exists on paper into electronic form.

This expanded hypothesis, in turn, will be used to explore the utility of managing electronically a special class of documents: those which already exist on paper and which are usually selectively consulted, instead of being read in their entirety. In this context it is important to highlight an essential assumption of this research; that is, that scientific documents are more suitable for electronic translation then novels or other documents which need to be read sequentially and in their entirety. This is why this research has concentrated on the translation and use of scientific papers such as proceedings, series, manuals, and other related material used for reference purposes rather than for comprehensive consumption, and which are of specific use in problem solving.

The translation into electronic form of this kind of document is intended to help readers to access and use information more effectively by providing a powerful environment which supports them in accomplishing their tasks. Therefore building this particular electronic book must take into account users needs, intentions, and the environment around them. One of the guidelines for building electronic books should be that the user must be placed at the centre of the design process. This principle differs from the technology oriented approach which creates electronic objects on the basis of using the available technology without concentrating on its appropriateness for the end user. The electronic book is therefore considered as an object which will ultimately be part of an electronic library, offering a rich environment where readers can search and retrieve the information they need.

At the same time this research is intended to show that the particular approach chosen provides a rational method for organising large amounts of paper documentation in an electronic format which maintains its typographical features and helps users to consult information in a form which is already familiar. This is in fact one of the most innovative issues that this research will attempt to validate: the impact of typography and design on the overall value of a document (where a document is intended to be the sum of the content of the text contained in it and its appearance) and how this can be translated into electronic terms to enhance in a similar way the value of electronic documents.

Within this context the key hypothesis of this research has been broken down into the following list of sub-hypotheses:

h1) The book metaphor is an appropriate and effective model for designing interfaces for an information system;
h2) A book's appearance is a key factor in the specification of interfaces designed to present information which has been published on paper;
h3) Following from the book metaphor it is possible to propose user services which translate reading habits into an electronic form;
h4) Typographical rules are essential components of the cognitive model of a book, and for this reason they are relevant to the translation of the metaphor of the book into electronic form;

h5) A new role has emerged in the electronic publishing process: the designer of electronic books, as the person in charge of the final appearance of the electronic book;

h6) The application of an visual rhetoric to the book image facilitates extraction of its logical structure;

h7) The user has to be placed at the centre of the design process for the production of electronic books;

h8) A computer can provide active support for readers who need to solve specific tasks.

All these sub-hypotheses start from the main hypothesis that information content and information appearance contribute in equal ways to the value of the information. In particular this research has focused on the concept of visual rhetoric, which is described below, as a means of studying the cognitive importance of a book's appearance and its impact on the production of electronic publications.

1.3. Original Contribution - Visual Rhetoric

The original aspect of this thesis is the importance given to the visual components of the physical book when designing electronic books together with the interpretation of an electronic book as part of an electronic library intended as an informative system with specific and innovative features. A new object, the electronic book, has been studied within the context of an electronic library by following an original approach which has highlighted and exploited its relation with the real object it imitates. In particular a new aspect, which has not been exploited to date, is that of visual rhetoric which is important to the design of both paper and electronic books. In general rhetoric is interpreted as the art of composing words and other elements of communication in order to make the resulting message more effective. Because of the study of different communication media in the context of this thesis, it is necessary to define a broader concept of rhetoric which is seen as the most effective way to communicate ideas and concepts by using all the possible tools and sources provided by the different media to their optimum.

In particular image rhetoric is meant here to encapsulate the art of adding value to flat textual information by using graphic, typographical elements. The use of different fonts and typographical styles, as well as the introduction of spacing and pagination rules helps to draw attention to selected parts of the text (Southall, 1992). When readers browse a book for the first time these clues activate cognitive processes, thereby attracting their attention and helping them find useful but unsought information. Visual rhetoric makes it easier to recognise those parts which are of greater interest to the reader.

The definition of visual rhetoric is however tied, at least in the first instance, to the concept of text rhetoric, which is a well established and popular example of rhetoric applied to written information. The idea is to define those parts which are more important for the comprehension of the meaning of the text. In order to achieve this purpose verbal and/or graphical techniques can be used. In fact a document can be interpreted as a visible representation of a text according to its semantic contents (Southall, 1989). Thus visual rhetoric is simply the translation into graphical terms of the text rhetoric which results from both the logical structure of the text and its pragmatic component. It provides the reader with a graphical mark up language which is immediately recognisable on the basis of previous reading activity. Different graphical presentations suggest different readings and affect deeply the interpretation of the contents of the same text. These observations lead one to conclude that visual rhetoric is a crucial aspect for both reading and browsing a document. The method this research will use to support this view is briefly described in the next section; for a more in-depth description see chapter 3.

1.4. Methodology

In order to validate the hypotheses which are listed in section 1.2 and are discussed in relation to the Visual Book design in chapter 4, a number of steps were undertaken and these are described in detail in chapter 3. The first one dealt with the collection of literature relevant to this research, together with the use, test and analysis of existing applications in areas related to this research. This made it possible to extract a description of the environment in which the research has been conducted and of the present state of the art, which are the subject of chapter 2. The

study and definition of the most appropriate methodology in order to achieve the purpose of this research, as defined in chapter 1, is continued in chapter 3. The next step was the analysis and description of the design steps for producing the Visual Book, which are described in chapter 4. Presentation and discussion of issues related to the implementation of the Visual Book, with particular attention to the technological components and its problems can be found in chapter 5, followed by an evaluation of the system in chapter 6. Finally a comparison between the results of the evaluation and system expectations related to the impact of this particular interpretation of the book metaphor (the visual approach) on the world of electronic documents is provided in chapter 7.

The idea has been to study specific features of real books, together with the way people normally interact with them. From this first examination it was possible to extract a brief profile (or model) of a particular type of electronic book called the Visual Book. In order to realise this special interpretation of a book, the design process focused on the analysis and translation of visual aspects of the original book into electronic form. As a next step, a system for electronic book authoring and consulting was designed and implemented in order to provide a valid test for the theory proposed. To complete and validate this experiment there was a secondary phase of use and evaluation of the system by user groups who were selected according to the particular application proposed. The results of these experiments were then interpreted with regard to the hypotheses discussed in section 1.2.

The next chapter provides a general overview of the topics related to this research, such as paper and electronic books, together with a section dedicated to the technological issues involved.

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Chapter 2:
Literature Review

2.1. Introduction

This chapter highlights the main topics which were considered during the development of this thesis and, in particular, describes the context within which this research was conducted. These topics include: the concepts of text, paper and electronic books, and documents in general; the study of cognitive processes, such as reading and browsing a book; the analysis of activities related to the production of books, such as designing and publishing a book; and the description of book repositories, such as libraries and book stores, which are reviewed in both their classical and electronic versions in order to evaluate their roles as part of an electronic publishing environment.

The aim of this analysis is to identify the key agents, entities and processes involved in the traditional publishing system in order to identify their electronic equivalents and the metaphors which can be used to build a digital version of this publishing system. In this regard particular attention has been paid to the analysis and definition of an visual rhetoric which is derived from the appearance of text, a crucial concept which

has been used as the starting point for the definition of the Visual Book. Figure 2.1 represents what, in this research, is the link between paper books and electronic books - the book metaphor - where electronic books are an electronic implementation of the book metaphor which has been extracted from the study of paper books. This is not strictly a direct link, i.e. various instances of electronic books can be derived from the same book metaphor under different interpretations. The advantage of using a metaphor as the basis for the electronic book system is in its flexibility and the possibility of adapting to different users' requirements. The book is considered in this context as an entity, the conceptual book, which is specified in terms of the aspects most representative and relevant to the environment where it has to be used, together with a minimal set of features which have demonstrated their utility through centuries of use. The paper and the electronic versions can then be viewed as different implementations of the conceptual book. In this way they both depend on the level of respective technologies available when each form of book was published. For this reason this literature review starts with an overview of the development of paper books and their associated publishing system. This is followed by a discussion of the features which may be present in various electronic book implementations. Finally, in order to provide a technological background, a series of topics which are more closely related to the practical implementation of the Visual Book are considered. These comprise the state of the art of standards and technologies involved in document image processing and presentation.

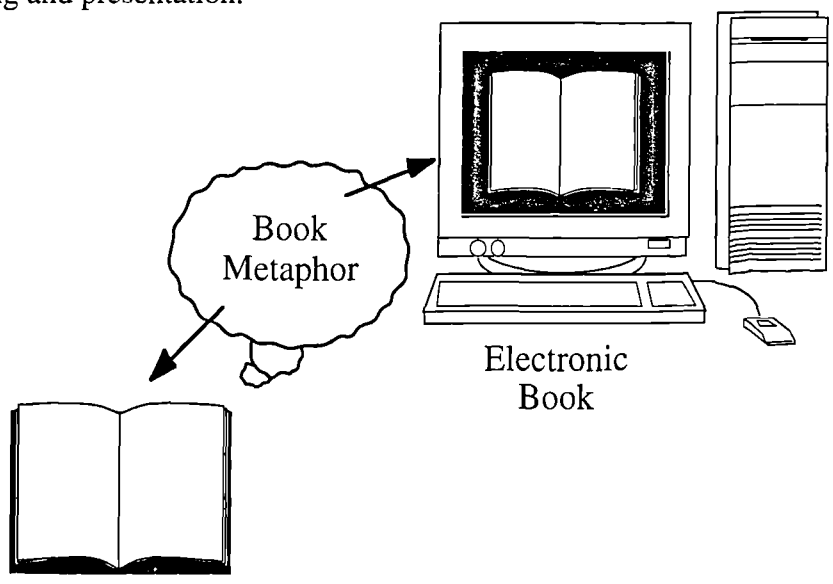


Figure 2.1: *From Paper Book to Electronic Book*

2.2. Paper Books

The purpose of this section is to define a very common object: the book. For this reason the concept of a book in its various interpretations have been examined: its function, its format, and its features have also been assessed. Books have been investigated in terms of:

- their textual characteristics, such as typographical format, logical structure and semantic content;
- their physical characteristics, such as the type of paper, ink, and fabric;
- their status as a product of both historic craftsmanship and a highly specialised modern industry.

Finally their use and contents have been analysed in order to complete this description.

There are two basic dictionary (Collins, 1979) definitions of a book, which describe it in physical and logical terms:

"**book**: a number of pieces of paper, either blank or with words printed on which have been fastened together along one edge and fixed inside a cover of stronger paper or cardboard";

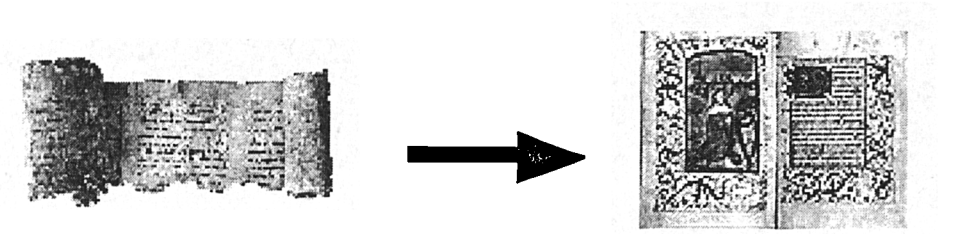
or

book: the story, the ideas, or the information written in a book".

A book may therefore be interpreted as an object which has certain well defined physical and conceptual features. It has a long history and it has gradually evolved to its present form. Its shape, dimensions, internal structure, materials and even its social function have changed over the centuries, resulting in its present form.

The most important event in the history of books, before Gutenberg's discovery of mobile printing characters, was the passage from papyrus scrolls to parchment books (see Figure 2.2), which incorporate the basic requirements for being a book. Papyrus scrolls were designed and produced with the prime purpose of keeping and recording information rather than to be read or consulted. Parchment books, however, consisted of pages organised according to a hierarchy which is much closer to that of the

modern book. Significant attention was paid to the physical writing of the text to ensure that it was accurate, legible and long-lasting. At the same time the presence of an elementary logical structure signified the attention paid by the designer to their use for consultation and reading. The basic elements of modern books were already present in this very first version of a book even if the publishing process, in the sense of making the information available to a wide audience, was absent.



Dead Sea Scrolls,70 A.C.

Book of Hours
Utrecht, 1475-1500

Figure 2.2: *From Papyrus Scroll to Parchment Manuscript*

The next significant development was Gutenberg's discovery of the printing process, an event which initially influenced the production, distribution and use of books more than it did their structure and appearance. Although the Chinese, Koreans and Japanese were already using movable types made in metal to print books long before 1440, because they did not have an alphabet (McLean, 1980) their invention was not as significant for Eastern civilisations as Gutenberg's was for European ones. However the interest of this research is far more in understanding the impact of this discovery on everyday life than in deciding who was responsible for it. The result of this innovation was an object with specific features and design rules, something which was even closer to the modern book. It is not just the quality of books which was affected by this discovery; its use and role in society also changed dramatically. With movable print books could, hypothetically, be economically distributed and read by everyone with very few constraints:

- the user must be able to read;
- the user should normally have an interest in its contents;
- the user should be willing to pay for it.

The production of books implies the existence of social, educational and economical structures and for this reason new professions and activities were created around the

printed book such as the designer, the publisher, and the book seller (Landoni *et al*, 1993; Catenazzi *et al*, 1993). Figure 2.3 shows the main actors involved in the production of books in the context of Gutenberg's discovery. The pyramid structure is intended to show both the primary role of the author and the relative number of actors involved in later stages of the publishing process. These actors form a group of experts in printing which is under the direct control of a designer, who is responsible for the effective translation of the logical structure of the book into the physical one, and an editor who is in charge of checking the semantic content of the book with its author.

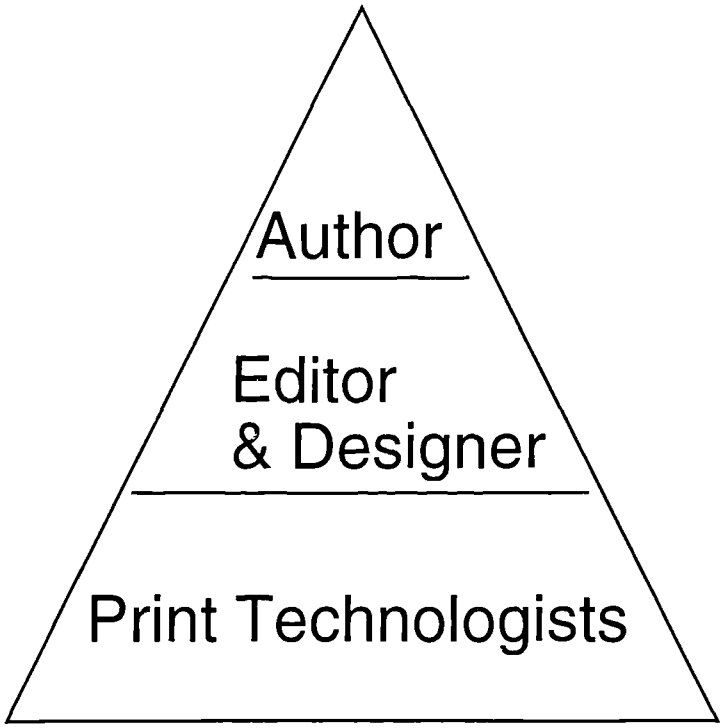


Figure 2.3: *The Classic Book Production Pyramid*

In this model the author has assumed a more important role than in the pre-moving type era because technological developments removed the dependency on scribes. In the era of the manuscript, ownership of a book's contents was defined by who paid for that book rather than by who wrote it. With Gutenberg's discovery came the development of a publishing industry and intellectual property legislation, (i.e. copyright) to protect the rights of the author. Books rapidly attained the same status as their modern day counterpart: an object with deep historical value which is a classical

tool for information delivery and which has both economic and functional importance. A functional view of books is that they are intended to :

- keep information,
- present information,
- distribute information.

The keyword in this definition is the word information and the way to transform text into information is to have a reader interested in its contents. Without readers' interest books are reduced just to common rectangular objects mainly made of paper. Readers' reaction, attention, and interest in the book is part of the book itself; it is what makes the rectangular object become an information system. A familiar principle of literary criticism (Burt, 1959) is that: the first requirement for any book is that it shall interest the reader, shall give some kind of pleasure, which implies a certain degree of value. Readers' interest may result from a need for:

- inspiration: e.g. religion, philosophy, poetry, fine drama, fine fiction;
- information: e.g. biography, history, travel, science, useful arts, sociology;
- recreation: e.g. fiction, drama, humour, essay, light reading in various fields.

If books are not interesting to anybody then they lose their intrinsic value. In effect books gain their value through use.

This section has highlighted the key developments in the transition of books from papyrus scrolls to their modern form. The next section analyses the key features of the paper book.

2.2.1. Paper Book Features

In order to provide a more detailed definition of electronic books it is necessary to analyse briefly paper books, and specify the advantages and disadvantages of this traditional version of books. A list of positive features inherent in paper books can be extracted by every day use and experience. The following are the main features:

- accessible without hardware;
- portable;
- possibility of browsing;
- possibility of annotating and underlining or highlighting;
- design and typographic conventions;
- a well defined method for reproduction;
- high resolution print and graphics;
- ease of reading.

On the other hand it is easy to observe that the paper book has a number of disadvantages (Barker, 1992):

- difficulty of updating the content;
- difficulty of locating information;
- absence of sound, animation and moving pictures;
- cost of dissemination;
- possibility of being easily damaged;
- difficulty of customising information.

It is interesting to note from this brief analysis that paper provides a good way to deliver information but, at the same time, readers may have additional needs which paper books can not satisfy completely. In order to meet these requirements it is useful to evaluate the efficiency of the paper book through at least three different parameters: one is linked to the physical nature of the medium, the second to the nature of the information it conveys, and the third to the effective use of this information.

Paper is a traditional medium for information delivery because of its ease of portability, but the information it contains is static and is limited to one of two basic information types: text and pictures. Readers assimilate this information by either browsing, reading or consulting the book depending on the task they wish to perform.

Table 2.1 contains a summary of the key factors which influence or define the way readers approach books, the way the book presents information to readers, and the relation between author and book (Polillo, 1992). It is evident that the features determined by the paper medium mainly act as restrictions to its use.

Factors:	**Values:**
Linear/Random Access	Both
Dialogue Possible	No
Interruptable Reading Process	Yes
Group/Individual Oriented	Individual
Reader as Author	No
Concentration Required	High

Table 2.1: *Paper Book Features*

For instance a book is essentially passive, as shown in the table by the parameter indicating the possibility of dialogue. Similarly its physical nature dictates that a book can be used effectively by only one reader at a time. On the other hand features related to the structure of books are more flexible and allow readers to access them linearly or randomly and to interrupt the reading process whenever it is convenient for readers. The first step in defining the book metaphor, upon which the Visual Book is going to be based, should therefore be to extract all the positive, desirable features of paper books, and discard all the negative ones.

If computers are to be used as the delivery technology then portability and widespread use present potential problems even when considering tools such as lap-top computers. However, the information can now be dynamic and different information types can be used including video, audio and animation. Finally the computer can assist readers by providing a dynamic and powerful environment which can integrate different types of knowledge, e.g. other applications which can help in solving tasks which the reader of a paper book has to solve separately.

Before starting a conversion process, from paper documents to their electronic counterparts, it is necessary to evaluate a number of parameters which are related to the nature and use of the specific documents being processed. In particular, the way the document can be accessed (mainly the choice being between random or linear), the available types and modalities of interaction (is it possible to have a dialogue between the user and the book and, if so, is it an interruptable one), the relation with the reader and with the author, (is there more than one reader and more than one author) and the

amount of concentration required of the reader, must be understood in order to define an operative model of the book.

Table 2.1 also highlights the involvement of an author in the book production process but there are clearly many more people involved. The next section introduces the main roles of these people in relation to the paper book, in an attempt to define a form of Virtual Publishing system which can not only be used as a basis for the modelling of its electronic counterpart (a task that goes beyond the purpose of this thesis) but also to add elements to the definition of the Virtual Book and its different components. The idea is that knowing more about paper book production can help to achieve a better understanding of the result, the paper book, and so lead to a better definition of a Virtual Book.

2.2.2. Publisher, Editor and Designer

The process that leads to the final version of a book, the one which the reader sees in a book shop, consists of several different steps controlled by experts as introduced in Figure 2.4. The editor, designer and producer collaborate to create the final result, each one having a specific task, which is by necessity interconnected, and which deals with various aspects of the same object. For this reason it is difficult to define their roles as distinct compartmentalised activities.

The publisher processes manuscripts and turns them into finished products. An important function of the publisher is to decide which writers to put into print and what the intended audience should be. From this point of view the editor and publisher perform similar tasks, but the publisher is more involved in the practical aspects of a book, and working on the printed version. The publisher is also more concerned with economical decisions. The essence of publishing is the interplay between the demands and needs of the audience and the judgement of the publisher in interpreting those demands.

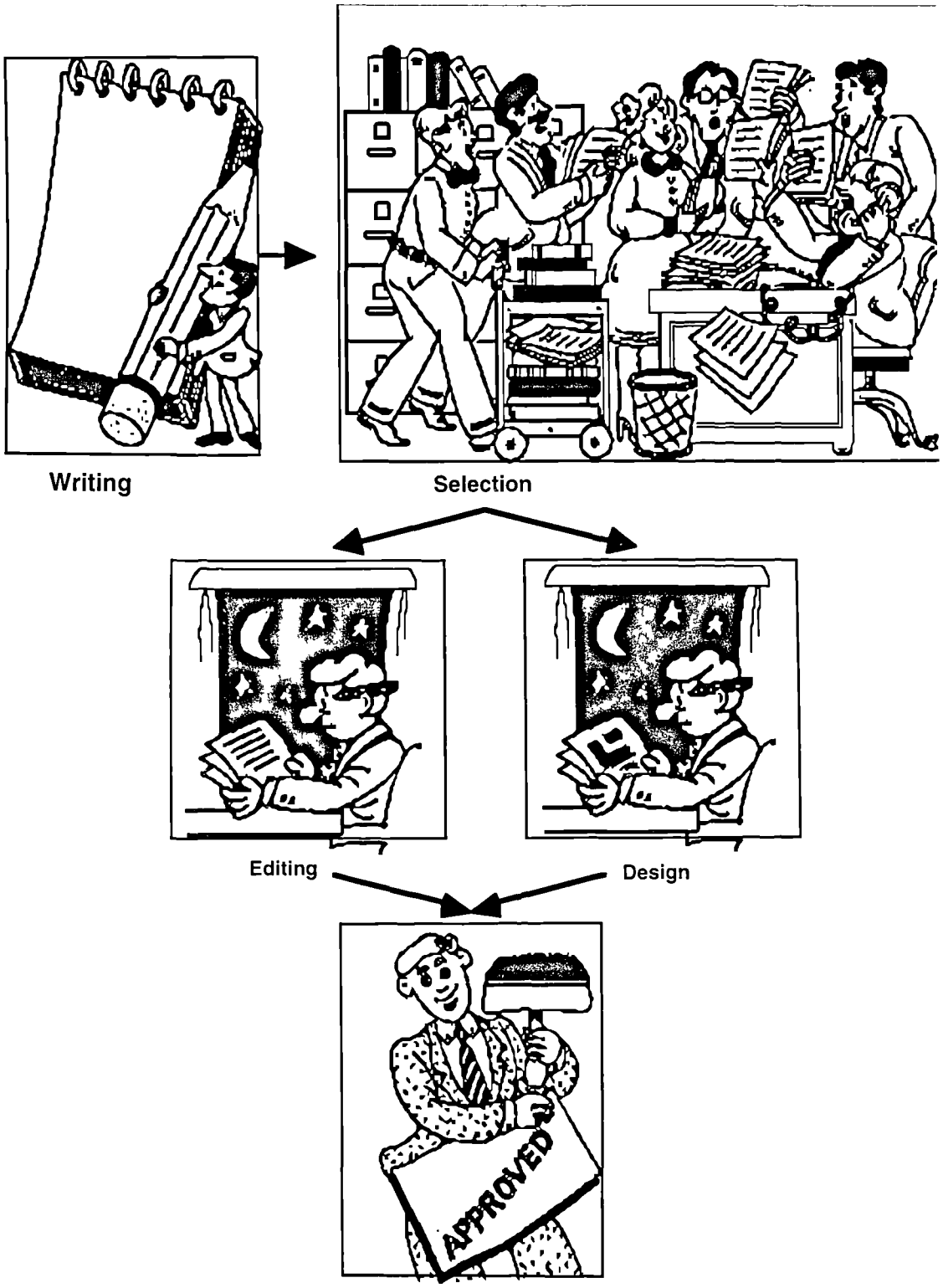


Figure 2.4: *Different Stages of the Publishing Process*

The editor is a person who decides on the final contents of what will be published, who may be responsible for a particular section of a newspaper or magazine, and whose job it is to check articles, stories, novels, etc., and to make changes and corrections before they are published. In multi-media terms editors can also be the people who prepare a film, or a radio or television programme by selecting some of what has been filmed or recorded and putting it into a particular order. The main aspect of this activity is the ability to evaluate and make useful changes to something produced by one or more authors in order to finish with a good result. The editor should have a sound knowledge of the audience and of the subject of the manuscript and take care of the semantic aspects of the publication.

The designer instead attends to the physical aspects of the publication. Design represents the sum of decisions which make a product serviceable and attractive. A designer is a visually literate person, just as an editor is expected by training and inclination to be versed in language and literature. The designer shares the task of defining the form of the final product with the editor, but will be expected to identify certain visual problems associated with presenting text and the means for providing their solution. There are a number of features which designers need to consider in order to achieve their tasks :

- levels of importance in headings and display;
- complexities occurring in the text;
- priority for the treatment of notes, table, figures or artwork;
- and a note of any missing material (Martin, 1989).

The designer aims to help an author in the visual exposition and organisation of material, and by possibly drafting in any special picture research. The book designer should also provide advice on the kind of jacket and external appearance that will best promote the book. The hidden client is the person the author wrote for, and the designer has considerable responsibility for bringing them together. Design also deals with influencing the decision to purchase, based on the degree of visual judgement applied by the reader when evaluating a physical object as something appropriate for its purpose and value for money. In this context the page design can be interpreted as an envelope for the author's message and nothing more.

The roles of the publisher, editor and designer will continue to evolve as the requirements of electronic books and their readers become more fully understood and the technological issues in electronic publishing become less relevant to reaching an

ideal situation where the author and the designer are both prime actors in the publishing process. This situation will also lead to a closer (see Figure 2.5) and more flexible relation between the author and the reader, with readers being able to interact with the author in changing the content of the book and having it tailored to their needs. During this transition the roles and aims of people involved in electronic publishing need to be clearly redefined, keeping in mind the traditional model but also keeping an eye on the technological changes. These new roles will require a different kind of expertise and while in some cases (e.g. publishing on the Internet) some of the tasks involved in the new electronic publishing process will become easier to solve because of the additional functionalities provided by the computer, in some other situations it will be the contrary, e.g. it is far more difficult for a publisher to establish the look and feel of a book or journal electronically than in print. With paper he has page size, font selections, logo, layout and cover within which to work. The problem with video is that the uniform appearance of the standard display tends to give all material equal weight.

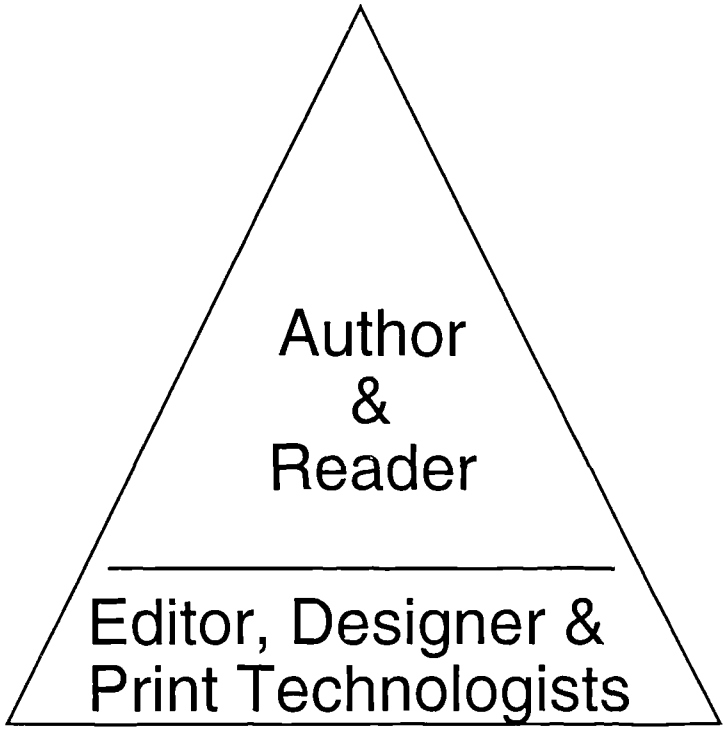


Figure 2.5: *The Electronic Book Production Pyramid*

These brief observations are intended to give an idea of the complexity of the electronic publishing concept and how many problems could be created if there are no

appropriate control mechanisms. Many experts have tried to predict the future of publishing, but have produced very different answers. The commonly accepted theory is that paper documents will survive but that different kinds of book, which cover different areas of interest, will become more and more popular, particularly where the paper book has been shown to be insufficient. So future worlds where paper books are relics of the past seem unsupportable. The aim of this work is to identify situations where an electronic image book could be more useful than the paper one and to identify what should be retained from the paper version and how improvements can be made which both incorporate the important aspects of the book metaphor and also add useful new features. The first step in the book metaphor is to identify the different uses for books. Related to this issue is the distinction between various kinds of reading.

2.2.3. Books and Reading

It is possible to identify at least two different points of view concerning the reading process: those related to printing and associated typographical issues, and psychological ones. Printing can be seen as the mechanism for making books available to people who are interested in them, by making available versions of manuscripts which would otherwise not be accessible for the majority of readers. Typography is the art of presenting written information in a form which is easy to read and most appealing to readers, and contributes to making information contained in books more easily assimilated by readers. Gutenberg's discovery can be seen as a fundamental and radical revolution which has influenced strongly the distribution and use of information. It has made possible the availability of books that were once the preserve of a very closed aristocracy of librarians, whose role was mainly to act as custodians and who did not necessarily read and use them, a scenario (see Figure 2.6) well depicted by Umberto Eco (1980) in "The name of the rose". Today many copies of the same book can be seen, read and used by anybody interested in their contents. Manuscripts had been revered as holy objects because they were the only repository of precious and ancient knowledge and were not accessible to the wider public. Books, on the other hand, are tools to propagate information to as wide an audience as possible. As their importance is based on their contents, in order to be able to extract this information, a main requirement of books is that they should be legible.

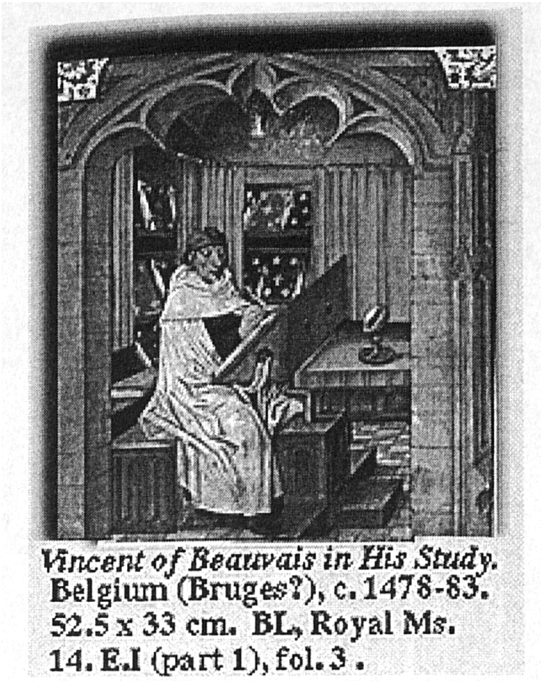


Figure 2.6: *The Pre Gutenberg Scenario*

The printed book represented the beginning of a completely new interpretation of concepts such as knowledge and information. It was also one of the signs of the awakening brought by the Renaissance and its new ideas; the beginning of a new era where the focus shifted significantly from God to man. No longer were mysterious handwritten texts kept in exclusive places far from the common people. Instead new texts were created by exploiting technological developments with the prime intention that they should be used to propagate ideas and knowledge. This was in perfect harmony with the principle of that period where the new man, *homo novus*, or Renaissance man, was seen as a dwarf on the shoulders of giants, i.e. those great authors (e.g. Plato and Aristotle) whose manuscripts were now available as books. Knowledge was now regarded as a tool, something dynamic that could change in time with human needs and discoveries; a highly sophisticated interpretation which was no longer appropriate for medieval blind respect and devotion to the past.

As a result of this revolution the roles of all the people involved in producing books changed completely. In the pre-moving type era *manuscripts* were the most significant component of the publishing process, with no mention either to the *amanuenses* or to the author whose identity was very often confused and uncertain. The concept of a guarantor of text was missing and many errors were introduced and indeed replicated.

In the post-Gutenberg era authors became the central guarantors of text, with a supporting role being played by editors. Together with designers and typographers editors are responsible for making the content of books readable and of interest to the public. They all share the responsibility for transforming the ideas which are initially in the author's mind into information useful for the public. In fact information becomes essentially a kind of common property which is available to entire communities, at least in its final stage. For the moment it is generally agreed that one of the most effective means of transmitting textual information is through the printed word, with books being the most widely experienced form. The physical aspect of books is determined by typographical and design components. Choices are suggested by fashion, tradition, style and taste, as well as by the reaction of people to certain formats and visual presentation. The study of human reactions toward a book and the way reading processes are performed at a psychological level can help the designer and the other people involved in book production to understand the reasons for those trends and choices. Psychologists have studied in depth how human beings are involved in reading processes, and this can help to define presentation rules which are also relevant for the electronic environment. A difficulty in this field is the definition of the different processes connected with reading. People who are used to reading do not make explicit distinctions between different phases of this process. For this reason observations of children learning how to read and of eye movements during reading are the main sources of knowledge in this area (Burt, 1959).

For the purposes of this discussion some very general distinctions will now be introduced. They deal with different classes of readers, based on purpose, and with various kinds of reading techniques. It is possible to recognise at least three main classes of book reader as represented in Figure 2.7 which shows how those groups are interrelated:

- individual consumer;
- professional and business customers;
- people involved in education such as teachers and students.

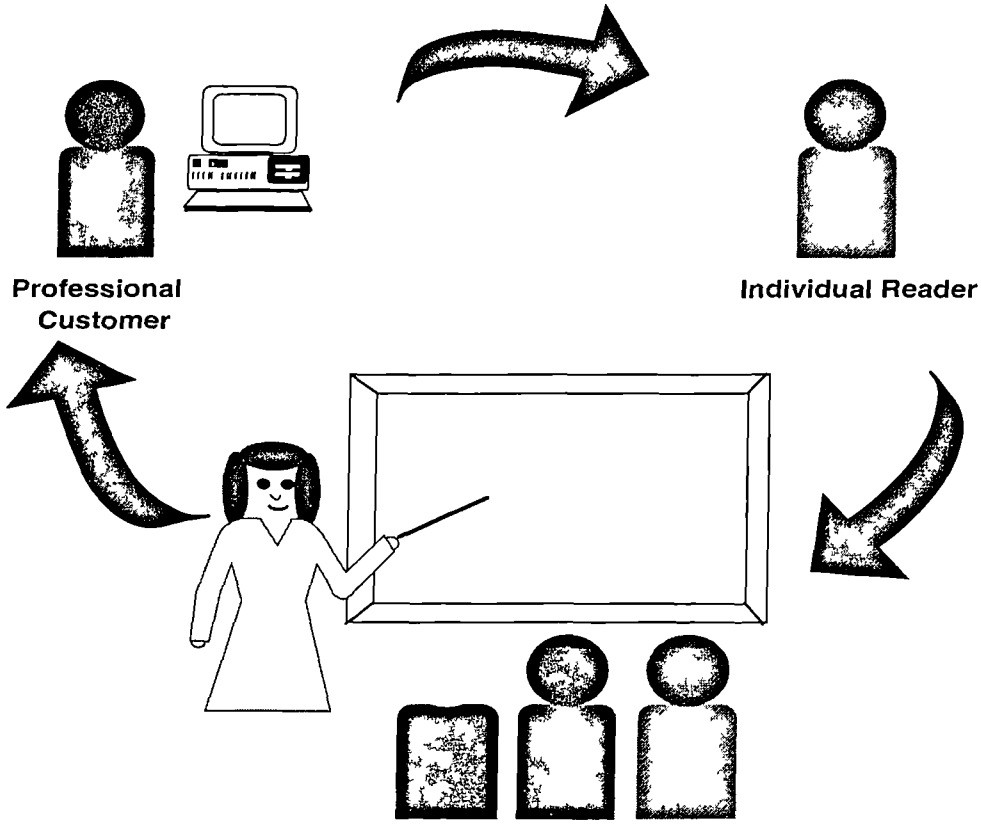


Figure 2.7: *Inter-relationships between Classes of Book Users*

In particular many professional books are consulted rather then read. That is, they are a means of acquiring specific information as desired. All these uses are supportable from a computerised data-base that supplies facts on request to a video screen. Professionals doing research have no great interest in the physical form; it is the information they are seeking. It is also possible to distinguish between different kinds of reading such as:

- reading a reference book as a pointer to an item of information;
- reading a novel, to stimulate the imagination and give pleasure;
- reading a newspaper, to scan a large amount of information, and to keep up to date;
- detailed reading of a text, to acquire knowledge.

The printed book is too convenient, low-cost, portable and familiar to yield to any current electronic surrogate. This is still true even if a new family of products, which can be labelled as portable electronic books, is becoming more and more popular, e.g. DynaText[1]. They do not pretend to substitute for the conventional book, being very particular interpretations of the book concept and dealing mainly with a specific application area such as reference books. Some functions of books such as bibliographies, look-up or tutoring are better handled by computer access, by audio-visual display or by a combination of printed and electronic means. These considerations suggest that in the very near future conventional publishing will increasingly be only one way to make information available for any particular need. At the same time because books are so firmly embedded in most modern cultures and hence have a strong cognitive value they will remain a highly familiar object, and not become merely a relic of the past. Many types of material will still require the detailed reading that is only possible with printed pages, especially for individual consumers.

As the landscape of communication changes, so will the role of books and the perception people have of them. Therefore it is very important in order to be able to publish the books of the future to study and understand the value of books as one of the best tools for information delivery. The first step in this analysis is the consideration of relationships between the appearance of text and its legibility, i.e. how typography can help readers.

2.2.4. Typography and Reading

Psychology and a study of typography can both help researchers to understand how reading processes are performed by human beings. This section focuses on reading from paper, while a discussion on differences between reading from paper and screens can be found in section 2.3.3. The type on pages can be perceived as a shape that is tracked according to a visual pattern which is independent of its semantic content. That is to say readers are trapped in a mechanical reading loop, following the lines automatically but assimilating little or no meaning. This state can be created by poor authoring, or most commonly, through bad typography. The difference between

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good and bad typography can be measured in terms of such vital factors as the comparative time taken to read a book, the degree of pleasure and profit derived, and consideration of care for the eyes.

Reading is a technique dependent on the context, the kind of text, readers' attitudes and readers' needs with regard to a particular text. Typography has a major and essential role in determining the percentage of an author's message that is successfully conveyed. Some aspects of the reading technique are well known. For example the fact that eyes travel above the line has implications for letter design which may be summarised by stating that the recognition characteristics of a typeface are concentrated in the upper part of letters. It is also held (Rubinstein, 1988) that the vertical field of vision expands with the horizontal one to an extent that certain peripheral information about the structure of the reading passage is acquired from two or more lines at the same time. Eye movements focus attention on the importance of interlinear white space for continuous reading. A fluent reading rhythm of two and a bit spans, where a span is defined as the linear amount of text covered with a single glance, is found to be normal (McGarry, 1991).

Typically the main steps in reading are:

- scanning of the page from left to right;
- fixing of a point to permit the eye to focus;
- selecting a process that lets the reader recognise words from their graphical appearance;
- forming a perceptual image based on those cues plus expectation;
- matching between visual cues and ideas or concepts already existing in the reader's mind;
- guessing on the basis of this match, the result being stored in short-term memory;
- if no guess is possible reading some more text in order to collect more cues;
- if the choice is still impossible then going back to find an easy to recognise point and starting the reading process from there.

In essence, reading is an activity in which readers consider ideas and relate them to their own experiences, matching text cues based on their graphical features (McGarry, 1991). All these facts can help book designers to establish the best features for

assisting and facilitating reading processes. Such typographical elements also influence reading processes and these are discussed in more depth in the next session.

2.2.5. Typographic and Physical Aspects of the Book

Physical aspects of books, which also represent the component parts of its format, are: size, type, paper, illustrations, and binding. The format of a book, more closely defined as shape and size, is the term commonly applied to the general appearance of a book. Format differs widely from book to book, although there may be house styles which may help to induce an element of familiarity and hence facilitate the assimilation of information.

Size may be said to be two dimensional as its most important elements are width and height. A book is well proportioned when its width is in an appropriate relationship to its height. Many books follow the Golden Section ratio (21:34 or 1:1.6 width to height). At the same time any book that has to be read with comfort should be small enough to hold conveniently and large enough to permit a size of type that is easily read. That means that, for convenience of handling, from 450 to 650 pages (depending on the kind of paper) should be the maximum thickness of the usual twelvemo or small octavo volume. The common book-trade terms used to describe the various book sizes (folio, quarto, octavo, twelvemo, sixteenmo) indicate, for each, a height in inches that establishes the standard dimensions appropriate to that size. These terms were originally derived from the folding of the printed sheets prior to binding in a volume:

- Folio is the result of one folding and it is composed of two leaves each sixteen inches wide and twenty-five inches high;
- Folding twice, four leaves are formed, making a quarto;
- Folding three times gives eight leaves and makes an octavo; Another method of triple folding made twelve leaves (twenty-four pages) and makes a twelvemo;
- Folded four times to make sixteen leaves (thirty-two pages) is a sixteenmo; and so on, through eighteenmo, twenty-fourmo, thirty-twomo, forty-eightmo, and sixty-fourmo.

More exact designation is made possible by the use of the metric system, commonly followed in library cataloguing, by which the actual height of the book is recorded in centimetres.

2.2.5.1. Typefaces

Typeface is a technical term used to indicate the size or style of printing that is employed in a book, newspaper, etc. Type must first of all be legible. Eye movements focus attention on the importance of interlinear white space for continuous reading. The reading act, from the ophthalmic point of view, is in fact made of two distinct steps separated by a micro second, the first demarking, and the second absorbing material (Rubinstein, 1988).

Reading is always affected by the spacing and the leading of the page. The spacing between words should be even, unobtrusive, and sufficient to give a sense of freedom to the eye. The leading, i.e. the interline spacing between lines, should not be so great that the white spaces seem to dominate the stream of print, nor so reduced that the page seems a solid mass of print, with the words so closely crowded together in every line and the lines following one another in such close proximity, that the eye soon experiences a sense of confusion and discomfort. A fluent reading rhythm of two and a bit spans is found to be consonant with an ideal average line length of 10 to 12 words; in unusual formats as few as 7 or as many as 15 justified words a line may be averaged on the single column page, but the designer must have a clear justification for doing so as it may have an adverse effect on the reader.

The type measure, or length of the printed line, should not be more than four and a half inches for an octavo page. Laboratory experiments (Rubinstein, 1988) have shown that a longer line in the type sizes ordinarily used in books slows down the process of reading and increases the fatigue of the eye, and many authorities recommend that the maximum width of line should not exceed four inches. The most common measurement system is the point system. It was invented by P. S. Fournier in 1737 and the revision adopted in America in 1871, in which the typographic point was set at 0.013833 inches. The 12 pt multiple (or approximately 72 to an inch) is called pica and is 6 to the inch. The 12 pts calibrations can be used for specifying

column widths. A common measure in standard paperback format, for instance, is about 20 picas.

The basic principles (Martin, 1989) for selecting typefaces is to use one type for one book and make sure that the general result corresponds to the internal logic of the manuscript, as a series of decisions which articulate degrees of structural emphasis or importance through size of the type and its spacing and arrangement. Close attention to the manuscript will show where a more adventurous approach is needed in order to bring out the functional relation of its parts, or where qualities in the writing or illustration call for more sophisticated typographic treatment. Also important are illustrations, unusual typographic requirements and page size.

Design of a book is basically a matter of setting out and signposting the reader's path through a document; that is, the visual editing of a text. Some very common typographical mistakes, which make reading more difficult, are:

- the use of empty lines to emphasise a particular part,
- the use of underlined terms,
- and the abuse of highlighting techniques.

Working with different levels of headings can also be problematic, the use of over-emphatic headings can upset the reader's concentration and make it difficult to follow the structure of the book. A step of two points, e.g. from 10 pt text to 12 pt text, could be the natural choice (Martin, 1989) to identify a new set of headings or to save space with expensive notes or extracts. An appreciable contrast in size or style becomes possible and often desirable when it comes to the articulation of the major sections into which a book is divided: e.g. the chapter headings.

2.2.5.2. Layout

Page makeup, also called pagination, is concerned with laying out the parts of a large document into pages. There are many rules in this context (Rubinstein, 1988; Martin, 1989):

- The depth of the page must match when the document is printed on two sides; the vertical extent of the page must also match on the left and right page.
- Widows and orphans must be avoided. A widow is an isolated line set at the top of a new page, the last line of a paragraph from the previous page. An orphan can be the first line of a new paragraph at the bottom of a page, or a title or header line associated with the next paragraph.
- It is also bad form to hyphenate a word across a page break. Forcing the reader to look ahead to the facing page or to turn a page interrupts the flow of reading.

Therefore text cannot be divided blindly into pages. It must be adjusted to prevent unacceptable situations. Since facing pages must match, it is necessary to look ahead. Paragraph breaking and pagination can be combined to improve the layout of the entire document. Line breaking is harder then page breaking because the format of a document normally prescribes a specific line length. Page and type produce the printed page but the page has its own requirements in terms of arrangement, design, and symmetry. In particular much of its aesthetic acceptability depends upon the proportions of the margins.

Margins occupy up to 40% of the page (Martin, 1989). The original objective of margin design was the utility and aesthetic effect of the facing pair of pages when the bound book lay open. Well proven mathematical and geometrical systems of proportions were used to relate text area to the page shape. Many of the books produced according to this philosophy are still very elegant and harmonious but as they require non conventional processes, economics will often dictate that they cannot be used.

Margins are useful for many reasons: i.e. to permit the reader to flip the pages of a book, to let the typography refine the dimension of the page itself without cutting out important information, to save the written part from damage, and to enable a reader to write annotations anywhere on the page without obscuring the main text. Margins are important elements in page design, as they allow the two open pages to be presented as two columns of black, separated by the white column of the inner margin and framed in white at the top, bottom, and sides by the remaining margins. These margins are of varying proportions. Traditionally, the inner margin is the narrowest; it should be about half the width of the outer (so that in the double page its width

appears equal). The top margin is next in narrowness, being visually about half as wide as the bottom. The outer side margin is less in width than the bottom one and more in width than the top one. The grid system (Martin, 1989; Rubinstein, 1988), commonly used to set the dimensions and position of margins on a page, is based on dividing the page into different kinds of grid see Figure 2.8. The grid is used to define the layout of both textual and pictorial elements. It also has to foresee all possible pagination problems during the whole book preparation.

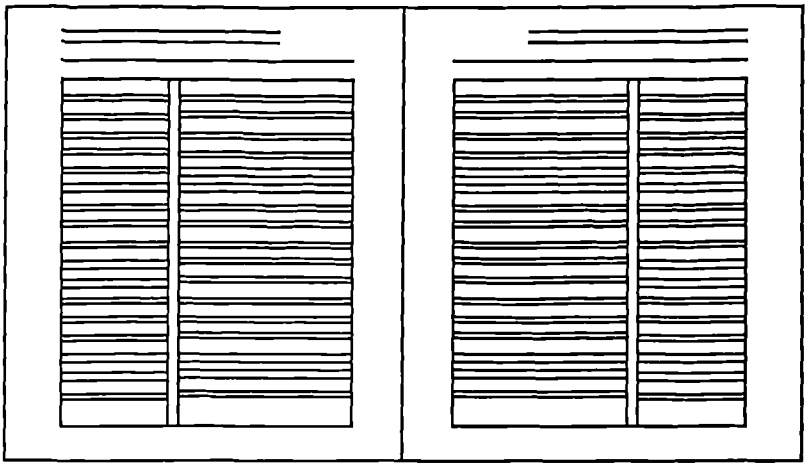

Figure 2.8: *Example of a Grid for a Book with Running Headings and two Columns*

In page design there are many other details of importance. A book may have a running head (or headline) at the top of each page, or it may have none. If there is a running head, it may be the same on each page, or it may give the title of the book on the left-hand page and the title of the chapter on the right-hand page. Instead of the chapter-title it may give on the right-hand page some phrase descriptive of the immediate content of the text. The page numbers may be placed at the top of the page or at the bottom, in the centre or at one side. There may also be side notes, marginal or indented. Finally, dates may also be indicated as a part of the running head. In general different elements in a book have their own particular characteristics. A brief description of their usual role in book design and structure definition is given in the following sections.

2.2.6. Book Elements

The textual features of a book, which can be interpreted as accessories to the main body of the text, include the title-page, copyright page, dedication, preface, table of contents, list of illustrations, introduction and following the text, appendices, bibliographies and index (usually arranged in the order indicated). In many books only some of these features may appear, in others there may be additional ones, depending on the book's subject or character. Current texts indicate that there is no standard definition for the components of a book (McLean, 1980; Tschichold, 1991). Their presence, location, content and style depend on the author's and the designer's decisions. However publications usually follow the scheme shown below (Rubinstein, 1989; Martin, 1988).

The preliminary pages

The preliminary pages are not standardised and may consist of white space, a publisher logo or a dedication. Their main function is generally to provide physical protection for the rest of the book. As the reader may wish to proceed to the meat of the book there is a tendency to skip these preliminaries and the designer has to try to capture the reader's attention by employing different kinds of presentation.

The half title

The half title precedes and protects the true title page and also serves to identify the book in as simple a way as possible. It may contain the short book title or, in the case of a series, the title and series editor; continental practice would add or substitute the publisher's logo. A well-designed book could present a visual horizontal line from this first page through to the last at certain clearly defined levels, corresponding to the head and foot margins, and the chapter drop.

A common mistake is to set the half title too large and reduce the effectiveness of the title page which follows; another is to abolish the half-title, and this has to be resisted (Martin, 1989), no matter how severe the pressure on space or other reason. A different use has been found for this page in the case of the mass market, (e.g. unsown paperback), where it now customarily carries the blurb in the absence of a front flap.

The title

The title page should suggest to readers the subject matter of the book. The title page is the front door to the book. By its design and typography it should be in very broad harmony with the nature of the volume. The frontispiece and title page form a double page spread also called an opening. If the book is to be structured in terms of openings, i.e. a pair of facing pages, as units of design, then the process should start here. The frontispiece was often printed with a separate process and this survives as a style of a number of literary houses. Lines of print that appear there are units of information presented visually, and as such are no longer strictly subject to the grammatical rules of sentence structure and punctuation. The content of the title page has evolved naturally to a formula of author, title and publisher. These are elements in a message that contain all that the reader needs to know and can be expected to take in at a glance.

In practice, the designer needs to establish an order of importance for each element and to assign it a value: i.e. to emphasise the ranking of a writer (rather than the title of the book) because the market is more interested in the author, or the importance of a sub-title in relation to its title, before thinking about possible sizes and styles of type, and the grouping and arrangements of these elements on the page. These elements will be reassembled into a complete message by the reader, with the help of the order of emphasis which has been superimposed. What broadly takes place is not continuous linear reading from the head to the foot of the page so much as absorbing a total field in one span if it is a simple one, or otherwise in successive iterations according to visually delineated levels of importance (Rubinstein, 1988). It does not really matter whether the author's name appears below the title or above it since relative emphasis is more effectively controlled through size and spacing than by literal order of appearance. From this it follows that such details as the use of the word "by" preceding the author's name, as well as punctuation at the end of lines in title page display, are not only redundant but serve to draw attention to themselves. Display is a higher form of punctuation, and requires the consistent and sensitive reduction or elimination of conventional punctuation.

Successful title page design hangs on the treatment of the main title, and any sub-title or subsidiary wording that stands in relation to it. The designer will look at all the possible line divisions of the titling to resolve the twin aims of stressing the sense and the rhythms of the wording as well as creating an acceptable shape to the page. The same process has to be repeated for the book jacket, and the less disparity there is in

approach between the two solutions the better. The isolation of author and title at the head of the page from the publisher imprint at the foot has been a convention but various European publishers have recently used alternative solutions for series and for individual titles.

The imprint or biblio page

The material which appears on the verso of the title page has proliferated in recent years but in a more standard form. The publisher's name appears on the title-page, usually with the year of publication. The year of copyright appears on the back (verso) of the title-page. There may be more than one copyright date where first publication has been in a serial publication or where the current publisher has obtained an agreement to reprint the work under a new imprint. The printer's imprint (not the publisher's) is also usually found on the verso of the title-page with the indication of the country of production.

Preface/Introduction

When a book contains both a preface and an introduction, the former is usually a brief statement of the author's purpose and the authorities on which the book is based, while the latter frequently takes on the character of a preliminary chapter, summarising the book's theme and scope. If there is only an introduction, it should give the information otherwise looked for in the preface, but it may also include much more and run beyond the ordinary preface length. Introductions written by someone other than the author are usually designed to convey appreciation and enlist public attention.

Table of Contents

For reference works and other books of information the table of contents should outline the organisation of the book, using hierarchy levels, and demonstrate the material it deals with. A table of contents that simply registers successively numbered chapters is of little use to the reader.

Text

This is the body of the book. Its design has to be consistent with the other book components.

Appendices, notes, bibliographies

These represent the material that reinforces a book's informational content. The reason why they are relegated to the last pages is that they are not necessarily part of every publication and there are different rules for their design according to the kind of publication they belong to. In particular, appendices and bibliographies are of extreme importance in scientific books and in scholarly books where their layout has to be carefully designed in order to meet existing convention and avoid confusion in the reader.

Indexes

An index should be the indispensable key to every non-fiction book. Its presence or absence will often tip the scales in deciding between two volumes of otherwise fairly matched excellence.

2.2.7. Book Rhetoric

Rhetoric, in its original sense, is speech or writing that is presented in a forceful and dramatic way in order to appear to be rigorous and important. It is a grand, poetic way of speaking which once used to be practised as an art. In the context of this dissertation rhetoric means a particular care in presenting information, so that its message can be more effective. Books are examples of the application of writing rhetoric as well as of visual rhetoric (see section 1.3) because of their physical nature and traditional presentation styles. Thus the term book rhetoric here stands for a combination of both visual rhetoric and writing rhetoric (textual rhetoric). This research has focused on the importance and use of visual rhetoric when presenting information on a screen and in particular on the influence of visual rhetoric in the presentation and use of electronic books. The study started from the comparison of the effect of visual rhetoric on the paper book and its impact on the presentation of the same book when it was translated into electronic form. A further step was to consider whether visual rhetoric could also have an impact in the design and presentation of electronic publications which had no paper counterparts.

2.2.8. Summary

In this part of the literature review different aspects of paper books have been evaluated. It has been shown how important the visual component of a book is in both choosing and reading a publication. A brief description of the book and its components has shown that the role of each component should be analysed in detail in order to establish its function for presenting information.

From this overview of paper books it is clear that book covers provide various aesthetic, protective and informative functions while the pages within a book are mainly informative. Usually, the pages of information embed both textual matter and pictorial material. The manner of presenting it is relevant to communicating knowledge to readers. A consistent and logical design is not only an aesthetic attribute but is also essential in order to offer information in a readable and comfortable way. The ability to capture the attention of readers and to make information pleasant to consult is derived from the joint efforts of authors and designers.

Shape, format, typographical styles, and layout rules all contribute to marking clearly the underlying logical structure of books and helping as cues to the user in the reading process. An understanding of the processes which connect visual information aspects with the reading activity is the basis for visual electronic book design. In this section paper books, their history, production, appearance, distribution, use and structure have been investigated with particular attention being paid to the role of readers as, with their expectations and reactions to published material, they can greatly influence the publishing process. As a result of this analysis the main features of paper books have been highlighted and they are now ready to be compared, where possible, with their electronic counterparts. The fact that the internal structure of books plays an important role in attracting readers, and making reading processes more or less pleasant, influences the whole publishing system. This will be considered in detail as part of the discussion on the development and design of electronic books in the sections below.

2.3. Electronic Books

The result of integrating classical book structure, or rather the familiar concept of a book, with features which can be provided within an electronic environment, is referred to as an electronic book, which is intended as an interactive document which can be composed and read on a computer. From the conceptual side, it is an attempt to overcome the limitations of paper books by adding a series of useful features which are made possible through the nature of an electronic environment. The main features of electronic books are that they are dynamic, reactive and can be made available in different formats and/or editions in a short time. For this reason the translation from paper to electronic environment is not appropriate for every type of publication and for every type of reader; the process of reading and the tasks readers are attempting to complete have a central role in judging the suitability of this translation. In any case the cognitive overhead which results from the special environment chosen (i.e. the computer) represents a valid reason for carefully considering the appropriateness and the method of realising this conversion. The fact that technology is able to represent documents on the screen is not a sufficient reason for translating every piece of paper into electronic format. It is important to consider the subject matter and usage of the specific paper book in order to decide whether an electronic version will be useful or not. Observations of the behaviour of the market for paper and electronic publications show that currently only a very small percentage of paper publications (up to a maximum of 10% for extremely successful productions, such as Encyclopaedia and Dictionaries) are sold in electronic format, and that in any event users prefer to keep a paper version in addition to the electronic one (Saur, 1996).

For this purpose it is important to define different kinds of use corresponding to different types of document. These range from ancient manuscripts to modern examples of hyperliterature such as Afternoon by M. Joyce[2] and Manhole[3], a HyperCard stack, which tells a children's tale through pictures and invisible links. From the technological point of view electronic books need powerful processors, large amounts of storage and the capability of managing combinations of different

2 Available at http://www.duke.edu/~mshumate/mjoyce.html

3 See http://sirrus.broder.com/affiliates/manho.html

types of data. It is the same kind of difference observable between a classic typewriter and a normal word processor, these work with a static and a dynamic version of a document, respectively.

2.3.1. Electronic Book Features

The choice of an electronic environment in order to overcome the limitations of paper books results in new conceptual and cognitive problems. An important and quite general principle in electronic book design is to determine which paper book features are most useful and familiar to the reader and to reproduce them in an electronic environment. Particular attention has to be paid to the functionalities an electronic book could obtain from the electronic environment and the choice of those which are most useful and consistent with the specification of the concept of a book. In particular a set of functionalities which are already available with the paper version, and widely used by conventional readers, are of particular interest:

- to insert bookmarks;
- to add notes in the margins or elsewhere in the text;
- to highlight interesting parts;
- to recognise a particular and frequently used chapter by opening the book easily at the correct page;
- to find signs of intensive consultation of a page, such as changes in colour or spots;
- to know at any time the exact ratio between pages already read and those unread;
- to be sure about the position where the reader last read, and to control the reading progress;
- to browse, looking for interesting sections.

It is possible to identify in this list one group of personalising functionalities (i.e. the first four functionalities) and a second one of orienteering functionalities (i.e. the last four).

Factors:	**Values:**
Linear/Random Access	Both
Dialogue Possible	Yes
Interruptable Reading Process	Yes
Group/Individual Oriented	Group/Individual
Reader as Author	Single/Many
Concentration Required	High

Table 2.2: *Electronic Book Features*

Table 2.2 contains the results of the analysis of general features for electronic books using the same approach as in section 2.2.1 (see Table 2.1). The features are the same as the ones considered for the paper book, and they have been chosen to be as simple as possible in order to be independent of the particular implementation of electronic book considered. As expected, features directly related to the nature of the media used have different values in the paper and the electronic contexts. Of importance to the Visual Book design is the fact that the features which are more dependent on the original book metaphor are the same for both versions. Another important consideration is that concerning the author's role which, in the electronic version, is a role readers can adopt themselves in a very active and creative environment. Of course, it is necessary to highlight that any discussion of electronic books has to be very general because of the great variety of electronic books and their different features.

Starting from these basic requirements various different approaches for defining and designing electronic books can be identified. In particular it is possible to distinguish a first approach which offers the reader an object as similar as possible to the paper book, replacing its essential physical features with visual ones, such as size and quality (Barker, 1992; Benest, 1987). Another approach to studying electronic books consists of emphasising their main function of delivering information rather than evaluating interface issues. The idea behind this is to concentrate on the role rather than the method of delivery. The result should be something that "... embraces the screen metaphor where information scrolls off the bottom like a modern word processor" (Wood, 1992). A third approach, which stresses portability as the main feature of paper books, is the one chosen in producing solutions called portable

electronic books, supported by a particular class of machines such as lap-top computers (Feldman, 1990; Lande, 1991). Electronic books can also be divided into categories defined by the kind of different sources of information which contribute to the final book (i.e. textual electronic books vs. multimedia/hypermedia electronic books), or also by the purpose for which the electronic book is created as shown in Table 2.3.

Purpose:	**Example:**
Education	Electronic books produced by Barker's laboratory Benest's Book Emulator
Amusement	Expanded Books (Voyager ©)
Supporting working tasks	CORE Mercury
Consultation	Encyclopaedia of Corrosion Grolier Encyclopaedia
Technological exercise	HyperTextBooks
Quick delivery of critical information	Internet Books at Library of Congress

Table 2.3: *Electronic Book Examples and their Purposes*

2.3.2. The Metaphor of the Paper Book Applied to the Electronic Book

The metaphor is a rhetorical tool which provides a valid means for expressing difficult concepts by referring to simpler objects which have the same qualities. Introducing metaphors to computer system design and teaching presents opportunities to play an important role in augmenting people's familiarity with the computer world. For this reason it is important to investigate more deeply the role and meaning a metaphor could assume in a specific field such as computer systems. Different experiences and choices can be found in this area from which it is possible to extract some guidelines for using metaphor while avoiding the risk of confusing the user with poor or inappropriate choices.

Two main aspects of the metaphor are its scope and its level of description. The first attribute defines how broad should be the range of objects belonging to the system reproduced by a metaphorical substitute. The second dimension suggests the existence of different levels of description when working with metaphors. For example it is possible to distinguish between: activity metaphors, mode of interaction metaphors, and task domain metaphors. The first type supports users in expressing their intentions at a high level, the second suggests a model for user-computer communication, while the third helps users to understand the task being supported by the system.

One of the possible approaches for designing an electronic book is to follow the traditional book metaphor. This is intended to be an activity, mode of interaction, and task domain metaphor. Books are well known repositories for information. Their structure has historical and functional value and this structure invokes a way to read and consult them that is familiar to readers. By maintaining the same model on screen, people's access to electronic information can be facilitated. Readers can be presented with an electronic representation of books which can be browsed and used in a similar way to the original paper version.

This particular approach helps to overcome some of the limitations inherent in an electronic environment, such as the loss of the physical aspects of the book, e.g. its thickness, which can be used as orientation clues. Evaluations of the use of the book metaphor have proven that it represents a suitable basis for building good interfaces for a variety of electronic books (Barker *et al,* 1994). Nevertheless, there is another set of problems which are related to technological shortcomings, mainly the limited screen size and resolution, that makes reading an electronic book less pleasant than a paper book. The next section will discuss the results of experiments into the legibility of screen-based textual information. These results have played an important role in the design and implementation of the Visual Book.

2.3.3. Book Legibility

One of main problems encountered in designing an electronic book is concerned with its legibility (McDonald, 1994). Readers are used to reading from paper with

well-defined features, such as page and character dimensions, the ratio between words and spaces, the contrast between characters and the white page, and many other typographical elements (Burt, 1959). Typography and good legibility are strongly related and it is held that "Comfortable legibility is an absolute benchmark for all typography" (Tschichold, 1991).

The transition from paper books to electronic books presents a set of problems which are specifically related to typographical features. In particular the attempt to maintain the same ratio between written text and white space requires the use of large screens (21 inches or more). The need to reproduce exactly the same character appearance requires a flexible text processing environment which can support the construction and use of new sets of symbols. Finally, screen resolution remains a heavy limitation which only technology can overcome.

Many experiments have been conducted in order to establish the effective difference between reading from paper instead of reading from screen, even if it has not always been possible to identify which screen features were responsible for the difference. A possible reason is that different variables can interact to create this situation and, as there are so many parameters which contribute to the reading process, it is difficult to distinguish between them and to repeat the experiment with the same parameters. Technology, also, is important in determining display features and it can modify meaningfully the results of this type of experiment (Black and Boag, 1992).

Particularly relevant is a well structured set of experiments conducted by a group of researchers working at the IBM Research Centre in New York (Gould *et al*, 1987a; Gould *et al*, 1987b). They produced two different experiments: one aimed at recognising single variables involved in the process of reading from the screen, and the other at demonstrating that a CRT display can have almost the same performance as paper if the image shown is as similar as possible to its paper counterpart. While the first attempt failed, as mentioned above, to distinguish the contribution of individual parameters to making reading from a CRT display slower than from paper, the results are still very useful for defining a meaningful list of these parameters and in finding, as a side effect, that while it is a multiplicity of aspects that makes the difference in these two readings a predominant role is the one played by the image aspect. The closer this is to the paper version the faster is the reading process. So a

possible solution for electronic text presentation is to imitate the same style as the paper presentation.

2.3.4. Book Creation

The development of an electronic book passes through a number of key phases, as shown in Figure 2.9.

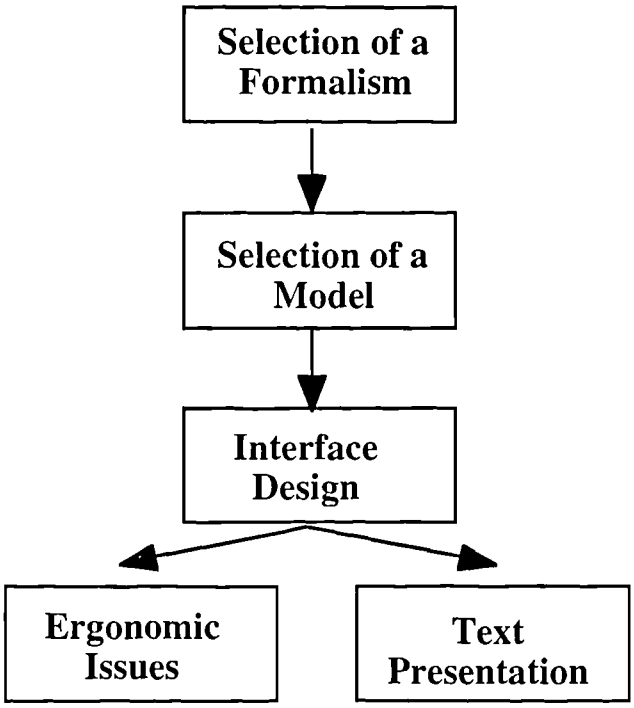

Figure 2.9: *Steps in the Creation of an Electronic Book*

The first step is to select a formalism, (e.g. a logic or a grammar) and then, on this basis, to construct a conceptual model which defines the structure. The formalism used to develop the Visual Book is described in section 4.3. Probably the most flexible conceptual model is that developed by Barker (Barker *et al*, 1994). This model views a book as consisting of three main parts:

- a front cover that signifies the start of the book;
- a back cover, where the book ends;
- a collection of electronic pages of information.

Other conceptual models also exist (e.g. Catenazzi, 1994) but these are restricted to specific applications and cannot easily be used in more general contexts. Having defined a conceptual model the developer can address the practical issues involved in creating an electronic book.

In this context, terms related to the paper version of the book are used in their metaphorical meaning. Their translation to electronic form is relatively easy to do and can be mainly reduced to a user interface solution. For this reason, in electronic book creation, interface design plays a central role. Also it is very important to identify the future readers of the book and how they will use the information in it. Only this analysis can lead to the right presentation style and the definition of the appropriate electronic book functionalities.

It is possible to identify the need for different expertise at various stages of the creation of an electronic book thus establishing a parallel with those used in the paper book creation process. Sometimes, as a result of the use of an electronic medium, additional expertise is also required. For instance the electronic publisher has to judge if an existing paper book or a brand new manuscript is suitable for electronic translation. This complicates the process of deciding whether a manuscript is going to be published or not. However the individual roles adopted in the paper publishing process may become combined in the electronic equivalent. For instance it is much easier for the author to be also editor, publisher and distributor. It is also possible to identify different factors, connected with the use of a computer, that make electronic book publication problematic. There are two main groups, the first of which is composed of features related to physical elements (Gould *et al*, 1987a; 1987b), such as screen type (CRT or LCD), resolution and dimension, the machine's location and position, and other ergonomical factors such as:

- distance from the screen;
- light source position and intensity;
- intensity/contrast;
- glare problems.

The second group deals with text presentation aspects. Studies conducted in this area (see Rubinstein, 1988) show that reading black text on white is less fatiguing for

the eye than reading white on black, while the fact that CRT screens emit light does not seem to be a great problem. Flicker seems to be responsible for legibility problems but does not contribute to fatigue during reading. However, screens are vertical while paper is usually viewed when horizontal, paper is more readily adjusted for viewer comfort than a screen, and the viewing distance for paper is generally closer than for a screen. The resolution issue is still an open problem. Only technological improvements can overcome this limitation. While on a standard screen it is common to have 8 by 14 pixels per character or 80 pixels per inch for a high resolution graphic screen, a typesetter can print at up to 5000 pixels per inch, so it is very difficult to have the same degree of definition on a screen as on paper.

On the other hand text presentation aspects such as the choice of margins, grids, fonts, style, text disposition in space, i.e. design components, are closer to well known paper publishing features and incorporation of these themes could close the gap between paper and screen presentation of information.

2.3.4.1. Models and Design Guidelines

The communication of information is a basic requirement of all types of book and particularly in electronic books, where methods of information and knowledge delivery are different from those used in conventional paper books. "Fundamental to the whole design process is an understanding of the nature of the various categories of end-user for whom a particular book is intended, and an important part of this understanding relates to the nature of the types of interface, style of interaction and different communication modes preferred by particular categories of user. Another major consideration is the nature of the facilities and reader services which a book will contain. Obviously, the type of facility included in any given book will depend very much on the end-user group at which the book is targeted, and the purpose(s) for which the book is to be used." (Barker, 1991).

The general model proposed by Barker is a relatively simple structure, where three elements have to appear:

- a first page;

- the text (with no specification about its internal structure but the presence of objects called pages that constitute its inner part);
- the end page.

Here page is defined as a visual unit of information presentation. There is a bilateral relation between pages and the numbers that identify them. The practice of sequential reading of a book is based on this relation. In Barker's model there is also a function that when given a page (or preferably a page position represented by a number) returns the following page, and another that extracts the previous one, where that is possible. These functions return to the first or the end page when the number exceeds the total number of existing pages. The existence of these relations makes the distinction between simulating a stack of paper and a book. In this way it is possible to keep the linearity inherent in the classical book definition.

2.3.4.2. Design Applied in Other Electronic Books

Different approaches are possible for electronic book design which are connected to the choice of media used:

- conventional text and graphics;
- multimedia resources;
- hypermedia material.

The first type is based on paper versions of the book which already exist. Commonly this case is solved by translating the paper text into electronic format, storing it on CD-ROM, and providing an indexing module and an information retrieval package. The quality of the interface design is the discriminating factor in this group of well known products. For example:

- the Grolier Encyclopaedia, (Grolier Interactive ©)
- the Oxford Textbook of Medicine on Compact Disc.

There is another family of electronic books which derives from conventional books but has assumed a strong hypertextual connotation, where active links leave users free

to browse through the information presented in the book. Examples of products in this family are:

- the Expanded Books (Voyager ©);
- HyperTextBooks.[4]

The multimedia approach refers to the possibility of the computer application incorporating different presentation media. Presentation strategies are based mainly on text, graphics, audio, video and animation. Essential for the choice of the best presentation medium or media set are consideration of:

- the nature of the information to be shown,
- the profile of the final user,
- the constraints of the target hardware,
- the requirements of the environment where the information has to be used;
- the production cost.

A more sophisticated solution is the hypermedia approach, which can be interpreted as a special case of the multimedia one. In this case it is possible to perform operations on data through editing functions and dynamic links. The philosophy of this kind of system is that heterogeneous data can be managed by a minimal set of functions such as searching and retrieving. The result of this approach is a powerful, rich and interesting system, but its complexity from the users' point of view as well as from the designer's side is very high, and technological help is essential for this type of platform.

2.3.4.3. Design Considerations

Designing an electronic book is a task that has to take account of both the principles used in designing a paper book and the different nature of the electronic book. It is possible to isolate at least three distinct stages in electronic book design:

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4 Available at: ftp.dartmouth.edu

- the application design, where the specific application requirements are considered in addition to users needs;
- the conceptual design, defining the book's appearance to the final user;
- the basic design, involving hardware, software and user-interface definition.

In addition to these components a fourth one has to be studied in order to offer an environment in which to create the electronic book: authoring tools.

The fundamental elements of the basic design stage are:

- the set of interfaces that enable interaction with the electronic book;
- the media used to construct the book;
- the contents of the book itself;
- the design template (the framework) that allows the book to be created.

After this first stage, it is convenient to define the book presentation style in relation to the final user's need. The last step consists of an application study in order to define a set of design rules suitable for achieving the result of the previous phase.

This process can be presented also as the sequential definition of the overall book structure, page structure, the media mix to be used, and reader services. Once the first three of these components are defined, the focus will move to the user needs, in connection with the particular application requirements. The result of this comparison will be the definition of a control mechanism, which is able to monitor and support the user activity in the system.

The control methods used in electronic books are very similar to those of an interactive computer system. Therefore experience in designing human-computer interfaces is relevant to the design of electronic books. There are two basic components of an interface for an electronic book: a display screen and some form of pointing device. With these elements it is possible to present the book to the reader and at the same time to let the user interact with information. Today's technology offers different pointing mechanisms, the most common being:

- touch screen;

- some form of stylus;
- mouse;
- joy-stick;
- virtual gloves and suits.

The aim of these solutions is to give readers an easy way to control reading of electronic books. A keyboard may also be attached to books when it would be useful to add some typed information.

Another important point is the design of the objects on the screen, as their location and representation are relevant both for aesthetical and communication reasons. The area in which each object lies on the screen is called a window, a widely implemented and well known metaphor. A window is a part of the screen with a certain size, dimension, location, shape and colour. It can be opened, closed, moved and modified in size. Particular care should be taken in the choice of how many windows to show on the screen and where to let them appear. The risk is overlapping windows and obscuring important information which is hidden to the reader. A solution is to resize windows, giving them a certain priority in order to organise their appearance on the screen.

A possible choice for information display is to divide different kinds of media into distinct windows, so different areas can be defined for text, picture, control function, video and audio facilities and so on. This solution is very machine oriented and suits technically orientated users, such as computer experts, who fully understand the reason for it and accept it easily. On the other hand the readers of paper books are used to finding different media mixed on the same page. The pages of the electronic book also have to be mapped onto the window system in a consistent and logical way.

Particular attention has to be paid to the control structure. Menus, commands and query languages, natural language, direct manipulation, (screen formatting) and use of graphics, animation and colour, are all effective solutions depending on the kinds of readers and their skills. The pictorial solution seems to be the most natural, as it avoids as much as possible the introduction of a cognitive overhead. The central issue in this case is consistency. The risk caused by a poor design is that readers will get confused as metaphors working at different knowledge levels will be mixed up and

generate different reactions in users. In fact, when working with icons, it is very important to evaluate the following factors (Shneiderman, 1992):

- aesthetics,
- communicativeness,
- suggestiveness,
- memorability.

So the steps in designing an interface based on icons could be summarised as: identification of the concepts to be represented, translation into pictorial form, and development of stimulating and, at the same time, consistent icons.

Some issues concerning hardware improvements in the human-interface field are (Shneiderman, 1992):

- keyboard design,
- large, high resolution displays,
- rapid response time,
- fast display rates,
- novel pointing devices,
- speech input and output.

Improvement in these components could be useful in making more user-friendly computer systems as well as electronic books.

2.3.5. Examples of Electronic Books

It is useful at this point to introduce a classification of the various examples of electronic books. It is possible to assert that an electronic book may have different interpretations according to which feature of the original paper book is considered as the main one. A meaningful distinction can be made between physical and logical features of the book, so some electronic books (e.g. Benest and Barker's interpretations in Benest *et al*, 1987; Barker, 1991 and Barker *et al* , 1994) try to simulate mainly the logical aspect of the original paper book, while others (Feldman, 1990) are more concerned with simulating the physical components or a specific

aspect, such as portability, of the paper book. Many hybrid interpretations can be proposed according to the specific application and users' needs. A first and very simple distinction is that between research products, which are usually the results of academic research and in general available in only a prototype version, and market products, which are available to the final user in a complete version for an agreed price. Even if this seems to be a very clear distinction there are lots of solutions in the middle. A common one is to have products available as shareware, or products which are free in their prototype version and then become payware. In any event this classification is necessary to ensure that products are compared at the same level of development.

Besides this classification, which responds to practical needs, another conceptual classification can be made between electronic books which implement the book metaphor in different ways. It is possible to delineate a hierarchy starting from the ones which imitate the paper book in all its physical components to the so called cyberbooks which do not have anything more in common with the paper book apart from being a tool to present information to readers. Among the book imitators it is useful to identify additional subclasses each of which focuses on a different aspect of the book metaphor and gives greater or lesser emphasis to the features inherited from the paper book. This classification which is summarised in Table 2.4 ranges between:

- page turner books;
- scrolling books;
- portable books;
- multimedia books;
- hypermedia books;
- cyberbooks.

Type	**Name of related project**	**Name of market product**
page turner (manuscript)	Bodleian Library	
page turner (manuscript)	Project Dante	
page turner (hypertext)	HyperTextBooks	
page turner (hypertext)	Hyper-Book	
page turner (hypertext)		Expanded Book
page turner (hypertext)	VORTEXT	
page turner (hypertext)	Book Emulator	
page turner (hypertext) with text image counterpart	CORE	
page turner (hypertext) with text image counterpart	Mercury	
scrolling	Gutenberg	
scrolling	Runenberg	
scrolling	Manuzio	
scrolling	SuperBook	
scrolling		DynaText
scrolling	Country Studies/Area handbook	
portable		Virtual Book

Table 2.4: *List of Electronic Books Considered in this Research*

Page turner books can be divided into those which imitate the original paper book, and those which have no paper counterpart and imitate the general idea of a book, i.e. the book metaphor. Among those which have a paper counterpart there are different levels of closeness, from those which maintain all the visual features of the original book by using a picture of the original pages, to those which use a graphic template to imitate the original book but do not allow the reader to interact with it in the same way as a paper book. The Bodleian Library[5] has developed a system which presents the user with an online picture of the page, as it appears in the traditional paper publication, with hypertext links to other documents. These include pictures from a

5 Available at: http://rsl.ox.ac.uk/imacat.html

Book of Hours, (MS. Lat. liturg. f. 3, fol. 51r, from the "La Coche ou le Debat de l'Amour" France 1540) which are available on the Internet. This is only one example of projects which deal with the presentation of ancient manuscripts to a large public through the Internet. Others are the Dante project[6] which provides pictures of the originals from the "Inferno" and other parts of the "Divina Commedia" which is famous for being the first book written in "Italian" and which is the basic reading for any Italian student of literature. The same sort of approach is found in "The Dead Sea Scrolls"[7]. All of these are mainly presented as high resolution pictures because the appearance of the original manuscript has a clear artistic value which has greater significance than just the textual content.

Another large family of page turners is one based on HyperCard™, which includes experiments such as HyperTextBooks[8], the Hyper-Book system for publishing and viewing a Hyper-Book, (Catenazzi, 1994) and the Expanded Book[9]. This family of electronic books is more hypertext oriented than the previous group and pays particular attention to the definition of links and browsing techniques inside the text presented in the book. In this way the translation to electronic form adds some value to the original book. Another good example is VORTEXT (Burrill and Ogden, 1989). The most original idea of this project is concerned with solving the problem of providing orientation facilities within the book. In a real book they are provided by the use of running headings and the thickness of the paper itself. The solution adopted in VORTEXT is the idea of closed pages. The text is displayed between two sets of vertical lines which represent the thickness of pages before and after the current page. Section names are indicated between these lines and may be selected in order to go directly to that page. Another problem that is addressed in VORTEXT is the personalisation of a book. Bookmarks can be inserted into the current page of the book by dragging the pointing device in order to turn down the corner of the page.

Another example in the page turner class is the book emulator which incorporates an electronic book shelf on which are displayed the spines of the electronic books

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6 Available at: gopher://gopher.dartmouth.edu/00/AnonFTP/pub/Dante/README

7 Available at: gopher://ftp.tex.ac.uk/11/Archaeology/deadsea

8 Contact: j5rson@aol.com

9 Available at: http://www.voyagerco.com/

(Benest, 1987). The electronic representation of each book on the shelf is directly related to the number of pages in the book, providing a search cue for familiar books. It is envisaged that publishers would provide distinctive spine designs to capture the attention of the casual browser and provide a further cue for familiar books and for those belonging to a familiar series. If the book is selected, the bookshelf initiates a computer process within which a book emulator runs. While the book pages are read into the emulator, the dynamic sub-icon representing the book on the bookshelf gradually is displayed in black until the book emulator is ready to display the book. The book has a structure consistent with its paper equivalent: Chapter 2 follows Chapter 1, the contents of the book are listed on the front, and the index and references are located at the back of the book. If the contents page is displayed, the user can note the page number, make a jump to the location within the book, and flick pages until the required section is reached. Various functionalities are available within this kind of book, which can be referred to as reader services:

- pages may be turned and selecting within the black bands enables the reader to make large approximate jumps;
- pages may be annotated either with a normal pen or with a highlighting pen, and such annotations may be removed with an eraser (without partially erasing the text underneath);
- book marks may be inserted into the book; the marker may be selected and the book turned to the marked page.

A project which incorporates both of the types of book described above is the Mercury project. It is based on the idea of a full text electronic library (Arms and Michalak, 1990) and has been developed at Carnegie Mellon University. The project aims were to demonstrate that current technology (high speed networks, high resolution screens, multimedia facilities) and the techniques for processing electronic documents, make it possible to build such libraries. Mercury is also evaluating a number of different approaches for acquiring and storing documents (e.g. scanning documents and saving them as images or capturing documents in machine readable format). Very similar to the Mercury project is CORE (Chemistry Online Retrieval Experiment) (Lesk, 1991), which has produced a prototype for the storage, searching and displaying of primary scientific journal data in electronic form together with related graphical information such as tables, graphics, etc. It is particularly relevant to

this research because of its attention to the initial acquisition of documents from paper and for the accurate design of the evaluation process where legibility problems are addressed by a comparison between the use of the original documents on paper with their electronic and image versions.

Scrolling books are ones where text is presented according to a scroll metaphor. This was the classic way to write text on parchment and in modern times this metaphor is very close to that used in word processor environments. This strategy lets the designer determine the page size based on the space available and dimension of the screen. The page, as a logical and physical unit, no longer exists nor does any reference to page numbers or to the page sequence. The text scrolls almost without any physical limitation. As a result the electronic scrolling book is portable on different platforms and does not have any dependency on screen dimension. However, readers lose one of the classical and fundamental keys to accessing information in a book, the page number, and they can easily get lost in the flow of information. The book metaphor is kept in its logical structure. The information is presented according to a book style hierarchy, made of chapters, subchapters, paragraphs and sections. Another important observation is that information in this class of electronic book is made of text and graphics, even if there may be some hypertextual features such as the presence of links to browse the electronic book. This is still a very traditional way of interpreting the concept of a book in electronic terms and for this reason it is closely related to the paper book. Examples can be found in extensive text repositories such as that organised and maintained by the Gutenberg project[10]. These are aimed at translating into electronic form and making available on line as many existing classics as possible in different languages. They accept input in ASCII, or mark-up form, and the final result is a plain scrolling copy of the original book. The repository created by the Library of Congress[11] is a collection of a series of books prepared by the Federal Research Division of the Library of Congress under the Country Studies/Area handbook program sponsored by the Department of Army in the USA.

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10 Available at: http://jg.cso.uiuc.edu/PG/welcome.html, see also Project Manuzio available at: http://sunsite.dsi.unimi.it/ftp/pub/culture/Manuzio/.list.html, and Project Runeberg, available at: gopher://gopher.lysator.liu.se/00/project-runeberg/about

11 Available at: http://lcweb.loc.gov/homepage/lchp.html

Other examples of scrolling books with more sophisticated hypertextual interfaces are Dynatext[12] and Superbook (Egan *et al*, 1991). Both of these provide full-text indexing, links, navigation and orientation through a dynamic table of contents and a multi-window text display. An interesting aspect of these two systems is the fact that they provide the capability for automatically importing text which is available electronically in different formats.

Portable books are becoming more and more common, as appropriate technology has developed. They imitate the book as a portable tool for providing information. A side problem is that they have to deal with limitations in screen size and resolution and efficiency, but these are all technological rather than conceptual aspects. An example of a portable electronic book is the one presented by Feldman (1990). The main feature of this electronic book is its portability based on the use of a lap-top computer. A similar project is the Virtual Book[13] developed at Digital, whose main component - Lectrice - is defined as "a prototype reading appliance" by its authors and at the moment is just about to be marketed. The problem of legibility has been solved by using a 122 dpi screen, greyscale, and allowing bi-orientation (e.g. landscape and portrait) so the book can be read in the orientation that is more suitable to its format. The main effort has been put into digitising, recognising and compressing the original pages of the documents to be viewed. In the case of documents already in electronic form Virtual Book is very flexible and able to display ASCII, PostScript and HTML documents. The result is a very pleasant, easy to read, portable tool which allows users to read and flip through the pages of the chosen electronic document without frustrating delays. This still has to be considered as more of a viewer than as an example of an electronic book as its authors have decided not to be involved in any design processes of the document to be shown; instead they have concentrated on the functional interface. The same philosophy has been followed by Sony™ while producing the popular Data Discman™[14] and the more advanced Bookman™[14], both providing a small and light high resolution monitor for presenting electronic books which can be prepared by using the Sony Electronic Book Authoring System™.

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12 Electronic Book Technologies, Inc. 1990, see: http://www.ebt.com/

13 Mark Hayter 1996, see: http://www.research.digital.com/SRC/virtualpaper/

14 http://jefferson.village.virginia.edu/elab/hfl0014.html

Multimedia books represent a further step away from the paper book. The contents of such books are no longer simply electronic text or pictures but a mixture of different contributions such as video, sound, animation, text and pictures. It is no longer possible to keep this sort of enriched form of information inside the physical border of a classical book. That is why the electronic environment is the natural one for this class of book. They still borrow essential features from the book metaphor by either imitating its physical appearance or keeping the same logical structure. The metaphor is enlarged to consider this new form of information as generic book contents and to organise it in the new book container according to new needs and presentation paradigms. An example of a multimedia book, mainly aimed at education, is the one produced by the HCI laboratory at Teesside Polytechnic (Barker *et al,* 1994; Barker, 1996).

It is also worth mentioning multimedia books which are essentially composed of pictures and various contributions from different media. An interesting approach has been made by Barker (Barker, 1991) in connection with children's books. In this type of book visual information and particular attention must be paid to how this information is presented to the reader. This requires that particular attention is paid to the definition of the logical screen, a conceptual place, where information in its visual form is displayed. Depending on the different nature of the source information, different instances of this logical screen are generated by the authoring system. For each kind of information the most expressive and powerful representation has to be chosen and at the same time the representation has to be dynamic in order to allow users to change it depending on their individual needs.

Hypermedia books present textual material and integrate it with other related sources, such as video, sounds, and pictures, and provide the reader with alternative reading/browsing paths. The resulting book is an augmented version of the original. Hypermedia books inherit all the problems related to the use of hypertext and hypermedia, such as orientation problems, and the risk of confusing users with too much information. A rich subset of hypermedia books are those, which are becoming ever more common, which are available on the Internet. An example is "Lady

Freedom among us"[15], a poem readable or better read on the Internet as part of a program for celebrating the acquisition of the four millionth volume at the University of Virginia Library. It is possible to see and listen to the poem read by its writer. Another group of electronic books which are widely available are those on tape where actors read for the reader/listener pieces from classical literature.

Cyberbooks are completely free from any physical/conceptual dependence on the paper book, as they have only appeared in electronic form. In this context the term book is used in its broadest sense as a repository for information. On the other hand they depend very much on the dynamic nature of their context, the computer. In this sense they can be defined as active books with which readers can interact. They are part of an alternative new line in modern literature, called Postmodern literature, which closely integrate the computer culture with the classical human one.

In the same way that paper books are stored, organised and managed in a physical library, electronic books may need to be stored, organised and managed in an electronic equivalent. Therefore, to complete this overview on electronic literature the next section introduces the concept of an electronic library.

2.3.6. Electronic Libraries

The label *electronic library* is currently used for several different entities. A traditional library with paper documents and on-line catalogues can describe itself as an electronic library as can a repository of electronic text which is available only in electronic form. A hypothetical electronic library would be the natural place to store and search for electronic publications but how, and when is not yet clear. Will all paper books be translated into electronic form, even if they are not suitable for this translation? Who is going to pay for the cost of the whole process? What about the risk of being trapped by an obsolete technology which may make certain electronic publications unavailable in the future? If not all books are going to be in electronic form what is going to happen to the paper ones? What sort of professional roles will be required by the new library? These are some of the open questions which a

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15 Dove R. 1996, see: http://www.lib.virginia.edu/etext/fourmill/DovLady.html

growing number of research projects are addressing. In the UK the FIGIT (Follett Implementation Group on IT) of JISC (Joint Information System Committee[16]) is sponsoring some 50 projects on the feasibility and challenges of electronic libraries. The main role of JISC is to coordinate the various electronic libraries initiatives, providing, when possible, guidelines and standards, and facilitating links between different groups, with consideration to other countries.

It is clear that the future of books is very closely related to the future of libraries and this research is aware of the importance of the research in electronic libraries. However the main focus is on book design and use, and for this reason, as the previous sections have highlighted the importance of technological issues, the next section presents an analysis of the state of the art of the technology required for the realisation of the Visual Book.

2.4. Document Image Systems

Document Image Processing Systems are technologies whose aim is to capture a document image electronically, to convert it into digital form, and in a second phase, to process and access it with similar facilities used in office automation for traditional text (e.g. image processing, image retrieval, image publishing). Historically this research started within medical and satellite imaging environments.

The great interest now shown in this subject is due to the availability of cheap processing power and high density mass storage (optical media). The observation that about 95% of the information held by commercial and governmental organisations is on paper (Hendley, 1987), when taken with technological and economical considerations, discussed above, indicate the importance of this research field.

The basic objects of such systems are images and as this term has different meanings in different contexts it is appropriate to introduce some initial definitions.

16 See: http://www.niss.ac.uk/education/jisc/

"An image is a representation, likeness, or imitation of an object or thing, a vivid or graphic description, something introduced to represent something else".

"A picture is a visual representation drawn, photographed, printed, or otherwise presented in two dimensions ... an image refers to the representation of a picture in terms of the binary 1s and 0s upon which digital computing is based." (Lunin, 1987)

An image, in computer terms, is a form of unstructured or uncoded information while text or anything inserted via keyboard is considered to be structured or in a coded form. Image processing is a special form of two-dimensional (and sometimes three-dimensional) signal processing. A generalised image processing system has five key modules:

- input (i.e. scanning or other forms of digitisation);
- processing;
- storage;
- communication;
- output (i.e. displaying or printing).

For each of these modules the technology is still the crucial issue as bottlenecks can occur where the relative performance of the co-operating elements is mis-matched. For instance input devices already provide a level of quality which is already extremely high when compared with that offered by output devices, such as printers and screens which lag far behind in terms of resolution. Processing software (e.g. PhotoShop™) which was available on the market at the time this dissertation was written, from the quality point of view, already satisfies the quality requirements of image system designers. However from an efficiency perspective PhotoShop™ could be rated less highly as it is computationally intensive and also needs a high level expertise to use it effectively.

One area which appears to be well-addressed by technology is that of storage. Storage devices have become increasingly powerful yet cheaper at the same time. In addition techniques for compressing images have become more sophisticated and effective thus making better use of mass storage devices. Although there are several applicable standards for images most of these have been ratified at international level

and enjoy wide use. The communication module, although of great relevance to the global perspective of the Virtual Library, is not considered in this research where the emphasis has been mainly on the input, processing, storage and output modules. The weakest elements of a document imaging system (DIS) are the output devices. For instance the screen resolution for a standard PC or Macintosh is still less than or equal to 75 dots per inch, while printers will normally offer between 300 and 600 dpi although this can be enhanced via software through the use of interpolation techniques. This observation is crucial for the design of the Visual Book system, because it is through the screen that readers are going to see, read, consult and use the Visual Book. If the result is low quality and it is difficult and unpleasant to read then the main point of having a Visual Book is lost. The Visual Book system is the result of the integration of different technologies and this section and its subsections provide an analysis of the different aspects involved in the construction of such a system, with particular reference to:

- scanning techniques;
- image and document processing;
- technologies for physical and logical storage ;
- output mainly as display technology.

2.4.1. Scanning

The input process is performed by scanners which are machines which can capture the image in electronic form. During this first process, called bit mapping, the image is broken into picture elements (or pixels) which are captured individually. Each pixel has a number representing its colour together with brightness or darkness and an address. This array of digital data (the digital image) is then stored for ready access by a suitable device in a form amenable for computer processing. Users are usually able to modify the output image pixel by pixel. The final result is displayed using a process that is the reverse of digitisation, i.e. for each of the numbers codified in the digitisation process the equivalent pixel is reconstructed and displayed on the screen. If the digitisation/display processes use appropriate coding and decoding functions the two processes are perfectly reversible.

2.4.1.1. Scanning Technology

A scanner is a device that examines printed characters or graphics and represents them as electronic signals. Often this machine is linked to an image controller that provides image enhancement, compression and decompression, conversion from analogue signals to digital streams and the physical management of images in the system (Alford, 1992). There are different kinds of scanners but for document image applications the most relevant are those that support OCR, line art and continuous tone scanning. OCR stands for optical character recognition, which is useful for text treatment, while line art refers to black and white images, and continuous tone images to the handling of photographs which could contain more than a million different tones of grey.

A further distinction can be made between rotary scanners that accept only single sheets of paper of a particular size and flat bed scanners that can accept bound volumes and large size documents. Another category of scanners are those used for standard microfilm formats. While document scanners are simple input devices, microfilm scanning subsystems can also incorporate a large film store and mechanisms for automatically handling the film, retrieving specific frames and digitising the image.

The computer treats images as an array or a series of elements. The number of pixels per inch used in this array together with the size of the screen determines the resolution of the image: using only a few pixels generates a granular image while using many pixels results in a smooth image. The number of bits per pixel determines the possible grey scale level (grey scale refers to the number of shades of grey expressed in the image).

Image resolution and grey scale level together determine the quality of the resulting image. The grey levels are encoded in binary form, e.g. eight bit pixels provide 256 different grey values in black and white or 256 unique colours. The number of bits per inch determines the resolution of the stored image and the fineness of detail that can be recreated. This number is called lines per inch, because scanning devices generally operate between 200 and 400 lines per inch. A scan of 200 lines per inch is satisfactory for office correspondence and the body text of most printed matter (text as small as 4 point type). The major difference between this kind of text and the usual

encoded data is the quantity of information stored. Usually a single character is encoded in one byte, and an average page image takes 25 times more storage then a corresponding character-encoded page.

2.4.1.2. Commercial Scanner Products

During the prototype development a number of products were tested. These were the Agfa Focus II™, the Datacopy™ and the AppleScan™. In addition, technical documentation was obtained for two products which were representative of technologies which were felt to be at the leading edge (Kurzweil Discover 7320 model 10™) and in the middle ground (Sharp™ colour flatbed scanner). For high performance the Agfa Focus II (Mac) and the Kurzweil Discover 7320 model 10 are competitive high quality products that can be put in the same category as regards price and complexity. Although the first of these has been designed to work most effectively with graphics and the second with text, the nature of this research considers them as broadly comparable when considering text as a readable image.

The Focus II is a high quality monochrome flatbed scanner which uses a SCSI interface so that it is possible to connect it to different computers, such as the Apple Macintosh and IBM PC. In the Mac version the associated software (ImageView) is very flexible and user friendly. The resolution, a maximum of 800 dpi, is inversely proportional to the grey scale selection (up to 256). Focus II is unbeatable for scanning images that have to be output as high quality halftones, and it is thus the best choice for graphics work.

The Kurzweil Discover 7320 Model 10 is better oriented to character management. The company calls this ICR, or intelligent character recognition. It has a co-processing board featuring a separate processor (Motorola 68020) and a full two megabytes of memory. When it cannot recognise a character it evaluates the signals by referring to a built in 50,000 word lexicon. It is possible to add words to the lexicon and it remembers, during the scan phase, every incomprehensible character and it then attempts to provide a logical substitution based on the rest of the text. It does not work well with images and there are no editing facilities provided.

In the middle category as regards price and quality is the Sharp colour flatbed scanner which has a resolution of up to 300 dots per inch with 8 bits of colour. It has good performance on colour photos and graphics but it is not particularly suitable for text images in black and white.

In the bottom category both the DataCopy and the AppleScan were tested. They are both black and white scanners with a maximum resolution of 300 dots per inch. Their performance in scanning black and white text was not much different from these of the most expensive scanners listed above while they showed serious limitation in scanning images especially if the original was a colour one.

In each of the tests the conditions were the same: a page of black and white text, without graphics and tablets, and with dimensions of approximately 13 x 20 cm., was processed using grey scale (64 levels) scanning. The page dimensions were fixed in order to reflect screen limitations, although larger page size could be handled by the scanner. Pages were taken from different publications, which had the same fixed dimensions, in order to test the scanners on different quality paper as well as on different typographical design elements (font and size mainly). The experiment was limited to approximately ten pages from each publication. The experiment was aimed at testing the legibility of the same page taken with different scanners, and to evaluate, at the time, how much the quality of the print influenced the final result.

The results obtained showed that a very sophisticated colour scanner such as the Agfa has the same performance, on black and white text, as DataCopy, and that the real problem is not in scanner quality or in the quality of the software for image processing but lies mainly with screen resolution which, as discussed below, remains a technological limitation.

2.4.2. Image processing

Image processing can be defined as a function pertaining to pictures captured from the physical world as opposed to those created electronically using a computer graphics system. The main kinds of processes associated with image processing are: enhancement, restoration, segmentation, description and compression (Besser, 1995).

Enhancement is the attempt to improve pictorial information for human interpretation and machine perception while restoration deals with reconstructing or recovering an image that has been degraded. Segmentation aims to subdivide the image into particular regions. Segmentation algorithms are based on discontinuity (edge detection) or similarity (thresholding and region growing). Description extracts features from an object for recognition purpose. This kind of information has to define unambiguously one object independent on its location and orientation.

Compression is important for reducing storage or transmission requirements. There are two kinds of compression techniques: reversible, that makes a perfect reconstruction possible, and irreversible where some information is lost and the image is degraded. Compression is perhaps the best defined area and one which has seen the development of a number of important standards to facilitate information storage and interchange. JFIF (JPEG File Format - described in ISO 10918-1/-3, 1992, 1995) is a standard format for image storage while JPEG (Joint Photographic Experts Group) is the standard compression algorithm which is also under consideration as a standard for WWW graphics. JPEG algorithms (Wallace, 1991) work on the image to be compressed by removing details in order to achieve a lower quality image which will take less space for storage. The quality of the new image is set by a parameter defined by the user: higher quality images will take more space and vice versa. It is important to notice that this compression process is not reversible. The decompressed image will have less detail than the original so the quality parameter is very important. However even if there is a loss in quality the degree of compression is still significant as the compressed image is usually reduced to a fourth of the original size (Wallace, 1991). JPEG has become the most popular compression algorithm in current use.

JPEG works at its best on full colour images (photographs) while GIF (Graphic Interchange Format), the other main standard for compression which uses a lossless compression algorithm launched by CompuServe, is still better for cartoon images or images with few colours and large uniform areas. Neither is ideal for text images where there are only black and white areas, as JPEG cannot produce any significant compression and the graphical areas are not wide enough to make GIF a good alternative. This was the result of the experiments conducted for the Visual Book storage module which highlighted the necessity for a different paradigm for image

compression. Research is still ongoing in this area and a possible solution is to use various ad hoc mark up languages in order to separate the text from its presentation component and obtain in this way an ideal compression which is ASCII based. Another interesting possibility is to use fractal compression[17] which has the advantage that is infinitely scalable by the user.

2.4.2.1. Document Image Processing

Documents in a computerised environment can be considered as graphic objects and it is interesting to look at the possible interactions between the document and its users. It is very important, at this point, to investigate the visual properties of these objects, the relation between them, and the message carried by the document itself. Several document aspects can be distinguished: content structure, graphic structure and text. (Southall, 1988)

Several technological developments have made the use of scanned documents a more practical and economically acceptable solution for document management:

- high-resolution (400 dpi) document digitisers have become available at relatively low cost,
- data compression methods have been developed for a wide variety of image types,
- advances in screen and printer technology are lowering the cost of high resolution display of uncoded document images.

Processing scanned printed documents can be divided into two broad categories: format analysis and character recognition. This work will concentrate on this first aspect, the extraction of layout information without considering individual objects, because the emphasis is on the textual image rather than on the textual content. Character recognition has been restricted to the reproduction of indexes which were incorporated in the original document. Specific aspects of format analysis are discussed in the next section.

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17 See, for instance, Fractal Image Encoding Page available at http://inls.ucsd.edu/y/Fractals/

2.4.2.2. Document Image Analysis

A document image is a visual representation of a printed page which consists of blocks of text mixed with halftone pictures, lines and icons. Document image understanding may involve interpreting photographs, text, graphs and the interaction between them, and implies the correct recognition of each of its constituent components. Document image analysis is the task of deriving a high level representation of the contents of a document image. There is analogical representation, based on the spatial extent of a block, or propositional representation, which is like a semantic network where nodes are entities distinguishable in the document and the links are the relationships between them.

The various processes necessary for *document analysis* can be divided into three groups:

- optical scanning, digitisation and binarisation,
- block segmentation and labelling (page representation),
- several parallel operations for processing text, graphics and half-tone images.

An *optical scanned document* image is usually an integer array. It can be converted into a bit map by a thresholding operation which depends on the choice of a threshold t; pixels values below the threshold t have to be black, those above white. The top down approach for *segmentation* divides the entire document into major regions then into sub-regions and so on. The well known methods of this kind of segmentation are smearing, projection profile cuts and Hough transform.

The smearing method starts by considering the scanned document as a black and white image. It tries to merge into a continuous stream of dark pixels those black pixels which are nearer to a certain threshold than to other black ones. A run-length smearing algorithm (RLSA) is first applied row by row and column by column. The result is then related using the AND logical connector (Srihari and Zack, 1986).

The projection profile cuts approach is based on the observation that a printed page can be divided into rectangular blocks. The document is represented in the form of a tree of nested rectangular blocks. The cuts definition is based on the document

configuration. A local peak detector is used to find where to place these cuts. An X-Y tree, i.e. a data structure used to represent the layout of printed pages, is obtained by applying recursively this horizontal and vertical partitioning. The resulting tree will not be binary because the number of horizontal and vertical cuts is variable. The X-Y tree can represent both the physical and logical structure of a document. The root is the binary page image while the leaf nodes represent the particular parts of the page such as text fragments, or parts of an illustration (Nagy and Seth, 1984; Nagy, 1989).

The Hough Transform is a technique for detecting parametrically representable forms in noisy binary images. Bottom-up analysis is based on successive steps of refinement of the input image. The image is processed to determine the individual connected components, and is useful for recognising whether a connected component is a part of a line drawing, text or half-tone picture. This choice can be made by using information about the size of components by counting the number of pixels and considering it not to be a character if it lies in a fixed range. Also the branching structure and the consequent complexity of a component can indicate if it is a character or not. The topological properties can also be useful for the choice based on the Euler number, e[18], of a binary image, that is the number of components minus the number of holes.

After the segmentation phase blocks will be labelled in a subsequent step. One approach is a statistical one which, after taking specific measurements of components, compares found data with a certain threshold. Another is rule-based using a knowledge base comprising layout and composition rules for specific classes of documents. In the same way that each programming language has a fixed set of rules, each publication has predetermined format conversions. So size, position, spacing and ordering of the blocks, logical entities of the page, are predetermined. This document structure consists of a family of conventional string grammars for horizontal and vertical profile at various levels. An example of this approach is found in the Unix compiler utilities Lex and Yacc. In constructing this kind of grammar it will be useful to have measurements of samples of scanned copy, publisher style manuals, and so on.

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18 the first 1 million digits of the number e are available at:

http://antwrp.gsfc.nasa.gov/htmltest/gifcity/e.1mil

One research centre specialising in this area is CEDAR[19], the Center of Excellence for Document Analysis and Recognition. CEDAR is involved in a number of projects for the recognition, analysis and interpretation of digital documents in three areas:

- handwriting

  HWAI (Handwritten Address Interpretation) which resulted in the development of a system for postal address reading in real time;
- image understanding

  PICTION, which studies the use of textual information (captions) in image understanding;

  Show&Tell, a system which combined speech, text and image understanding.

  Taxile, a digital library which offers a full range of papers, slides and video for people interested in knowing more on document analysis and recognition.
- foreign language OCR

  Japanese Document recognition, a special OCR for converting printed Japanese into electronic form.

Another centre for research in document analysis and OCR/ICR is the DFK; the Department for Document Analysis and Office Automation, University of Kaiserslautern, Germany. This centre has been involved in a number of projects for analysing document layout and logical structure in order to extract as much additional information as possible to be added to the text content such as:

- ANASTASIL, a hybrid knowledge-based system which analyses document layout at different levels of abstraction in order to extract information to help define the electronic representation of the same document (Dengel and Barth, 1989; Dengel, 1989);
- Office Maid[20]: a system prototype which is the result of a project called AVL, for the study, analysis and recognition of scanned text. In particular AVL

19 Available at http://www.cedar.buffalo.edu/

20 Available at http://www.dfki.uni-kl.de/da/

focused on single-sided business letters, by scanning the text, recognising it, and producing a content description.

- Omega[20], a study, design and development of an authoring system able to perform document analysis tasks such as: "layout extraction, text recognition and text analysis".

The Document Processing Group, University of Maryland, is another active centre for research in document analysis, structure representation, page decomposition, text image compression and handwriting recognition. They have also built a document image database, accessible via the Internet, to let people browse hierarchically their collection of text images. Although specific results from these centres have not been incorporated in the Visual Book the concepts investigated have been important in setting the scene for this research.

2.4.2.3. Optical Character Recognition

A natural step following the document image analysis is the application of a module for recognising the text contained in a text image. This is achieved by using a well known technique called Optical Character Recognition. Optical Character Recognition (OCR) systems contain two main modules: a scanning module which reduces the printed page into a bit-mapped picture, and a recognition module which breaks the image into blocks and determines for every character in a block its ASCII (American Standard Code for Information Interchange) value. The result is a significant compression of the original file, e.g. from 1Mb (for the image document) to 10K (for its ASCII version), combined with the possibility of editing this new document.

The scanning process has to result in an image of the original page which is as clear as possible in order to facilitate the task of the recognition process. The type of fonts used in the page, size and spacing, as well as paper and printing quality, are all relevant factors in recognising the text. The page layout, i.e. the way pictures, graphics, columns and text are mixed on the page also contributes to the complexity of the recognition process.

Usually an OCR system can distinguish between different type styles and tries to preserve the original layout of the text. OCR is based on two main methods (Cahan, 1989):

- matrix matching, which matches every character with a library of possible shapes;
- feature recognition and extraction based on artificial intelligence techniques, where a set of rules about the general principles of letter shapes are used in order to support the recognition process.

In addition to these techniques, some OCR systems are also able to learn by interacting with a human operator who corrects mistakes and solves ambiguities. However, no OCR can be 100 per cent accurate 100 per cent of the time and the recognition process has always to be assisted by an operator who can check the result. OCR solutions are particularly well-suited to large assemblies of documents with the same typology (layout and physical representation). Two leading software packages were experimented with by using an OCR package to interpret part of the text used in the Visual Book system. TextBridge, by Xerox™, and OmniPage by Caere™, are two of the most popular and efficient software packages for optical character recognition on the market. Both have shown that they work well on a set of documents with the same layout, TextBridge was found to be a good choice in the case of English text while OmniPage proved to be more flexible language-wise. Neither was 100% successful in recognising text.

2.4.3. Storage

In the case of a DIS (Document Image Systems) application the storage module is divided into a physical and a logical component, where physical storage is related to hardware aspects and the logical one is concerned with appropriate use of structures and systems for organising and storing images and their textual description in order to be retrieved as quickly as possible.

2.4.3.1. Physical Storage

Currently there are at least three main different kinds of storage on the market:

- optical disks (e.g. CD-ROM, WORMS);
- magnetic tapes (e.g. DAT, Exabyte);
- magnetic disks.

Optical disks offer certain advantages when it comes to storing data. They are available in both read-only (WORM) and updatable modes (erasable optical disks). The write-once feature protects images for archival purposes and is important for applications where the original documentation has to be guaranteed to be unchanged (e.g. legal contracts and financial records). The large amount of data that can be stored on this medium is important for image management, taking into account that a scanned document occupies hundreds of times the space of the same typed page. Other advantages in using WORM disks are their stability and their physical resistance because there is no danger of mechanical damage. Different strategies are suggested for data storage: all images are online on one side of a number of WORM disks, each one with its own drive; the data are stored off-line on double sided WORM, an index to all data stored on magnetic disk is searchable at any moment; for larger files WORM disks are collected in multi-drive changer units with up to 21 readers giving access to up to 84 volumes (4 disks per volume) with mechanisms able to retrieve any one disk and to flip it depending on which side the data is stored. For even larger storage there are now jukeboxes with from 50 to 500 platters for terabyte data storage.

Tape performance is generally slower than both optical and magnetic disks and is not as safe as the medium can be damaged more easily. However they offer a cheap and quite reliable solution for backups where the time of accessing data is not as relevant as in other applications and the price is a far more important parameter. Technological improvements are making the differences between tapes and disks less noticeable as a lot of effort has been expended on improving reliability and fast data access.

Magnetic disks are the fastest and most expensive option. In addition to conventional hard disks which now can store up to 10 GB of data, there are technologies such as low cost removable cartridge hard disks with high storage capacity and reasonable access speed (e.g. EZFlyer, high speed, 230 megabyte, released in June 1996). RAID (Redundant Array of Inexpensive/Independent Disks) is

another way to get cheap and efficient storage support. In this technology several disks are put to work together to provide large storage capacity this avoiding the use of single large and expensive disk. It is also possible to implement a hierarchical storage strategy in which magnetic disk is used for online, high-speed access of the most current data, with optical disks for archival data which can be mounted within seconds, and tape for long term archives.

2.4.3.2. Logical Storage

An initial definition of an image database might be as a system in which a large amount of image data and related information - text captions or brief descriptions - are stored in an integrated manner. Two extreme interpretations are also possible: a system where all images are collected without being compressed and the DBMS only provides pointers to them, or a system where images are reduced to symbolic terms and then managed like common data (Besser, 1995). Two other possibilities are systems for image management which do not use database concepts, or use a database which does not contain images but only their descriptions. There are no clear definitions of what an image database is and some basic issues are still open, such as: how to represent unstructured information in a database model, or what is the result of a retrieve operation in a image database or in which form it is best to present the output. For the moment the answer offered by existing systems (Sieverts, 1994) is that they are very much text oriented, in the sense that even if there are pictures in them they are still indexed and retrieved through the textual information which describes them. This can be explicit, i.e. in the form of the original citation provided with the image on paper, or implicit, i.e. as a set of keywords chosen by expert indexers. In both cases the image is treated as an appendix and not as the focal part of the database and the information that it carries is not exploited at all. Research on how to exploit this richness of information contained in images is still open. One option is to use icons as an abstract representation which could be compared against stored images (colour, shape, 2D, variety). In this method retrieval could start from alphabetic symbols (black and white, coded) which are part of the textual description of the object and an icon of that concept could then be used to match against picture elements which have not been verbally described (Eakins *et at,* 1997). Another path is

the one followed by the Virage team[21] (Bach *et al*, 1996) where images are the core of the system and they are described in terms of four fundamental pictorial features, such as colour, composition, texture and structure, which are then used to retrieve them. In the case of the Visual Book the images are of a very special nature, being text images, and more precisely, book images. These can at least be addressed through their unique page number and hierarchically organised according to a book's original structure.

2.4.4. Output

Typically three types of display terminal will be offered. Most popular is a single screen able to display both standard coded data and raster image data. Many systems use windowing so it is possible to have on screen at the same time more then one image, or different segments of the same image. Another solution is to use two terminals, a standard one and an image display terminal, the user can search via the standard one and then see the results on the one dedicated to images. The last and simpler solution is to have only a standard terminal to make queries to the system and then print the result.

A major problem in this area is the level of resolution required to display a scanned document. If a document has been scanned at 300 dpi it should be displayed at 300 dpi. Practical and economical problems mean that an intermediate solution might be acceptable. For example 80/100 dpi resolution with the possibility of zooming could be enough for many applications (Alford, 1992) though not in the case of the Visual Book. Experiments were conducted with a high resolution screen (Radius 150) and showed that even this resolution which was the maximum available on the market at the time of this work (Blatner, 1996a) is not enough to have pages clearly and pleasantly readable on the screen. The technology is not moving very fast in this area, and it is possible to identify at least two reasons for it. Firstly there is no great interest in looking for the right tool for displaying scanned text on screen, when it is much easier and practical to recognise it with an OCR package and obtain the same information, or at least the same content, fully searchable and automatically compressed as ASCII. Secondly the majority of people involved in graphics are more interested in presenting colour images on screen and therefore they are facing and

21 Project Virage is available at: http://www.virage.com/

solving problems which are very different from those related to presenting black and white text images. The tools developed for their purposes, such as the stochastic screen (Blatner, 1996b) are not suitable for the Visual Book because they work on colour or greyscale objects and not black and white objects such as text images. However one of the assumptions of this research is that it is realistic to believe in technological developments which will lead to a significant increase in screen resolution so that in the future that will be able to match paper resolution.

2.4.5. Results of the Technical Survey

It is clear that document image processing systems can offer several advantages to commercial users. These include:

- elimination of cost and misfiled documents,
- simultaneous viewing of documents at multiple workstations,
- control of document access for security purposes,
- simple duplication of text and image databases for backup and distribution,

However the technical survey given above has shown that there are also clearly identifiable problems associated with the limitations of current technology. These include:

- lack of standards for logical storage and retrieval of text images,
- screen resolution too low to guarantee readability of text from screens;
- lack of compression algorithms specific for text images.

These are all important practical problems although it can be expected that technological improvements will resolve some if not all of these in the immediate future. They all influence the Visual Book system as a particular instance of DIS (Document Image System) and this is why they have been explored in this literature review.

2.5. Conclusions

This chapter has introduced the main concepts which have been investigated in the rest of this thesis. The emphasis is on the role of books and how their paper versions, which are the best known and most used till now, represent the answer to many readers' needs. The result of this analysis is that there are positive and negative features in the paper version of a book. In the analysis of the process which produces paper books, these negative and positive aspects have been highlighted and a possible solution has been proposed to change part of the process while keeping the part which produces the good results. At this point it is possible to define not only the features of the Visual Book but also the process which is able to produce it and the relations it is going to have with the paper book. From the analysis of the state of the art of the technology which can support the publishing and production of the Visual Book in real terms, it is clear that the electronic book is the object closest to the Visual Book. It is still very important to highlight all the negative features that the electronic book can inherit from its production process, the media where it resides, and all the possible mistakes from referring to the original metaphor generated from paper books. It is clearly more difficult to produce good electronic books than paper ones for many reasons. There is no tradition, no standards to help in the design of electronic books, and the book metaphor, which has undoubtedly proven to work well in the design of electronic publications can still be interpreted in so many different and sometime inappropriate ways. It is not yet evident what the real use, utility, context and necessity for this new category of objects is but certainly there is great, and growing, interest and expectations about them. An additional problem, which is completely new when compared with the ones known for the paper version, is that the media involved can be very different, offer different functionalities, and involve in any case, specific skills and a high degree of participation from readers.

The implications of these considerations on the design of the Visual Book are quite significant. It is immediately clear that a great degree of attention has to be paid at the user interface of the Visual Book system, and mainly on how the book metaphor is going to be translated into electronic terms in order to satisfy readers. A critical point is the study of the profile of the possible user in relation to the kind of book to be translated into the Visual Book. So technological issues such as scanning and display

techniques and devices which are closely linked with the physical quality of the Visual Book have to be considered together with theoretical ones such as the effective impact of electronic books on readers, the needs and interests they are going to satisfy and raise, how appropriate the book metaphor is and for which kind of user, and how relevant the technological issue is going to be on the overall design. Answers to these questions can be found in the next chapters, and especially in chapter 6.

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Chapter 3:
Methodology

3.1. Introduction

This chapter represents the link between the literature survey presented in the previous chapter and the design, production and evaluation of the Visual Book system which are the subjects of the next chapters. It describes the various steps followed in this research, both on the theoretical and the practical side, providing a justification for the choices made on the way to producing the Visual Book system. It explains the purposes behind the creation of such a system as a suitable tool for demonstrating the validity of the theory proposed by this thesis, which is summarised below:

> It is feasible and appropriate to identify and replicate the logical structure of a document by starting from the appearance of a paper document (i.e. from its layout structure) and applying a form of image rhetoric.

This hypothesis, in turn, has been used in this thesis to explore the possibility of managing electronically a special class of documents: those which already exist on

paper and which are usually selectively consulted, instead of being read in their entirety. There are two main approaches which were adopted in order to explore this theory (Benyon *et al*, 1990):

- deductive and investigative;
- analytical and constructive.

In both cases a detailed analysis of the related sub-hypotheses (see section 1.2) was essential before developing a strategy for building a prototype.

The first strategy, the deductive and investigative one, considers existing projects with the same or similar scope and examines the results obtained with respect to the specific features which are recognised as relevant for demonstrating the basic ideas of this thesis. This task is based mainly on bibliographical resources and the collection and examination of material about related systems. This choice involves decisions as to the systems worthy of being considered, the criteria to be applied in their examination, and how to elaborate the results of this evaluation.

On the other hand the analytical and constructive approach is one which leads to the design of a system which is able to satisfy the requirements identified from the analysis step. Using this approach it is possible to choose between different stages of development of a system in order to prove the validity of the proposed theory as well as between various strategies for the same functionalities. Three steps were pursued in order to achieve this goal. The first one dealt with the design and construction of the system while the second was concerned with system evaluation. The third step, which involved making a comparison between the results of the evaluation (see section 6.5) and system expectations (see section 6.4.4), focused on the impact of this particular interpretation of the book metaphor (the visual approach) on the world of electronic documents.

This research has combined the two approaches. The deductive and investigative one has been applied at the beginning in order to define the state of the art and the starting point for the development of the Visual Book system which has, in turn, been based on an analytical and constructive approach. The idea has been to study specific features of real books, together with the way people normally interact with

them. From this initial examination it has been possible to extract a brief profile or model of a particular type of electronic book called the Visual Book. In order to realise this special interpretation of a book, the design process has focused on the translation of visual aspects of the original book into electronic form.

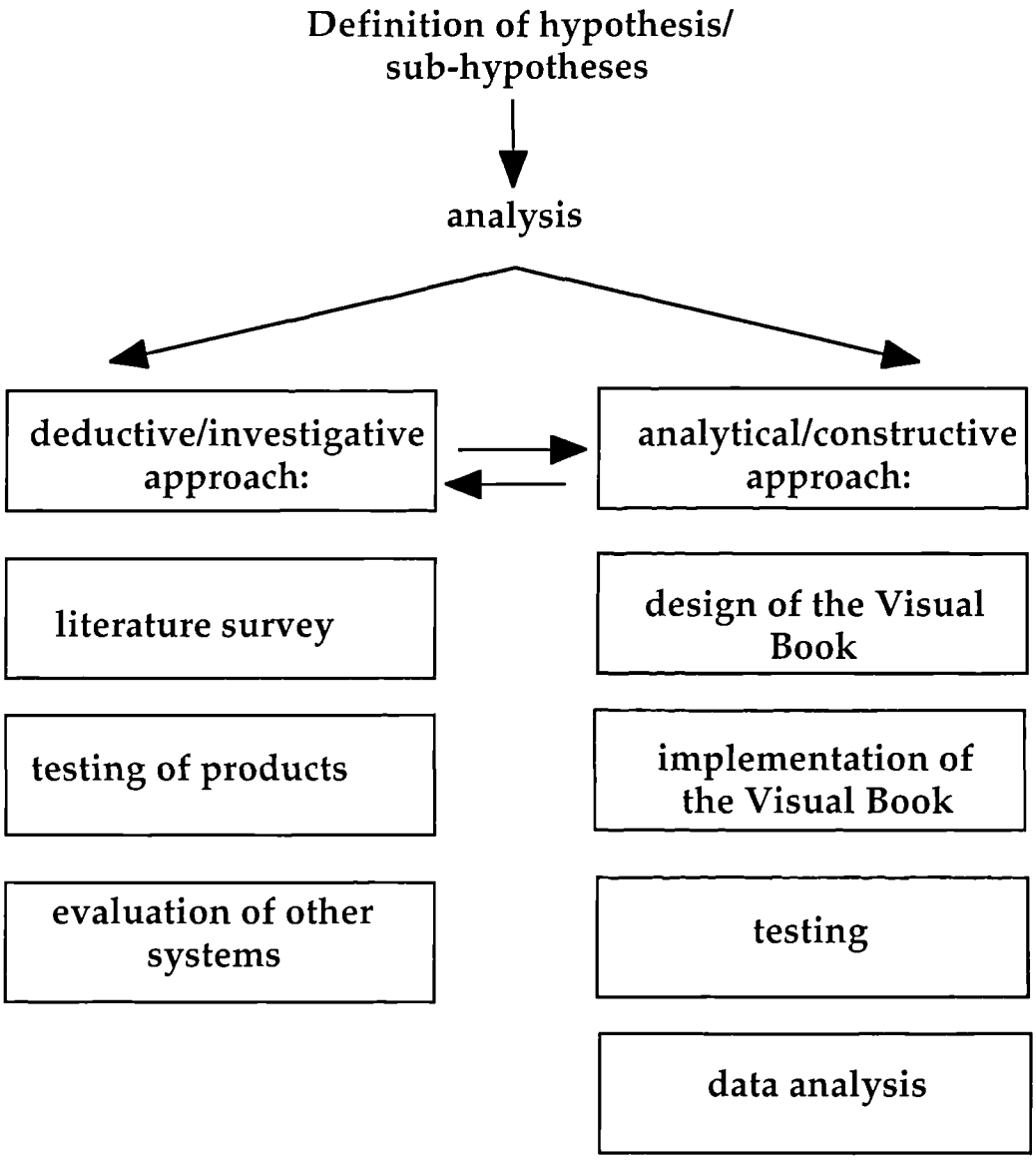

Figure 3.1: *Methodology Steps*

First, a system for electronic book authoring and consulting had to be designed and implemented in order to provide a valid test for the theory proposed. To complete and validate this experiment there was a second phase of use and evaluation of the

system by user groups who were selected according to the specific application being evaluated (see section 6.4.3).

This chapter follows the scheme depicted in Figure 3.1 up to the design step, while the subsequent steps are considered in chapters 4 through 6. The analysis techniques which were used to expand the general hypothesis asserted in chapter 1 are described below.

3.2. Analysis Techniques

There are a number of different techniques for obtaining information about specific design requirements (Benyon *et al*, 1990):

- Task analysis identifies what operations have to be performed by the system;
- Requirements analysis specifies the system functionalities;
- Usability testing defines the acceptable performance of the system in a context determined by the types of user and the specific tasks which they have to carry out.

A large number of task analysis techniques were studied in order to help the designer to collect information about the users' tasks. These methods can be divided into macro, in which the whole system is analysed; intermediate, where the system is divided into subparts; and micro techniques, where elementary tasks are studied and reduced to cognitive units.

A promising technique, among the macro ones, is open system task analysis (OSTA), which aims at studying the changes related to the introduction of a computer system into a working environment (Eason and Harker, 1980). The information extracted with these methods is expressed through flowcharts and natural language. This technique was applied from the start of this research with respect to general issues such as the role of information systems, information providers and information users, and how the appearance of information can influence complex information systems. After this initial analysis the application of this method to the Visual Book system led to the study of the effect of the

introduction of the Visual Book to both the publishing and the reading and consulting processes. The resulting changes on the way that tasks within these two systems, such as information publishing, delivery, retrieval and consultation, are subsequentially performed has also been evaluated. Because of the generality of this method and the dual function of the Visual Book system, e.g. as a system for publishing and consulting books, this analysis was found to be too general and for this reason other less general techniques have had to be considered.

The most commonly used method among the intermediate analysis techniques is hierarchical task analysis (HTA) which, as the name suggests, describes a task in terms of a hierarchical tree of subtasks (Philips *et al,* 1988). This too could be applied to the Visual Book study, as a way to reduce the system to its minimal components, but after a more careful study of the issues related to the Visual Book, and after realising how they were all interrelated (e.g. going to an index page does not have to come before or after consulting a Table of Contents, or running a search or flipping through the book, as they all perform similar and interchangeable roles) a holistic approach has been chosen instead of a reductionist one, and this has made the hierarchical approach the least suitable. The same kind of solution, but at a more in-depth level of description, is provided by micro techniques like goals, operators, methods and selection rules (GOMS), a family of models which use the description of methods to accomplish specified goals (Kieras, 1988). Here methods are described as a series of steps made of elementary operations the user has to perform (Card *et al,* 1983). Selection rules are applied in order to choose between different methods. The finer level of description makes this methodology more suitable to the analysis of the Visual Book's fundamental tasks but the problem is that there is not yet a family of models which have been applied to electronic books in general and hence cannot be used with the Visual Book.

Another micro technique is cognitive complexity theory (CCT). This is based on the subdivision of the how-to-do-it knowledge of the system into knowledge of how a system works and the overall context (job-task environment) (Kieras and Polson, 1985). An appealing feature of this method is that the resulting specification can be used as the basis for an executable system. However, system-oriented methodologies are not compatible with the user-oriented philosophy which is at the centre of the Visual Book system.

An alternative technique, among the micro ones, is the command language grammar (CLG), a top down approach, based on grammar specification, which provides four connected levels for the description and examination of the system (Moran, 1981). Task-action grammar (TAG) has been proposed to model the relationships between a user's tasks and actions ((Payne and Green, 1986). The advantages of applying this technique to the analysis of the Visual Book has been carefully considered, as a grammar-based technique seemed quite promising, flexible and productive in terms of producing a suitable model for the Visual Book. Its application, together with another well-known formalism (Petri Nets) which is particularly suitable for modelling concurrent processes (Stotts and Furuta, 1989) will be analysed in the following chapter in the context of the design of the Visual Book.

Usually interviews and questionnaires, together with evidence obtained from an existing system, are considered to be the appropriate methods for collecting information for the requirements analysis. However, in the case of the Visual Book, the objective was to test a set of specific hypothesis and sub-hypotheses. These were based on a previous requirements analysis conducted as part of the SuperLibrary project at Ispra and there was therefore no need for an additional requirements analysis phase (Catenazzi and Argentesi, 1991).

There is also a wide range of usability test techniques which can be used to find the most suitable technique for each kind of task and user. This is an area of research of extreme importance for this thesis and, for this reason, chapter 6 is dedicated to this subject.

The discussion of analysis techniques above has shown that none of them can completely match the needs of the Visual Book design as dictated by the hypothesis and sub-hypotheses listed in section 1.2. This set of hypotheses focuses on the importance of visual rhetoric in designing electronic books and can be interpreted as the fact that information content and information appearance contribute in equal ways to the value of the information. The value of information can be measured on the basis of how its target audience do or do not use it and how satisfactory the whole process is for the actors involved in it. It is clear that such a general assumption must then be reduced in analytical terms in order to be more easily

validated. For this reason the first step in dealing with this assumption has been the definition of a well known field of action: book production, delivery and use. When considering the specific field of study no single analytical approach has been shown to be completely satisfactory for dealing with all the processes and actors involved. For this reason different techniques have been used in order to explore as deeply as possible the publishing and reading processes. For the same reason another group of techniques belonging to the deductive - investigative family have been used while gathering information about similar experiments.

3.3. Deductive and Investigative Approach

As indicated in figure 3 this strategy commences with a phase of bibliographic searching in order to collect material about systems that, at least partially, match the description resulting from the previous analysis (see section 3.2) and to present a report containing the results of using and evaluating these systems. There are two broad areas within which it was possible to look for systems which match the requirements related to the hypothesis of this research. The first one was hypermedia systems for document access and consultation, and the other was document imaging systems (DIS). Both of these topics have already been discussed in the literature review (see sections 2.3.5. and 2.4). The rest of this section concentrates on a subset of systems which are particularly relevant to the Visual Book.

The Visual Book system has been designed to produce an object, the Visual Book, for presenting information of different types (text, picture, sound and video) and which will be used and read by a scientific audience. For this reason it is important to study and understand existing paradigms for the presentation of information and, even if at the moment there are no standards or well defined models, it is still relevant to consider a class of applications which has been faced with the same problems. That is, providing users with an appropriate interface for accessing different types of electronic documents.

One of the most promising experiments in the area of electronic access to documents is the Chemistry Online Retrieval Experiment (CORE). This is a large collaborative project (Lesk, 1991) which has involved the participation of many organisations: the Mann Library, the American Chemical Society, BellCore and the

Online Computer Library Centre. The project has been aimed at developing a prototype system for the storage, searching and displaying of primary scientific journal data in electronic form together with related graphical information such as tables, graphics, etc. Specific consideration has been given to the acquisition phase of the material and to the problem of evaluating an electronic library. An interesting peculiarity of this project is that it considered interfaces for both character display (SuperBook) and image display (PixLook) (Lesk, 1991). This feature is the one that has been considered carefully while designing the Visual Book system. In fact the Visual Book system could be considered as the interface for image display while its sister system, Hyper-Book (Catenazzi, 1994), could be seen as the interface for ASCII and HTML text. However this analogy does not work when it comes to the real nature of the two systems. Even if they started from the same general project, the SuperLibrary project (Catenazzi and Argentesi, 1991), still the principles involved in their design are very different. The Visual Book focuses on the importance of the appearance of the information carried by the book and its main aim is to provide some guidance for presenting information in electronic format starting from existing standards for presentation on paper (typographical and designing rules). The Hyper-Book is more concerned with investigating the electronic publishing world and related standards, and in providing electronic functionalities to the final user. Thus the analysis of the CORE project has helped to define more strictly the purposes of the design and development of the Visual Book.

A second important initiative is the Mercury project, which is based on the idea of a full text electronic library and has been developed at Carnegie Mellon University (Arms and Michalak, 1990). The project aims to demonstrate that current technology (high speed networks, high resolution screens, multimedia facilities) and the techniques for processing electronic documents, make it possible to build such libraries. Mercury has also evaluated a number of different approaches for acquiring and storing documents (e.g. scanning documents and saving them as images or capturing documents in machine readable format). It is another example of a project which attempts to incorporate a dual representational approach to information, i.e. text and the image of the text, where the page image is still considered as a secondary source of information while the electronic version of the text is the main one. Their analysis of the state of the art for presenting text images on a screen is

quite interesting but no attention has been paid to the presentation issue which is the core of the Visual Book study.

A further project which should be considered when exploring the interpretation of the library metaphor in an electronic environment is WALT, (**W**ashington University **A**pproach to **L**ots of **T**ext) (Frisse *et al*, 1991). It is not directly comparable with the two projects mentioned above because it is only a prototype interface built on top of a hypertext system. However it presents a lot of interesting features related to this research. It is composed of several elements which permit the user to examine a document, navigate it, and retrieve information. Search algorithms are refined by incorporating readers' judgement values about the material already presented (relevance feedback). The originality of its approach is the design of navigational tools following the shelf metaphor. Two components of this interface are particularly relevant and close to this research, the Book Shelf and the Spine Book. The first one offers a way of examining a collection of books through a graphical representation which is based mainly on their size. Books are presented on a shelf with legible titles so the user can browse a library shelf just as they would in a physical library. Book Spine provides the reader with an additional clue while reading the book by giving a graphical representation of chapter number and size (the ratio between each chapter and the rest of the book). Interestingly this component does not follow any existing metaphor, but introduces a new style of representation for physical book thickness (chapter size) combined with the logical book structure (chapter number). This hybrid representation can support user browsing in the book, but may also be confusing by not being as natural as the shelf metaphor used in the same interface. The importance of the proper use of metaphors is a crucial issue for the development of the Visual Book design as is the possibility of introducing new concepts that are not part of the book metaphor. The WALT project is a first step in this direction and as such has been carefully studied before producing the Visual Book design.

A meaningful comparison between books converted into electronic form through different hypertext systems and their paper counterpart is presented in (Rada and Murphy, 1992). The authors of this paper converted a textbook into four hypertext systems resulting in four different books:

- Ebook, based on extended Emacs-Info system (by Free Software Foundation);
- Gbook, realised on the Guide system (by Office Workstation limited);
- Hbook, related to the HyperTies system (by Cognetics Corporation);
- Mbook, based on MaxiBook (by BellCore), a particular version of SuperBook (see project CORE for more details).

The evaluation of the usability of these electronic books when compared with the paper counterpart has been conducted by examining the response of three sets of people: experts, novices and instructed, who were asked to perform some searching and browsing tasks on the different kinds of book. For each system the accuracy and the completeness of searching and browsing facilities have been evaluated. The results of these experiments show that paper is a good support and, especially for novels, it is the preferred one, resulting in the highest quality and speed in solving their tasks. Better results were obtained by systems which imitated the paper style, including page presentation and reference to the original page number. The conclusion arrived at by the authors is that hypertext and the paper book have to collaborate in order to present active information in a familiar way. This finding is very important for the demonstration of the sub-hypotheses (see section 1.2) of the Visual Book system.

While all other projects deal with a particular kind of information for a very practical reason (mainly related to the source of funds for the project), no serious consideration has been given to the suitability of different kinds of information being translated into electronic form. One of the assumptions of the Visual Book research is that not every kind of information is suitable for translation, as it depends on its contents, the purpose of the editor and author, how it is used, the context of its use and the profile of the possible users. For example the novel is generally written for a general audience which is not expected to own a computer. It is also expected to be read sequentially, from the beginning to the end. For this reason the designer and the editor of the paper version should have made sure that the quality of print would enhance the legibility of the novel, and that the book has an appropriate size and weight so that it can be taken and read everywhere. There is no need for great attention to be paid to pictures, titles, indexes and table of contents because the main component of this kind of information is its contents rather than its appearance.

An electronic version of this kind of information would have to place emphasis on technological features such as the availability of a light weight technology to support reading, which is cheap and easy to carry, and a very high resolution in order to at least match the paper version. The Visual Book experiment was involved in studying and proposing appropriate representation guidelines for electronic information with particular attention to the information and users' profiles. In this sense the Visual Book can be seen as a user and information-centred system, while the technological aspect is considered as important but not one of the primary subjects of this research.

A different area of research, DIS, has been a source for additional suggestions. DIS have been considered in order to identify technologies and tools that might be relevant to specific modules when designing the Visual Reader as an essential component of the Visual Book system. The study of various DIS systems has lead to the definition of a number of common modules which appear in the Visual Book design scheme (see chapter 4):

- input - the acquisition module for the use of scanners after establishing options and settings;
- processing - the image elaboration module which consists of tools for image processing, OCR, compression, etc.;
- storage - the module for supporting the storage on appropriate supports while addressing the file naming issue;
- output - the presentation module which considers high resolution screen, size and format.

The overall result of this evaluation of systems which are similar to the Visual Book albeit from different points of view, can be summarised as follows:

- the importance of the representation issue in electronic publishing;
- the crucial role of metaphors in designing interfaces combined with the integration to new functionalities more computer related (e.g. search facilities);
- the user-profile and information-profile as central components of the system;
- a list of technological issues to be considered for the design of specific modules.

3.4. Analytical and Constructive Approach

This approach is aimed at the design and development of a system which matches the requirements resulting from the analysis of the hypotheses of this research and which will be evaluated by users; the data resulting from this evaluation has then been analysed in the concluding part of this research. The rest of this chapter focuses on the first steps shown in figure 3 from the analytical/constructive approach to the design of the Visual Book, and leaves the other three steps to be discussed in the following chapters: chapter 5 for the implementation and chapter 6 for the testing and analysis of the results. A certain degree of feedback between the deductive/investigative approach and the analytical one is highlighted during the discussion in this section. Therefore this section starts with the introduction of principles for helping to achieve a good design which have been found in the literature. These are the results of research and observations by experts in human factor studies which all agree on the following four principles as a result of their findings (Gould, 1988):

- Early and continual focus on users: i.e. the necessity of a continuous and direct monitoring of user requirements and reactions to the system from the beginning and during the development of the design;
- Integrated design: i.e. the importance of paying attention to all the different aspects of the usability of the system at the same time because they all influence each other and the final result;
- Early and continual testing by users: i.e. the need of user testing at every stage of development of the system;
- Iterative design: i.e. the system has to be tested and modified continuously at each of the development stages according to user feedback.

This set of rules is so generic that it can be applied successfully to different system specifications and user requirements. At the same time it provides an effective way to help and control the design process. Each of these rules needs to be made more specific and tailored to suit different design needs. The first principle, concerning user monitoring, can be implemented in various ways according to the kind of users that are to be observed and their availability, e.g. students are easier to convince than business people partially because they are supposed to have more free time, or at

least their time is not as expensive, and partially because students are expected to be more curious and interested in new things while business people are already too involved in what they are doing and do not like distractions. A second step toward the implementation of the first rule is the definition of appropriate protocols and methodologies for observing and collecting data about the users' behaviour. In this case there are also many different possibilities according to specific needs, but a strong recommendation from the same group of experts (Gould, 1988) is the importance of being in direct contact with the users and being able to talk and explain to them what, why and how the system will take note of their reactions, doubts and wishes. Techniques that can help in performing this task can be divided into two broad categories: the ones to be used to obtain a good level of knowledge of the state of the art before the introduction of the system under design, and the ones to provide some initial feedback on the reactions of the users to the introduction of the system at a very early stage (i.e. prototypes or simulations on paper).

Among the methods for assessing the state of the art before the introduction of the system are:

- videotapes or audiotapes of users while they are working: to understand the existing procedures and the way the new system is going to fit into the existing environment;
- surveys and questionnaires to collect more information and build user profiles;
- observation of users working to learn about how their work is organised; to understand how people are expected to work and to get a background of where and consequentially how the system is going to be used;
- task analysis for learning about the way users perform their job, which is accomplished by collecting information about the main work activities, requirements and the environment.
- involvement of experts in the design team, in order to get some meta-information about the use of the future system;
- involvement of users in the design team in order to get access to an extremely valuable source of information on what the system is actually supposed to do on the practical side.

All these methods work well when the system and its future users are well-defined and reasonably restricted. In the case of the Visual Book, the purpose of

the system has always been well defined but its environment can vary considerably. In addition aspects related to electronic and paper publishing processes had to be taken into account, and because of the size of this task none of the methods mentioned above proved to work effectively i.e. none proved able to provide results in a reasonable time span. Bibliographic research and reading has therefore been the main source of information. With regard to the process of reading personal experience and bibliographic research have been the essential tools for collecting material, with special attention being paid to psychological studies of the reading process. Another source of information has been the analysis and use of electronic books which are commercially available (e.g. Expanded Books™, by Voyager) or on the Internet (e.g. scrollable books such as those published by the Library of Congress, or electronic newspapers with a paper counterpart) as representative of what the user can be familiar with and can expect from the present state of the art.

Among the techniques which could be used to evaluate the usability of the initial versions of the system are:

- trying the system by its designer, in the case of the Visual Book this has been done continuously with the assumption that the designer and the reader have to exchange their roles;
- thinking aloud: where the user thinks aloud in presence of the designer while using the system, or a system simulation;
- testing behavioural target goals: this consists of defining a representative target goal which the system is supposed to be able to accomplish and proving that the new system can perform it in a time that is less than the previous system and with very little help from the design team to explain how to perform it. The time issues have not been considered as vital for the Visual Book because the amount of time spent in reading a page depends heavily on the kind of reading, purpose, skills and attitude of the reader, and eventually on the typographical aspects of the page more than on the efficiency of the Visual Book system in presenting pages to the reader .

The integrated design principle, (see above), states that all aspects of usability have to evolve together. This point is particularly important in situations where different

groups deal with different aspects of the project, such as the system architecture, the user interface, and the help documentation. In such a situation it is essential to integrate the contribution of the teams in order to have a clear and general vision of the development of the project. The key word in this case is the project management structure which has to be flexible enough to ensure exchange of results and suggestions, and strong enough to avoid loss of contact between partners. A solution would be to have a single person who has the responsibility for all the different aspects of the system involved in the design. This makes the whole process centralised and prevents any loss of communication but at the same time puts considerable pressure on one member of the team and makes his/her role crucial for the future of the system.

Methods for carrying out early and continual testing by users include methods to check the reactions of the users to initial versions of the system and involving the use of different methods to simulate the real system such as (Benyon *et al*, 1990):

- printed or video scenarios; often used while developing the Visual Book, it is cheap and effective especially when it comes to the consideration of representation issues;
- an early user manual, written even before the system has even been designed completely;
- mock-ups;
- simulation of some of the components of the system; this has been used in the Visual Book design, especially when considering the inclusion of components which were not in the original book metaphor;
- early prototypes, as part of a series of increasingly complex prototypes resulting from discussions on what the Visual Book role is and what it is going to prove;
- formal prototypes, i. e. more refined versions of earlier ones;
- early demonstrations; these were often used for the Visual Book, because of their ease of use, low cost and effectiveness;
- test to destruction contests, or in the case of the Visual Book more of a "try to get lost" contest, to check the way that hypertext functionalities of the system worked;
- follow up studies, i.e. studies of the real use of the system after it has been released in order to collect data for future versions or new similar products.

All these empirical techniques contribute to obtaining plenty of immediate feedback from occasional and intensive users and do not require much time or effort to be prepared by the design team or to be performed by the users. They represent a set of effective techniques for obtaining cheap quantitative and qualitative feedback on the future system even before it has been completely designed.

Iterative design is another way to obtain continuous feedback from the users, it is mainly related to the use of good software tools for the designers to be able to work and make changes in a flexible environment where the interface module can be modified independently by the rest of the applications. Authoring systems such as HyperCard for Macintosh, which has been used for developing the Visual Book, and Visual Basic for PC are good examples of how these tools can work and help the task of designers by making it possible to work in a modular way and by providing a powerful and flexible environment.

The previous sections have highlighted the specific role of the Visual Book in relation to other electronic publishing systems in terms of the definition and evaluation of guidelines for electronic publishing and with an emphasis on the representation of information in an electronic context rather than on the production of a particular system driven by innovative technologies. For this reason the design and the evaluation have been the most crucial steps in the development of the Visual Book. Details concerning evaluation techniques can be found in chapter 6.

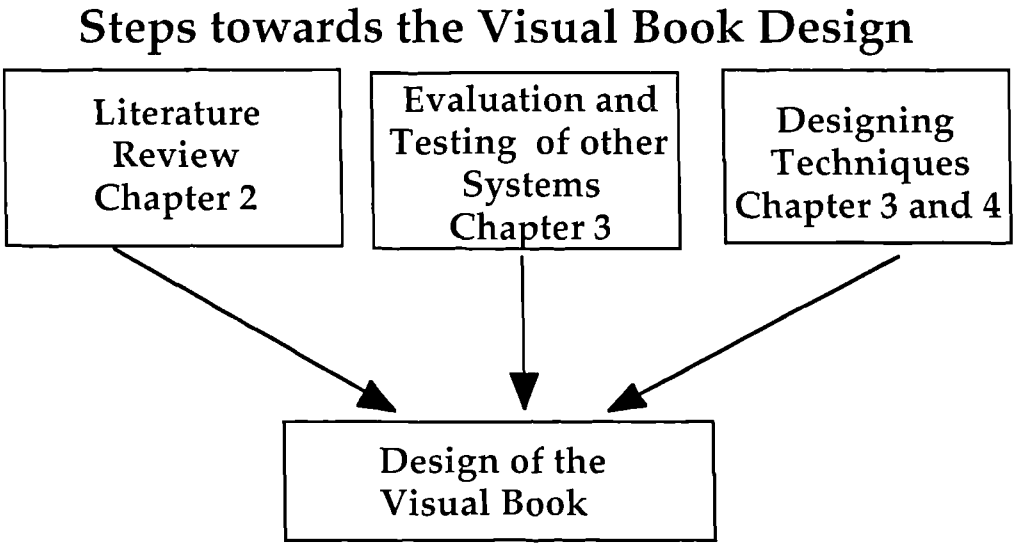

Figure 3.2: *Steps toward the Visual Book*

The design of the Visual Book system is the result of various steps (see Figure 3.2) such as the literature review contained in chapter 2, the evaluation and testing of related systems with observations on appropriate approaches (described above) and the introduction of design techniques which are discussed and applied in the next chapter. In particular the deductive and investigative step (see section 3.3) has resulted in a list of trends and principles from the examination of similar products either on the market or the subject of research elsewhere, as well as from the literature available on related areas (mainly DIS and hypertext systems). It has also provided indications of useful components of the system which must be considered. At this point it has become possible to outline a promising development platform and examine more practically the system design. The result is an initial design of the structure of the whole system, its functionalities and its interface as shown in Figure 3.3.

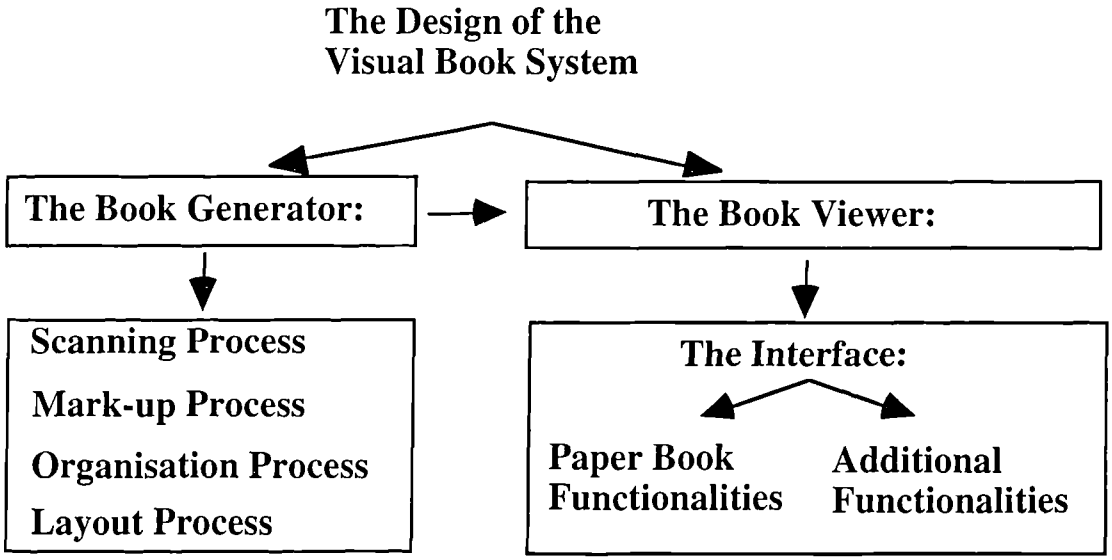

Figure 3.3: The *Design of the Visual Book*

The final architecture consists of an Authoring System which allows the designer of electronic books to compose the visual page, define the Visual Book structure and select reader services, and a Book Viewer which provides the final interface to the Visual-Book. Design techniques such as the ones highlighted in section 3.4. have then been employed in order to assist in the production of a system which is able to demonstrate the hypothesis and sub-hypotheses of this research.

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Chapter 4:
Visual Book Design

4.1. Introduction

The Visual Book is a system which has been designed to provide an electronic environment for proving the hypotheses of this research. It represents only one of a number of possible interpretations of the electronic book, but it has provided useful insights into the effectiveness of these concepts. The design of a prototype for the Visual Book has involved an in-depth study of design methodologies, and in particular has concentrated on the use of metaphors for the development of human-computer interfaces. The focus of the metaphor within this research is the book and its usage, both of which have been identified as important subjects for investigation (see chapters 2 and 3). The result of this investigation has been the definition of the components of the prototype.

4.2. Design Principles

There are a number of possible approaches to the design of an interface for an information system, depending upon the model used (Carroll, 1985, 1988). A simple way is to follow a naive-model which entails asking potential users of the system their expectations, and then to design an interface which satisfies these. A possible variant of this procedure is to start the design process with a preconceived model, and then to build a prototype, test it, and modify it through an effective interaction with users and their model of the system. This is a classical methodology, often termed the empirical approach, which has been extensively used for designing applications. In particular it has been used for the introduction of the desktop metaphor to the interface for office systems. A problem related to this strategy is the difficulty of separating, during an iterative process, the intended results of the model from the side-effects of other aspects of the redesign.

A second method is based on the possibility of reducing the system and its interface to its minimal (i.e. essential) functionalities but still testing the appropriateness of the translation of the chosen conceptual model. The difficulty with this approach lies in extracting a representative subset of the system in order to obtain a meaningful evaluation where a system does not yet exist. There is a danger that essential features may be omitted or simply left unidentified.

A third method emphasises the approach followed by users while learning how to use the system. The knowledge of how to interact with the system can be formalised and the resulting representation can be used to determine a satisfactory interface structure. On top of this structure will be built the different visual layouts which make up the final interface. For practical reasons, usually, these two parts, the structure and the visual layout, are independent, so that they can be developed at the same time by two distinct groups of programmers. The lack of connection between these two essential components of the final system makes it difficult to optimise the presentation of a sound mental model based on a task-oriented analysis. Even with these problems this approach seemed to be the most suitable for a system such as the Visual Book which is heavily dependent on end-user participation and approval, a factor which has driven the design philosophy. The purpose of the system is to provide users with a tool that they will use satisfactorily in order to successfully and

easily accomplish tasks they would have to solve with non-electronic tools. The technological component has not been considered as a central aspect but rather as a medium to be used to satisfy users' needs. Taking these considerations into account, the Visual Book has been designed as a user-centred project, and for this reason the study of users' needs and users' behaviour has played a crucial role in its realisation at every step of design, implementation and evaluation. In order to apply this approach it was necessary to understand the difference between the different kinds of formalisms, which can be used for representing knowledge, which are already in use, or discussed in the literature, for similar systems.

According to Carroll (1988) the user has three main types of perspective of the knowledge which they need to use the system:

- A simple sequence of actions which solve a particular situation;
- Knowledge of methods, where the representation consists of a description of goals and subgoals, together with the methods to accomplish them;
- Mental models, which deal with knowledge of the system with respect to its components, the underlying system processes, and the effects on the system components.

Mental models can provide a more complete knowledge of the system they are modelling and they can be more helpful in driving the design process (Carroll, 1988). For this reason they have been chosen for defining the components and the behaviour of the Visual Book system.

4.2.1. The Visual Book Definition

A mental model is a kind of conceptualisation that allows the user not only to construct actions for novel tasks but also to explain why a particular action produces the result it does. The term mental model is commonly used to refer to a representation of a physical system or software being run on a computer, with some reliable causal associations connecting the input to the output. It can be conceived as containing that knowledge about the system which is sufficient to permit the user to mentally trace actions before choosing the one to execute.

It is possible to distinguish between four different kinds of mental model (Carroll, 1988):

- Surrogates, which imitate perfectly the input/output of the system to be designed, but do not take into account the way it works internally.
- Metaphors, which are the result of the comparison between the desired system and one which already exists. For each task-action pair (i.e. a pair composed of the description of a task which has to be accomplished by users and the action which is required to cause that result) in the target system it is possible to find a counterpart in the metaphorical system which works following the same logic. It is essential to define the level of complexity which the metaphor will incorporate. One problem is identifying those metaphors which are valid for the user.
- Glass boxes, which are like surrogates as they imitate perfectly the target system and at the same time work like metaphors by helping users to understand the semantic content of the various parts of the system. In general they are the result of using different metaphors in order to produce a final surrogate of the system;
- Network models, which are composed of the possible states of the system and the actions which cause the passage from one state to another.

From this brief overview it has been concluded that the key to the proper use of metaphors is generally in being consistent and always taking into account previous experience, background, and expectations of the people to whom the metaphors are going to be finally presented. The metaphor approach has been chosen as the focus of this thesis (see below for a more detailed discussion). The elements which are translated in this model are those related to both the external and internal representations of a book.

The idea has been to emphasise the visual references that readers follow naturally and which are the result of an effective design process. Those parts of the text which are in bold or italic, or in a different size, indentation, meaningful spaces, or a particular choice for location of text are all visual cues that are embedded in text and which a reader captures automatically as a result of her/his reading experience in general, and of the familiarity with a specific design style. These features have to

be translated into electronic form by following a consistent and meaningful formalism.

An interesting evolution of the notion of visual cues in a book is the use of a mark-up language, e.g. a subset of SGML expressions (Smith, 1987a, 1987b). This has been defined in parallel with a colleague's thesis work (Catenazzi, 1994) and is based on electronic text translation to hypertext (in order to formalise this form of intuitive knowledge). This involves fundamental notions about reading processes in humans as well as design principles. Both these areas are based on heuristic observations and therefore the interpretation used as the basis of this module is only one of a number of possible views.

4.2.2. The Visual Book Model

A model for the Visual Book has to specify both its elements and the operations performed on them. Hammond and Allison (1987) suggest that there are four levels which could be considered when assessing how to translate a metaphor into a system: task, methods, lexical and physical. Within this research the third and fourth levels have been joined into one, the appearance level, as the nature of the Visual Book system has been mainly centred on the appearance of the metaphor in its general sense which includes both terminology and physical aspects. The role of each level is as follows:

- task level, which describes the tasks which can be performed by the system and the metaphor;
- methods level, which describes the semantics of the system and the metaphor;
- appearance level, which consists of the lexical level - the level which describes what are the entities of the system - and the physical level - the level which specifies how they are represented (as in Hammond and Allison, 1987).

An example of the application of this formalism to the case of the Visual Book system can be found at the end of this section.

It is possible to add a further specification to this description by distinguishing between those components inherited from the original book and additional features provided through the use of the electronic support. A generic book (B) consists of:

- a cover page (CP), characterised by the presence of pictures, colours, large titles;
- an ordered set of units called pages (P), visible two at a time when the book is open. Each of them contains text, and/or graphics and tables presented in various order, but according to a format common to the whole book;
- a back cover page (BC), which usually has the same style as the cover page but contains less essential information such as its author's biography, a brief summary of the contents or titles of related publications.

More formally this could be expressed as B = {CP, P, BP} (see notation used in Catenazzi, 1994). The set P contains a subset of elements (pages) which have a specific traditional meaning. In particular it is worth mentioning:

- the title page, which presents the title of the book, possibly in the style of the cover page, and contains a lot of white space;
- the copyright page, which is easy to recognise from the presence of a specific symbol for copyright (e.g. ©);
- the dedication page, which contains at most a few sentences which are usually at the top right of the page;
- the preface, which can span more than one page. Usually Roman numbers are used instead of Arabic ones, which are normally used for the main text;
- the table of contents, which is usually composed of two columns, one with titles and the other with page numbers;
- the appendices, which can have a style which is different from the rest of the text;
- the bibliographies, which are composed of small independent blocks, one for each reference;
- the index, which provides access to the subjects in the book.

Some of these pages are identified by a special notation in the formalism introduced by Catenazzi (1994) where the set of Pages is identified as $P = \{P_{ToC} \cup P_{in} \cup P_{fig} \cup P_{tab} \cup P_{body}\}$ (see Table 4.1)

P_{ToC}	pages which are part of the ToC
P_{in}	pages which are part of the Index
P_{fig}	pages which contains figures
P_{tab}	pages which contains tables
P_{body}	body pages

Table 4.1: *Notation from the Hyper-Book*

Table 4.1 can be modified to represent all the elements of the Paper Book model as shown in Table 4.2.

P_{ToC}	pages which are part of the ToC
P_{in}	pages which are part of the Index
P_{app}	appendices
P_{bibl}	bibliographies
P_{tit}	title page
P_{cop}	copyright page
P_{ded}	dedication page
P_{pref}	preface page
P_{body}	body pages

Table 4.2: *Notation for the Paper Book*

The action of reading and consulting a paper book can be assisted by a set of syntactic elements and actions, which are not mandatory apart from the first one:

- a browsing tool, commonly the hand of the reader which turns pages backwards and forwards;
- a reading cursor, such as a finger, that marks the reading path;
- bookmarks for marking special pages;
- a pencil or pen for adding comments and notes;
- a highlighter or a coloured pastel for highlighting parts of the text;
- a piece of paper to annotate information extracted from the book and to be used in a different context;

- the presence of books connected with the one currently being consulted, e.g. a glossary, a dictionary, a manual, books of the same collection, of the same author, of the same subject or other specific correlated sources.

According to the formalism introduced by Catenazzi (1994) bookmarks, annotations, notes and highlighters are represented using a state notation in order to take note of the changes on the book and the reading flow which are the consequence of the application of the actions listed above. The Visual Book notation is the same as in the Hyper-Book experiment because the definition of the user services has followed a similar approach which has been inspired by the Paper Book system. Thus the Paper Book system, described above, takes information as input from its author/s and supports users in reading/consulting it .

The Visual Book model takes as its basis the Paper Book and translates it into electronic form while focusing on its visual components. The general structure is the same as for the paper book, and it is possible to recognise an ordered set of units called visual pages as a set of specific visual elements composed of images of the original:

- the cover page;
- the back cover page;
- the index;
- the table of contents;
- the preliminary pages;
- the final pages;
- body pages.

In the case of the Visual Book the notations of table 4.1 had to be changed to take into account other special pages (see Table 4.3) where the term special is referred more to their visual components than to their function in the book. Thus the Visual Book can be represented as VB = {VCP, VP, VBP}, with VCP being the image of the cover page, VP the set of the visual pages and VBP being the visual back cover page. The set of visual pages is $VP = \{P_{ToC} \cup P_{in} \cup P_{pre} \cup P_{body} \cup P_{final}\}$. In this notation $P_{pre} = \{ P_{tit} \cup P_{cop} \cup P_{cop} \cup P_{pref} \}$ and $P_{final} = \{P_{app} \cup P_{bibl} \}$ to simplify the use of symbols.

P_{ToC}	pages which are part of the ToC
P_{in}	pages which are part of the Index
P_{pre}	preliminary pages
P_{final}	final pages
P_{body}	body pages

Table 4.3: *Notation for the Visual Book*

However, these objects have different and specific features and properties when compared with their paper counterparts. In general, most of the elements belonging to the Visual Book are images and the operations performed on them are determined by their particular nature: i.e. an image editor has to be used in order to manage these data; effective interchange of information depends on the existence of suitable filters to translate from one image format to another; compression techniques have to deal with images and are usually based on specific algorithms, and so on. Furthermore the Visual Book has to take into account other information such as the dimensions of the original page, its location on the screen, and all attributes which deal with quantitative aspects of the book and which must be specified at the appearance level.

4.2.3. The Interface for the Visual Book

There is a list of basic requirements which a well-designed interface must take into account (Carroll, 1988):

- an easily recognisable metaphor must be at the heart of the interface;
- data, functions and tools have to be considered in the context of a task-oriented cognitive model;
- an efficient navigation scheme has to be provided in the cognitive model to avoid users feeling lost while using the system;
- the quality of each visual element presented on the screen has to be as accurate as possible;
- it is important to provide an effective interaction sequence, a sort of operational protocol, between the visual elements.

As part of the Visual Book these issues have been considered carefully and have been reflected in the design of the Visual Book Interface module which is described below.

The interface for the Visual Book consists of two parts, a graphical simulation of the shape and dimensions of the book, and a set of tools which allow the reader to use the Visual Book by imitating the normal actions which are performed on a paper book. The representation of the content of the original book is particularly important. The image of each page is presented on the screen in an attempt to reproduce exactly its original format. In this way the information maintains the format resulting from the initial design process on paper. This choice allows readers to exploit a memory of the original page which they may already have and provides a presentation paradigm for electronic information based on conventional use and cognitive relevance. In order to define in more depth the impact of the book metaphor on the Visual Book system the three levels of specification defined in the previous section have been used (as in Hammond and Allison, 1987). An example of the analysis on the way a formalisation of the Visual Book works is presented in Table 4.4. Section 4.3 contains more details on the choice of a formalism for the Visual Book, where the complete formalisation of the Visual Book System can be found in Appendix A. This formalism has been used to study and show how the Visual Book interface is consistent with the original paper book metaphor.

	Metaphor	Target
Tasks	Consult a book	Consult a book (the contents of a set of page images)
Methods	Open it, search in it, read it	Open it (selecting and clicking on it), search (browsing by clicking on active areas), read it
Appearance	3-D book	2-D image of a book

Table 4.4: *Formalism for the Visual Book: an Example.*

4.2.3.1. The Task Level

A study of the task level has been carried out by considering the use and requirements readers of Visual Book will have compared with those of the same reader when using a paper book. Because of the assumptions made earlier as to the type of Visual Book user (i.e. a scientist requiring factual information) a set of fundamental tasks have been identified:

- consulting the information in the book;
- searching for information which will allow readers able to solve a specific problem;
- searching for specific pages or logical/physical elements of a book, such as paragraphs or pictures which somebody else could suggest as being relevant to users' needs;
- personalising the book, by leaving clues as to the reading history and the specific interests of the reader.

Each of these tasks can be reduced to elementary ones which are then easily interpreted as methods for satisfying user needs.

4.2.3.2. The Method Level

The set of methods available in a system defines the semantics of the system. i.e. the meaning of the system in terms of what it can be used to achieve. In the case of the Visual Book system these methods consist of a set of complex actions which represent complex tasks which the Visual Book is able to achieve, while assisting readers in problem solving, such as:

- letting users consult the book and retrieve the information they are looking for;
- letting users browse the book in case they can find something they are interested in (using serendipity);
- letting users personalise their use of the book so that they can always go back to previous reading experiences.

These tasks can be decomposed to simpler ones such as:

- opening the book;
- turning the pages;
- printing the pages;
- zoom in on a detail of a page;
- jump to a page;
- use the ToC;
- use the Index;
- search for a string;
- add notes;
- add a bookmark
- close the book.

The way these tools are presented to users is defined by the appearance level.

4.2.3.3. The Appearance Level

In order to map the appearance level of the book metaphor onto the design of the Visual Book System two main components had to be considered: the book template and the icon design.

Book Template

The book template is a graphic simulation of a paper book's external appearance. In particular the dimensions, the size and the shape have to be as close as possible to the original version. The thickness is supposed to give the same information about the position of the reader in the book as in reality. This representation is similar to the one used in the Book Emulator (Benest *et al*, 1987), but instead of having indistinct black bands in order to represent the number of pages already read on one side, and the ones left on the other, there is a proportional number of black lines depending on the relative quantity of pages to be represented. This is the same approach used in Hyper-Book (Catenazzi, 1994), a related PhD research strand developed in the same general project, Super-Library (Catenazzi and Argentesi, 1991). Tools for consulting the Visual Book are active areas of the screen and are represented as icons. They are grouped in a rectangular area at the top of the book template in order to make it easier for the user to find them.

Icon Design

The crucial points when designing the icons for the interface of the Visual Book were to maintain consistency, specificity, clarity, effectiveness and validity. A trade-off had to be made between the level of expression supported by the computer and the need to replicate objects and actions which have already a real representation in everyday life. The resulting choice consists, in this specific case, of using icons which are familiar to the user who has already experience of using computers, and of maintaining the same style when creating new ones, in answer to the specific needs of Visual Book.

4.3. A Formalism for the Visual Book

In order to choose a valid and operable formalism for representing the Visual Book system different possibilities have been examined. These include grammars such as the BNF-style grammars of Reisner's interaction language (Reisner, 1981) and task-action grammar (TAG) (Payne and Green, 1987), and representations based on first order logic or on net formalisms. The most pertinent aspect of the Visual Book that was considered when assessing these formalisms was the importance of the pragmatic aspect of the system; that is, that the emphasis is on the way information is presented rather than on its contents. This observation led to the selection of a net formalism (transition networks (Genrich, 1987)) to model the system behaviour and an icon based language (Catenazzi, 1994) to describe the page content.

Transition networks are less sophisticated than Petri Nets (see chapter 3) in that they do not cater for parallel processing. This choice was made because parallel processing does not occur in the Visual Book system. The main advantage in using transition networks is that they provide a powerful mechanism which is easy to use and understand, and which is suitable for representing the flow of actions and reactions between the system and the user. It is crucial in this case to isolate the relevant tasks performed by the user with the system and to highlight the meaningful steps necessary to accomplish them. From this first analysis it is possible to extract the elements of the net and associated states and transitions, also called cases and

steps. A transition relation specifies how cases are transformed into cases by the occurrence of steps. Thus a system can be specified by naming the conditions and the events which are the basic elements for defining the set of states, the set of transitions and their associated transition labels, and the initial case c_{in}. The graphical representation presents the state elements as circles and the transitions as boxes, while the members of the relation are indicated through appropriate directed arcs (Rozenberg and Thiagarajan, 1986), an example of the application of this formalism to the Visual Book is shown in Figure 4.1.

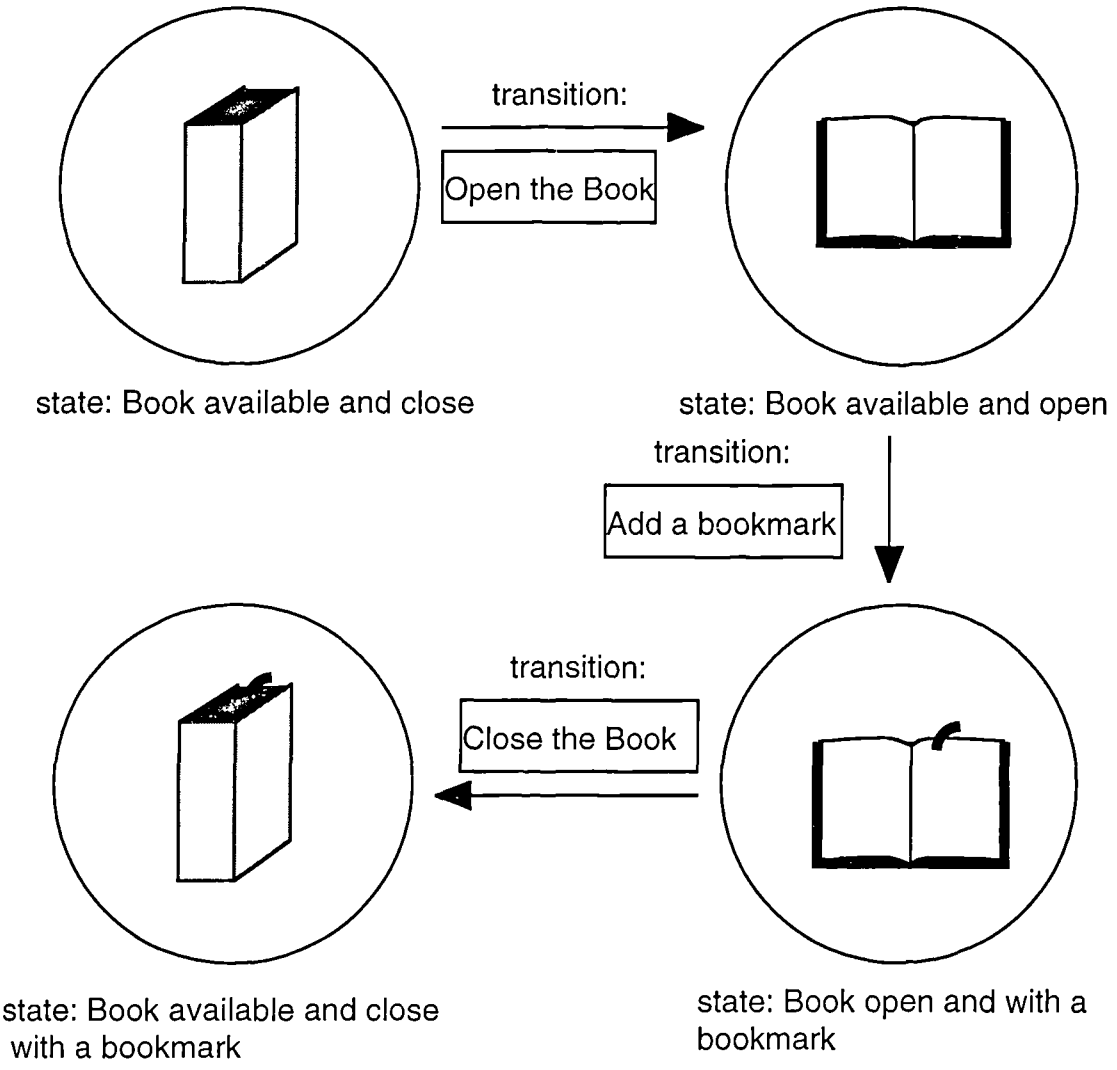


Figure 4.1: *Transition Network for the Visual Book: an Example*

A language based on icons was introduced in order to represent the visual objects presented on the screen. Its main role was to reproduce the original paper page and its visual features such as the presence of titles, pictures, tables, graphics, notes, headers and footers, the style and the format of presentation. In the case of the Visual Book an icon called page representation (Furuta, 1989), which reproduces the original page as it is on paper, was found to be effective and provided the possibility of presenting in more detail specific components of the physical page as rectangular areas, called blocks in the elementary case, or frames if they are nested areas, following ODA terminology (Brown, 1989). The lexicon of this language (see next section) was used to label the net elements (i.e. conditions with icons and transitions with alphabetic strings) and included a set of icons representing different states of the system.

4.3.1. Lexicon and Rule/Transition Definitions for the Visual Book Model

This paragraph introduces the lexicon and rules used to define the model to guide the design and implementation of the Visual Book system. This model is very similar to the one used for the Hyper-Book (Catenazzi, 1994) and it was selected because it allowed a comparison of the two systems to be made from the very start of the design process. The lexicon for the Visual Book model consists of a set of objects which play different roles in the production and display of a Visual Book, such as:

- typographical components of the book;
- a grid for assisting the designer in the composition of the pages of the book;
- tools which represent functionalities of the Visual Book.

Typographical components are objects which have a specific presentation style which conveys information on their role in the book such as:

- covers, which have the role of attracting the attention of the user;
- headings, which have to guide readers through the content of the book by representing its logical structure;
- page numbers, which help users to orientate themselves in the book and access pages they already know about;

- titles, which provide semantic information on the content of the book by using visual clues;
- images, which contain visual information;
- tables, which present tabular quantitative information to users or short summaries of the content of the book;
- captions, which add a textual component to the information in images and tables;
- open pages, which are the reading unit which the eyes of the reader use to span;
- special pages which provide meta information on the content of the book such as:

    - pages with a Table of Contents, which provide summaries of the logical structure of the book ;
    - pages with an Index, which provide a searching mechanism for terms in the book; these are usually found in scientific books;

- margins which simulate those of the paper book in order to support the use of annotation and bookmarks.

Tools which represent functionalities of the Visual Book are those which imitate the way the Paper Book system works and are presented in Table 4.5 along with their related icons (Catenazzi, 1994).

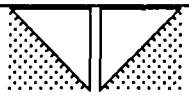
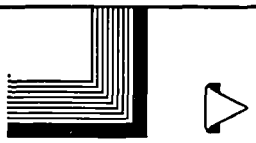
turn page	
flip pages	
go to page, using the thickness or specifying the page number	
print page	
zoom	
add notes	
add/remove bookmarks	
go to index	
go to ToC	
search	

Table 4.5 : *Visual Book Functionalities and Icons*

The rules which apply to these objects are a subset of those defined for the Hyper-Book (Catenazzi, 1994) and are described in terms of state-transitions according to the net formalism defined by Petri (Rozenberg and Thiagarajan, 1986). Browsing in the Visual Book is modelled according to a graph with conditional links. This is because some tools are only available while readers are browsing or interacting with specific parts of the Visual Book, e.g. if a user is in Pages of the Table of Contents then s/he can click on them and go to the corresponding page of the Visual Book. A summary of the transitions for the *not special states* (i.e. readers are consulting normal pages) and the *special states*, i.e. where the reader is either in a special page, (e.g. reactive pages such as ToC, Index, Cover), or the reader is interacting with reactive parts of the screen, such as margins or images, is given in Table 4.6:

state:	valid transitions:	new state:
not special state	normal transitions:	
	turn page	next page/previous page
	go to page n	new page n
	print page	same page
	add notes	same page with added info
	add/remove bookmarks	same page with added info
	go to index	index page
	go to ToC	ToC page
	search for a string	page where the string has been found or same page if no success
special state:	special transitions:	new state:
margin interaction	click margins	go to pages in position equivalent to the one on the margins
image/table interaction	zoom	enlarged table/image
ToC consultation	activate link in ToC page	page linked to the ToC
Index consultation	activate link in Index page	page linked to the Index
Cover interaction	open the book	page 1 of the book

Table 4.6: *State-Transitions for the Visual Book*

The model introduced in this section is compatible and consistent with the one designed for the Hyper-Book (Catenazzi, 1994), not only because they are both the result of a similar process of abstraction from the book metaphor but mainly because one of the purposes of this research has been to show the importance of the definition of a "good" model as being one which can be used for different implementations of the same concept, the electronic book. For this reason the design step has been a crucial one in this research by providing indications not only of the validity of the use of metaphors for building electronic books but also on how to use them in an effective way.

The first step in defining the model for the Visual Book, starting from the Hyper-Book model, was to remove all the features which are related to the practical

implementation of the Hyper-Book. The second step was then to tailor it to the Visual Book needs. These first two steps showed how flexible the model is and how useful it could be for future designs of different electronic books. At the same time it became clear that such a model has at least a couple of drawbacks:

- real life designers may find it too abstract and they may not find it "friendly" and easy enough to use it in an operational context;
- new paradigms for the presentation of electronic information are going to emerge as technology develops and this model may not be able to represent them.

The result of the adaptation and use of this model for the Visual Book case has led to consideration of to what extent it is intrinsically and strongly dependent on the book metaphor interpretation, and how difficult it could be to introduce new paradigms of representation within it. The models for the Hyper-Book and the Visual Book system are both very specific interpretations chosen from an infinite number of possible valid models which could cover and represent these two particular systems. Therefore there is a need for a set of design rules (for the design of generic electronic books) which can be consulted and eventually applied to ensure the presence of the basic features required for objects to be called electronic books. In order to assist electronic book designers in the future a set of more relaxed heuristic rules could then fill the gap between research and production of operational electronic books. These rules are proposed as guidelines rather than as part of a logical model with the intention that, in this form, they will be more easily and widely used, accepted and modified.

4.3.2. Design Guidelines for the Visual Book

Design guidelines for the production of electronic books have been presented in chapter two. It is clear that to date only limited work has been done in that direction and that the emphasis in the production of electronic books has mainly been on the final product rather than on defining a paradigm or a set of rules in order to achieve an abstract object worthy of the label "electronic book". The definition of what an electronic book is, or has to be, is quite loose and unfortunately this is unavoidable because of the nature of the object and the difficulty of defining something with so many aspects and functionalities (see chapter two for definitions of a book). As there

were clear problems in defining an object, even though it is very familiar and popular and has a long history of production and use, it is not surprising that it was also difficult to define an object which is derived from it. A possible solution was to collect heuristic rules and principles as a result of careful analysis of examples of electronic books which already exist and use the reader perspective as a discriminating factor. In general the perspective of the whole research described in this thesis is centred on readers and their needs, expectations and requirements. This was the first guideline and the main concern while designing the Visual Book system. After making this basic assumption, it became easier to find some elementary and basic guidelines for producing electronic books. The first step was the definition of three basic different categories of electronic books:

- those created from books which have only ever existed on paper;
- those originally generated in electronic form for subsequent printing on paper;
- those available only in electronic form.

This study focuses on the first category and mainly on the process of translation of existing paper books from paper to electronic form. For this reason the book metaphor plays a crucial role in the definition of guidelines for the design of the Visual Book. These guidelines fall into two broad categories. The first category is concerned with establishing whether a book should be produced in electronic form:

- reasons for producing books in electronic form: if somebody is going to read it and eventually prefers it to the paper version containing the same information[1]; this can happen in the following situations:

  if its paper version does not completely satisfy the reader;
  if there is no paper version and the electronic version can solve problems of dissemination and time wasting;

1 It is crucial at this point to clarify the notion of information as the combination of data plus interest in somebody to read, use or consult it. Another important issue is to define how relevant for information is its appearance, and how much information is carried by this appearance.

if reading from the screen is not a problem, i.e. the book is going to be "used" more than "read" sequentially;
if the electronic environment is easily available to the reader, i.e. the user is in a specific computer/electronic oriented environment already.

The second category considers when the term "electronic book" can be applied properly with reference to some basic requirements which need to be satisfied in order to make the use of this label/term appropriate.

- reasons for calling an electronic product an "electronic book": it has to resemble, be consistent with, and work according to some or all aspects of the book metaphor with no ambiguities, conflicts, inconsistencies or confusion. It is necessary to avoid situations such as the object on the computer screen looking like a book but:

the page metaphor is not respected, e.g. there is only one page at a time, or pages have scrolling functionalities so that the page is no longer a fixed unit for presenting information but a never ending scroll where the information can be easily lost, pages are extremely small in order to fit the screen.
the logical structure of the book is not considered. There is no table of contents, nor an Index. These are substituted by search facilities which can be more confusing for the user. This kind of mistake is usually related to the enthusiasm for substituting and/or introducing computer-oriented features to the book system without considering their effects on readers used to consult the paper counterpart;
the book template is used to present different kinds of information, not necessarily book related, the result being a heterogeneous system that has to be designed very carefully in order not to confuse users.

This is just an example of how the study of existing trends in producing electronic books together with the observation of readers' reactions, can lead to the definition of heuristic rules for the production of "good" and "readable" electronic books. There is of course more work to be done but the aim of this thesis is to show the importance of this study for the future of electronic books.

4.4. The Visual Book System

An analysis of document imaging systems, (see chapter 2) has resulted in a list of system components (modules). Thus, the final architecture of the system consists of an authoring system which allows the designer of electronic books to compose the visual page, define the Visual Book structure and select reader services, and a Visual Book Viewer which provides the final interface to the Visual Book.

4.4.1. The Authoring System

The authoring system provides support for three processes:

- the scanning process;
- the design (or layout) process;
- the organising process.

A designer of electronic books has to go through these three main steps in order to construct a Visual Book, and readers can access it through the Visual Book Viewer, which is an environment which provides tools for consultation of a Visual Book depending on the choices made by the designer in the previous steps.

4.4.2. The Scanning Process

This provides as output a readable image of each page of the paper book, together with more accurate images of its specific components (pictures, photos, tables and formulae) and an informative file, the Book Descriptor, which contains information specifying:

- the total number of pages of the book;
- the ISBN, International Standard Book Number, of the book;
- a list of locations of pictures, photos, tables, formulae in each page.

The first item of information has to be given in order to control the browsing process. It is not possible to extract this from the table of contents of the book

because of the presence of non-conventional enumeration (e.g. roman numbers for the introduction), blank pages, interrupted page sequence, or even final pages with additional information which are not strictly related to the book's content. The extraction of this kind of information can be performed using well-known segmentation algorithms but at this stage of the prototype, because of technological limitations connected with the chosen platform (i.e. the difficulty of implementing such algorithms for the chosen platform), it is realised manually.

The ISBN (International Standard Book Numbering) is information which is usually found on one of the initial pages of the book. It is not compulsory but it is very common for new publications. It is often used as an entry point to the MARC (MAchine-Readable Cataloguing) database which contains information about the logical, physical and subject features of the book. Publishers have the ability to generate a new ISBN for each book thus giving each book a unique, and international, numeric code. This was developed by the Library of Congress in the late 1960s and later ratified and adopted as a standard in early 1973 by ISO (ISO 2108, Information and Documentation).

The list of locations of pictures, photos, tables, and formulae is essential for reconstructing the final image of the page. The various components of the original page are treated in different ways depending on their nature (e.g. text is scanned with a different resolution then color images or black and white graphics), and need then to be reassambled according to the original page layout. This information has to be provided only for this particular implementation, in order to simulate the output of the segmentation process. In a future implementation this segmentation process will be performed automatically and will not need this additional information. One special output of this module is the table of contents and indexes of the original book interpreted via OCR. These represent a natural source of secondary information (meta-information) about the contents of the book. For this reason it is important to interpret their content in order to provide active interaction with the static information contained in the book.

4.4.3. The Design Process

This module can be interpreted as a special enhanced version of the image processing module described in chapter 3. In particular, after processing the output of the scanning module and taking care of the appearance level of the pages, the design module adds a logical structure on top of the pages to reproduce the same structure as in the original book. The design process takes as input the scanned images and the Book Descriptor file, producing the images of the final pages as they are going to be presented to the reader together with a list of user services which support consultation of the book. This list is the result of the requirements expressed by the classical designer and the designer of electronic books. The system suggests possible reader services and users can choose between them, selecting those which are more suitable for the consultation of a specific book. In specifying possible reader services it is important to take into account the subject of the book, the context in which it is to be used, and the tasks readers are supposed to accomplish. All of these are the same parameters as for the paper version of the book, which are themselves the result of the analysis performed by the classic designer. Aspects more related to the reality of the electronic book, and for this reason with the activity of the electronic design, focus on the specific nature of the Visual Book and the active role offered by the electronic support.

After a first brief analysis and evaluation of these parameters, based on discussions with colleagues, a comparison with similar systems, and the study of user needs and the personal experience in reading and consulting scientific journals, a set of desirable reader services has been extracted. These include:

- a set of navigation services:
  - the possibility to turn pages forwards and backwards;
  - the possibility to go to a certain page;
  - access to the reactive table of contents;
  - a history mechanism;
- a set of personalising capabilities:
  - the facility of adding and deleting notes;
  - the insertion of bookmarks;
  - the possibility of highlighting part of the text;

- a set of linking facilities:
  access to related applications (word processors or image processors, the application of OCR techniques);
  connection between books of the same collection or in different libraries.

Another output of the analysis described above has been the definition of a mechanism for the presentation of the Visual Book on the screen. The decision made at the beginning to maintain exactly the same appearance as in the paper version leads to the necessity of simulating physical aspects such as the correct size, dimensions and thickness of the paper book, as external features, while the coverpages, the sequence of pages and their position on the left or on the right of the open book are represented as internal features, which are related to the specific book and its contents. It is also important to decide whether or not to present the book open on a reader's desktop as a private corner of a more general library where the reader can access other related publications as well as contact people with the same kind of interests. Alternatives to this choice, some of which, and in particular those based on virtual reality techniques, have been investigated in the Super-Library project (Catenazzi and Argentesi, 1991), include:

- letting users access the book through catalogues instead of allowing them to browse through a graphical simulation of shelves of a visual library;
- letting users refer to an electronic librarian, e.g. an expert system, which is able to guide them in their searches;
- letting readers consult the book on their private desktop;
- obliging users to print the parts of the book they intend to read.

4.4.4. The Organising Process

This starts with the output of the previous two processes, and results in the organisation of the page images of the book according to the original logical structure of the book. This process is driven by the information contained in the table of contents, together with the content of the Book Descriptor file. This task can be performed entirely automatically. In this case the role of the designer is to consider non-standard situations and to provide any necessary changes. This is

particularly important for special sections such as preliminary pages or final pages which are freely interpreted in different collections/series of books. Particular attention should be paid to special reactive pages. such as, in the case of the Visual book system, the Table of Contents pages and the Indexes pages. Both of these need special treatment with respect to the definition of links with the rest of the passive pages in order to translate appropriately their role from paper to the electronic environment. This is a case where the interactivity of electronic support is a real advantage in comparison with the passivity of paper, but it is still important to maintain the appearance level of the metaphor in order to be able to use the cognitive background of the reader.

4.4.5. The Book Viewer

Starting from the result of the authoring system this provides the reader with a flexible and natural environment for book consultation. A minimal set of default features, based on the philosophy followed in the Design Process, has been defined in order to present the reader with a satisfactory interface to the Visual Book. The process of construction of the Book Viewer module is performed in a semi-automatic way where information collected during the previous interaction with the designer of electronic books are interpreted and related to the physical features of the screen and the hardware equipment the reader can access.

4.5. Conclusions

This chapter has highlighted the modules and the features that had to be implemented in the Visual Book system in order to provide a valid tool for the test of the hypothesis of this research. In particular the Visual Book system was divided into two main modules:

- the Visual Book Generator;
- the Visual Book Viewer.

For each of these the design analysis resulted in a list of requirements for the system architecture and the interface which was taken as input by the implementation

process. The next chapter explains how all these factors were considered when implementing the Visual Book Generator and the Visual Book Viewer, and the various problems and issues related to the productions of the prototype of the Visual Book system.

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Chapter 5:
The Implementation and Production of the Visual Book

5.1. Introduction

The Visual Book is a particular interpretation of the electronic book in which the physical aspects of a paper book have been key to its construction. The book metaphor has been expanded following the image rhetoric approach (see chapters 1 and 2) so that its visual components constitute the main elements involved in the electronic translation. The focus is on the book's appearance as this is part of a cognitive background which the reader already possesses. The Visual Book is a method of presenting information in a familiar way in an electronic context. Book functionalities have been designed in relation to how physical books are used, so that information will be presented in a natural way. At the same time reader activities are supported in a user-friendly environment as supported by the results of the Visual Book evaluation (see chapter 7 for more details).

There are a number of possible interpretations of a visual book (see chapter 2) and the one selected as focus of this research is based on the collection of page images

organised in a way to simulate the real book structure. An elementary model for the Visual Book was the result of the design phase of this research (see chapter 4). This is composed of pages, interpreted as pictorial objects with the functions of *previous* and *next* for moving between consecutive pages. The page can be segmented and different visual components labelled and used as clues for information retrieval. At the same time additional relationships can be defined between those objects which correspond to the structure of the book and those functionalities which are offered by the computer as a communications medium.

This chapter is concerned with implementation issues and the production of the Visual Book system, whose components have been described in the previous chapter. Figure 3.3, in chapter 3, highlights the various components of the system which are described in the rest of this chapter.

The process of producing the Visual Book system starts with the implementation of an authoring system, the Visual Book Generator, which assists the Visual Book designer to create the Visual Book Viewer This chapter also describes technological issues related to the production of the Visual Book and the way they have influenced the final result, the Visual Book system, its evaluation, and the overall findings of this research.

5.2. The Visual Book Generator

During the design of the Visual Book Generator some practical suggestions were provided by the CORE project and its paper image application: PixLook. The authoring environment for the Visual Book has to offer the following key features:

- a set of commands for acquisition process management (which should be as simple as possible) which is the implementation of the acquisition module;
- a set of commands for the application of the visual mark-up to the output of the scanning process;
- a set of commands for page image management (a subset of the system commands in order to manage only a particular kind of file, each of which

contains the image of one page, and organise them freely), which implements the organisation module;
- an iconic interface which is as natural as possible and which inherits and imitates different features from publishing and design processes which is the design module.

It also has to be the equivalent of an editor for handling text.

Following the study of mental models in the design interfaces, this research proposes that the role of the electronic book designer should be considered as a technologically enriched version of that of the paper book designer. In fact the design of the electronic book and its interface require specific expertise in order to be able to combine features of the paper design with those computer functionalities which the reader will find more useful. The main issues in implementing the Visual Book Generator are:

- image acquisition: legibility and storage, and then text image management;
- system management: efficiency and effectiveness;
- interface definition: consistency, metaphor, maintenance and ease of use.

5.2.1. The Visual Book Acquisition Process

This is mainly a scanning, image processing and compression process. The purpose of this module is to acquire good images of the book pages by recognising different components of the scanning process such as:

- multipage acquisition;
- parameter setting (contrast, brightness, etc.);
- image process (filters and cleaning functions);
- image storage.

The final result has to be a perfectly legible page, which is as close as possible to the original and which takes up the minimum amount of storage. Possible approaches have been suggested by the CORE (Egan *et al,* 1991) project and similar

studies. In the CORE project document images are acquired from existing microfilms. CCITT Group IV[1] compression is then applied so that each page captured with 300 dpi resolution will occupy only 100k.

After the acquisition process a mark-up phase takes place at two levels:

- to distinguish between different sources of information (mainly graphics, tables and text); this is the general level and algorithms commonly used in OCR can achieve this task without difficulty.
- to tag elements which already have clear visual importance in the text as a result of the design process (references to picture, notes, titles, abstract, current headline and so on). This particular task needs interaction between the electronic designer and the system to resolve ambiguities in a process that more closely involves human reading abilities.

The mark-up process is used to help the electronic designer in assembling the electronic page as it will appear on the screen.

A small subset of scanned pages were also transformed into ASCII text by using OCR and stored both in their image and textual versions in order to have them as reactive pages in the Visual Book Viewer. Reactive pages are those with active links on them which allow the reader to browse freely the information contained in the book. In particular the pages of the Table of Contents and the pages containing the index terms have been saved in text form in order to be available for automatic searching and browsing for the reader.

5.2.2. The Visual Book Mark-up

The book is a very important component of the authoring process. The purpose of this module is to use the visual references that readers follow naturally and which are the result of a good design process such as: parts in bold or italic; parts with different font, size and indentation; meaningful spaces; a particular choice for text location.

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1 see http://www.advent.co.uk/ccitt.html

These make it possible to define, on the basis of visual rhetoric, for each page a visual mark-up which reflects its logical structure. In effect it has been judged essential to incorporate all those visual clues that are embedded in the text and which readers capture automatically as a result of their reading experience and of their familiarity with a specific design style. These are the implicit and explicit elements which are meaningful for a reader and which have to be translated into an electronic form which is consistent and helpful.

The idea for realising this task has been to introduce a mark-up language, possibly a subset of SGML (Standard Generalised Mark-up Language, ISO 8879, see Smith, 1987a; Smith, 1987b), defined in parallel with a colleague's work (Catenazzi, 1994) based on electronic text translation into hypertext, in order to formalise this kind of intuitive knowledge. This involves fundamental issues concerned with reading processes in humans as well as design principles. As both these areas are based on heuristic observations the interpretation used as the basis for this module is only one of those possible and which attempted to incorporate aspects from different views e.g. text-oriented languages such as SGML, presentation-oriented mark-up languages such as PDF (Portable Document Format by Adobe) plus expertise in typography and book design.

5.2.3. The Visual Book Organisation

After acquisition, the organisation of a single page, and the mark-up of the distinctive objects contained in it, there is a final step related to the assembly of the book. The page is not a discrete, standalone entity and it has to be integrated into a structure which imitates a classic book. Elementary features, such as the sequence of pages, transform a set of objects referred to as the electronic page repository into the electronic book. The hierarchical structure which forms the basis of the common notion of a book is maintained, but a hypertextual perspective is also possible for electronic book consultation. The presence of special pages such as Indexes and Table of Contents offers a meta-information source (e.g. the Table of Contents provides active references to the logical structure of the book and the Indexes contain a list of key terms available for searching the book) that contributes to the final definition of the electronic book in terms of its hypertextual structure. The

model proposed to represent this structure is one specified by Barker (1991) with some additional features connected with the different nature of the electronic book proposed in this study. The active components such as ToC, Indexes, footnotes and references have been interpreted based on their paper counterpart. Particular attention has been paid to studying and implementing additional functionalities such as possible external links, ToC management and Indexes presentation.

Two distinct stages of development of the electronic book were considered. The first was realised by using the original (paper) information, in image format, after the acquisition process. The second stage took into account other kinds of information such as video, animation and sound, building on the results of the first study.

The first prototype started from the original page content and separated text from non-text (picture tables). At this point the mark-up process took place, recognising and labelling the meaningful parts of the page. After the first phase, whose aim was to update different page components, the next step was to put them together following the original book design and maintaining the same pagination and visual features which already existed in the paper version.

The designer of electronic books could then evaluate the reconstructed page to decide which particular functionalities should be added in order to make the electronic page more useful and the information more effectively represented. A set of design tools was therefore provided, which imitate the original typographic ones. Particular attention was paid to iconographic representation of commands in order to maintain both conceptual and representative consistency. Integration with additional commands provided by the electronic medium had to follow the same criteria of consistency. Problems which were addressed at this point were:

- how to maintain, in pictorial form, those visual or typographical clues which are explicit in the original text but usually lost in normal electronic translation, such as headings or the use of bold or italics. This is the purpose of the intelligent segmentation process which has to spot all these elements, recognise their functions, and subsequentially translate them into appropriate electronic form;

- how to extract a meaningful list of functionalities which the computer can provide and which the reader will find useful, and how to represent them; this was the result of the book template design module.

5.2.4. The Visual Book Layout

An essential component of the Visual Book Layout module is the repository of images of original pages. This is a file store where the book designer can find different book elements, such as video, audio, text and images, and fill in a template (see Figure 5.1) composed of two parts. The first part of the template is directly inherited from original paper books, it is a graphic which represents an open book, with thickness and margins as close as possible to the original. The idea was to investigate the validity of using the book metaphor to present information on a screen when translated from paper. The result of this analysis could then be applied to books which exist only in electronic form, offering a possible paradigm for electronic book presentation. This part of the template is filled in by the designer using the components stored in the repository, just by dragging and dropping them in the appropriate position in the page, as represented on the screen.

The second part of the template is composed of the dynamic components of the electronic book. These are features which are only supported by the computer, and in particular:

- a set of control commands/buttons (to open, close and consult the book, browse in it following its linear original structure or hypertextual links (explicit) embedded in the text);

- a set of reading and authoring commands/buttons (to support the reader with bookmarks, highlighting tools, annotation tools, and offering mainly a viewing set of tools). (See Benest and Dukic, 1990);

- a set of delivery commands/buttons for printing part or the entire document (a strategy for distribution control may to be introduced at this level).

Most of this module was realised by maintaining a strong manual interactive component.

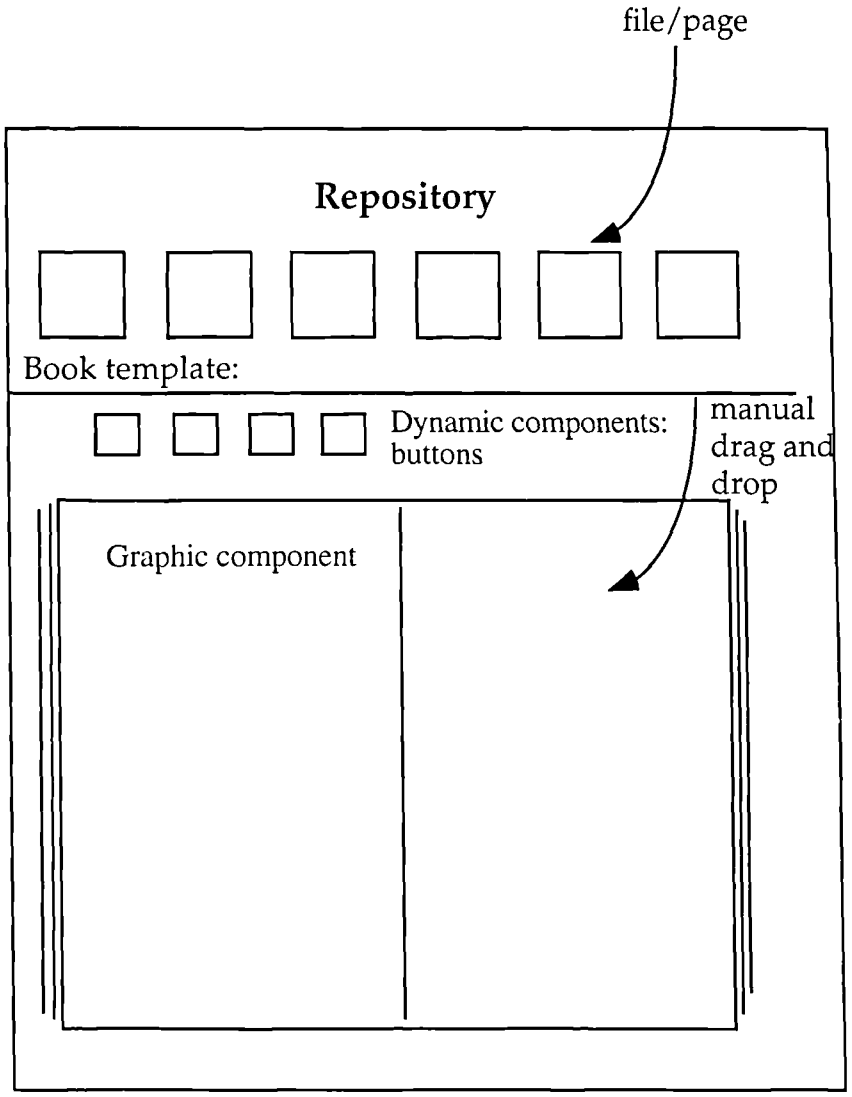

Figure 5.1: *Visual Book Repository: Manual Drag and Drop*

5.3. The Visual Book Viewer

The implementation of the Visual Book Viewer focused on the definition of the Visual Book interface components in terms of the Visual Book template and reader services. The book metaphor, and more explicitly the book appearance, were the basis of the design of this module. In particular, a first step in the definition of the

Visual Book interface was the study of the book's physical aspects, mainly appearance, in relation to book functionalities in order to define the reader services which are available while using paper books. The next step was to discover how the change of medium, from paper to computer, could modify and possibly enrich the book functionalities and thus motivate the definition of a new set of reader services.

5.3.1. The Book Template

The book template (as shown in Figure 5.2) consists of two parts: the paper-like one, i.e. a realistic image of open pages that constitutes the informative component; and the dynamic one that constitutes the electronic designer's contribution to satisfying readers' needs. Practical problems are the size and once more the legibility of the text. Conceptual difficulties are concerned with the study of iconic representation of tools that realise functions which are already part of the common reading experience, and integrating them with electronic specific facilities. In particular the action of flipping pages or the understanding of the position in a book from the thickness of the margins are quite crucial features for the Visual Book which must be designed to be consistent with the book metaphor. In order to achieve this task the margins have been made reactive in response to a mouse click, so that depending on the position of the mouse on the graphical representation of the margins, users are presented with the pair of pages they would have ended up with if they had performed the same action on an equivalent paper book. The turning page action has been implemented on the Visual Book interface by highlighting graphically the corners of the pages and making them reactive in response to a mouse click, so that clicking on the left corner will show the previous pair of pages, and clicking on the right corner will show the next pair of pages.

5.3.2. The Reader Services

The designer of electronic books has to foresee the readers' needs. In the case of the Visual Book Viewer prototype a set of basic functionalities has been provided to satisfy the generic requirements of readers, thereby guaranteeing the features of normal book consultation, and following as closely as possible the original metaphor. Further versions of the Visual Book Viewer should take into account

information about the user's profile in order to tailor the Visual Book Viewer to specific needs. Currently the commands which have been included in the Visual Book interface are (as discussed in chapter 4) a mixture of paper and computer-related services:

- navigation tools, which imitate the way the paper book is browsed with some additional features provided by the computer, such as :
    - flipping pages;
    - turning pages;
    - using margins, as it is possible to do with paper books, i.e. for adding notes or opening the book at a certain point;
    - using the ToC, which is transformed into an active page;
    - using the Index, which becomes an active page;
- printing tools, which are computer-related services;
- personalising tools, which simulate the paper book, such as:
    - annotation in a separate text box, which allows readers to work in an integrated environment on their computer;
    - insertion of bookmarks, which simulates the way this is done with paper books;
- zooming, a computer related service;
- full text searching on the electronic version of the Visual Book available through the Hyper-Book system (Catenazzi, 1994); a computer-related service.

The choice of the commands to be included in the Visual Book template has been driven by the experience of the Hyper-Book (Catenazzi, 1994) together with the purpose of emphasising as much as possible the visual component of the template in order to be able to evaluate the impact of the visual rhetoric in designing electronic books. Therefore, to keep the Visual Book appearance as simple as possible and as close as possible to the original paper book, the commands included in the Visual Book are just a sub-set of the ones in the Hyper-Book.

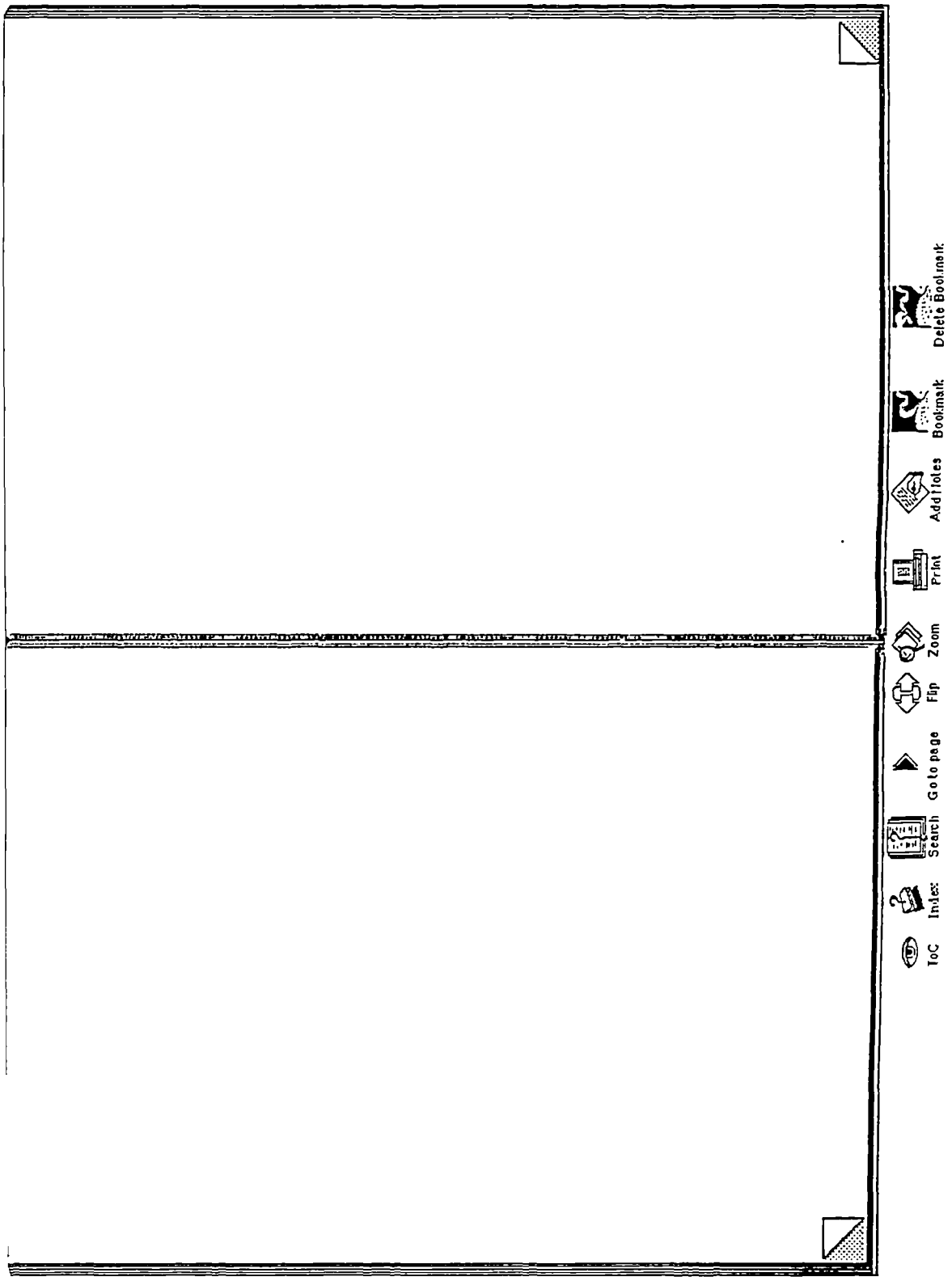

Figure 5.2: *Visual Book Template*

5.4. Technological Problems

The main and most significant technical problem has been the lack of monitors with a resolution which could match that provided by paper. Another essential requirement was that the size of screen should be wide enough to fit an average sized open book, in order to keep the visual impact as strong and close to the original object as possible. After an evaluation of products available on the market or under development it became clear that the technology available in the next few years was not going to be suitable for the purposes of this research. For this reason the Visual Book experiment became more of a conceptual exercise, thus gaining a degree of generality, in the sense that it was no more technology dependent and thus there was more room for investigation and speculation on the role and design of electronic books in the future. In order to produce a prototype to be used for obtaining information on the possible directions and issues for the future implementation of similar systems the size problem was temporarily solved by using as examples a series of scientific publications chosen specifically for their small size. For this reason they were able to fit perfectly on an average 20 inch screen, and the pages were scanned to a reasonably high resolution, 100 dpi, in grey level mode, to match the highest resolution available on a Macintosh screen, i.e. 72/75 dpi. In this way, even if the pages were not as good as desired for real readers it was still possible to study and analyse the production of the Visual Book and its different components. The choice of using as much information as possible from the scanning process had an obvious impact on the amount of storage space required by the pages of a full book but, as this was simply a temporary solution and the cost of memory is getting lower and lower all the time it was then considered as outside the scope of this research to undertake an evaluation of compression and decompression techniques in order to minimise the storage problem. A reason for this decision is that, on the one hand, at the moment it is inconceivable to produce and put on the market a system with such an essential limitation such as the impossibility of presenting decent quality pages and, on the other, the way the legibility problem will be solved by advances in technology will, in all probability, greatly influence the storage problem as a direct consequence.

5.5. Conclusions

This chapter has described the different levels and subjects involved in creating a visual electronic book based on a sequence of integrated steps. A small number of significant examples of similar systems for electronic book presentation (as anticipated in chapter 2) have been used as a guide for the identification of the main electronic book components. A set of technological issues have been raised and analysed before establishing the various components of the prototype. Their solution, and/or the impossibility of finding any solution to some of them, has influenced the way the Visual Book experiment has been conducted, partially modifying its extent and purposes and with a significant impact on both the evaluation and the partial redesign of the system.

The originality of the Visual Book system is that it has focused on the visual aspect of the book. The book metaphor is at the centre of the system development in order to overcome other possible limitations (problems in representation, difficulties in using a familiar tool in a different context and so on). The aim of this prototype has been to investigate both the different aspects of the book metaphor and the way users approach electronic information. The result has also been useful for defining more rigorously the concept of an electronic library, which is closely connected with the new electronic book definition.

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Chapter 6:
The Visual Book Evaluation

6.1. Introduction

The evaluation process is concerned with collecting data about the usability this term is used here in its broadest sense) of a system in order to improve or complete it. There are different ways to measure the usability of a system, mainly by comparison with other products available on the market or with existing standards, or by considering directly its impact on the intended users. The evaluation exercise described here has two main objectives:

- to determine the effectiveness of the interface in use:
- to provide a means for suggesting improvements.

An important feature of the evaluation process is the context in which it takes place, and this is determined by:

- the experience level of users:
- the types of task undertaken;
- the system used:

- the environment in which the study takes place.

The evaluation process is closely related to the design and development of the system and can be carried out as a formative evaluation, which takes place before or during the various stages of the implementation process, in order to influence the product from its beginnings; or as a final evaluation, which takes place after implementation with the aim of testing the proper functionalities of the final system (Gould, 1991; Shneiderman, 1992).

Forms of final evaluation are those where the product is reviewed to check that it meets its specification or tested to ensure that it meets the prescribed standards of, for instance, the ISO (International Standards Organisation). In the case of the Visual Book relevant standards could be found in classes of IT applications in information documentation and publishing (code 35.240.30) and data storage devices (code 35.220) [1] and EC directive 90/270/EEC on principles of software ergonomics (ease of use and adaptiveness of interfaces).

Other more generic parameters should be considered such as the architecture of the system, the efficiency of the software design and so on. In order to define an evaluation process for the Visual Book, a brief overview of various techniques is presented below, followed by an analysis of the main features which were tested in the Visual Book System and a description of the evaluation steps.

6.2. Evaluation Methods: an Overview

The evaluation methods described here are procedures for collecting relevant data concerning the way a user-computer interface works and how the final user reacts towards it. It is possible to classify these methods into four categories as follows (Beyon *et al* , 1990):

- Analytic evaluation;
- Heuristic/Expert evaluation;

1 as found in the International Standards Catalogue at http://www.iso.ch/cate/cat.html

- Empirical evaluation;
- Experimental evaluation.

Analytic evaluation, a formal approach, is based on formal analysis models. These models are derived from the system specification through:

- a task analysis;
- a user interface definition which details the input and the output of all user-system interactions.

It is possible to use different techniques in order to undertake an analytic evaluation of the system, e.g. the BNF-style grammars of Reisner's interaction language (Reisner, 1981) and task-action grammar (TAG) (Payne and Green, 1987). The major attraction of the analytic evaluation approach is that it does not require expensive prototypes and user testing. The main disadvantages of this approach are that it only considers expert users, which are generally a minority, and that it is time consuming because of the amount of knowledge, about the system and its users, the experts need to collect in advance.

Heuristic evaluation (Nielsen and Molich, 1990), also called expert evaluation, is a diagnostic method which can be inserted between the analytic approach and the empirical one. Experts, people with skills in interface design or human factors research, are asked to take the role of less experienced users and describe the potential problems they foresee arising for such users. This method has proven to be attractive because it is less expensive than user testing and usually experts are able to give valid suggestions which can contribute to the effective future development of the system. Drawbacks are linked to the need to find experts (especially in brand new fields), and to the amount of knowledge necessary to reconstruct the user typology.

Empirical evaluation, is the most used and well known. This is realised through experiments with test users following two main methods:

- Observational evaluation. This involves collecting data that provide information about what users do when they interact with an interface. There

are various techniques for collecting data: e.g. direct observation, video recording, software logging, interactive observation, and verbal protocol.

- Survey evaluation. This is a method based on the analysis of users' subjective opinions through the use of either interviews or questionnaires. Many different techniques can be used to prepare interviews and questionnaires, e.g. there are open and closed questionnaires, depending on whether the user is free to elaborate the answers or s/he is forced to select one from a list of possible answers.

Experimental evaluation is where an evaluator can manipulate a number of factors associated with interface design and study their effects on various aspects of user performance. The application of these methods gives information about five key criteria in system evaluation (Marchionini, 1989):

- environment requirements,
- capability,
- usability,
- reliability,
- performance.

Environment requirements are practical ones such as hardware requirements and cost. For an electronic book system these requirements are mainly described in terms of screen resolution, and storage. Capability is related to program specific features, and mainly to its meaning and purpose. In the case of an electronic book this is the capability of the system to let the reader access, read, consult, use and enjoy the information presented on the screen. Reliability and performance depend on both the result of software engineering and the hardware which is available. Usability seems to be the most difficult parameter to measure because of its qualitative nature and its strict relationship with user reactions. Nevertheless studies in this area (see Gould, 1991) have produced heuristics which suggest a number of attributes (e.g. quantitative ones: installability of the system and learning rate measured in term of time; and qualitative ones: average user satisfaction, and fear of not being adequately measured on a scale fixed by the design team) which can be measured as indicators of the usability of a system in order to facilitate and guide the evaluation process.

A further classification of evaluation methods can be made depending on the focus of the evaluation process, i.e. which stages of the system under development have to be considered and which are the most suitable techniques for each of the possible choices. This is particularly important with regard to accomplishing particular system requirements. For example, a methodology for hypermedia system evaluation has to provide timely feedback during the development of new technologies and has to overcome the difficulty of controlling a system composed of a large number of variables, and of understanding its complexity and expressiveness.

In this context the classification proposed by Dennis Egan is of particular relevance (Egan, 1990). Egan gives an overview of different techniques each of which is suitable for a particular phase of development of the system to be tested.

- conceptual laboratory experiments (e.g. Wizard of Oz, a method based on the simulation of the answers a computer would give to user interaction). This technique works well during the initial phase(s) of development, and is useful for defining in more detail the theoretical principles and effects of the system;
- prototype debugging, realised by observing a small number of people while they are using a prototype that still has bugs in it. This approach provides helpful support to the design task, especially by offering a good level of interaction with the real user;
- evaluation of prototypes using prospective end-users. This is obtained by simulating specific end-user tasks. This strategy helps to refine the system and takes care of real and well-specified user tasks and of the context in which they are supposed to be performed.

  naturalistic observation. Here the system has been installed in an operational environment and this method studies its real use. Efficiency, productivity and satisfaction are the main criteria in this evaluation method.

6.3. Usability

A good computer system should be useful, usable, easy to learn and should provide the functions which allow people to accomplish their tasks. Usability refers

to various aspects of the computer system, such as system performance, the user interface and the ease with which the system can be learnt. For each of these it is possible to define a set of parameters which should be considered in relation to the real use of the system. Four key points suggested by Benyon *et al* (1990) which have been used for evaluating the usability of a system are:

- learnability, which is the effort in terms of time and cognitive overhead required to reach an acceptable level of user performance;
- throughput or ease of use, which considers the speed in task performance and the number of errors;
- flexibility, which is the extent to which users can adapt the system when they become more expert and discover new interaction techniques;
- attitude, which is concerned with the level of interest, pleasure and satisfaction in using the system.

System reliability and responsiveness are the basic elements considered when determining user satisfaction or frustration. Other essential components of the usability of a system are related to the types of task the users have to perform and experience with that system, and with the technological elements which are available to the developers and the goals and resources of the development group.

In the definition of usability criteria an effective starting point lies in user performance and user enthusiasm. These parameters have to be considered together with the degree of experience users have of the system. For this reason it is useful to distinguish between novice, occasional and expert users. Measuring the usability of a system is traditionally a heuristic process as it is not easy to introduce quantitative methods to accomplish this task. Although some work has been done in this direction (Sweeney *et al*, 1993) it is based mainly on adding a quantitative measure on top of factors extracted using heuristic processes which are still an essential component of the evaluation process. This is the approach adopted for the Visual Book as described in section 6.5.3. An example of a set of heuristics is the summary usability specification table, which is the result of the application of a method called attribute specification introduced by Gilb (Whiteside *et al*, 1988; Gilb, 1981) and which is used in section 6.5.3.2. The aim of this method is to define operational

criteria for determining the success of a system. According to this method, it is important to specify for each system attribute (Whiteside *et al*, 1988):

- the measuring concept, which is "a descriptive definition of the attribute";
- the measuring method, which specifies what will be measured and what will be used as a metric;
- the worst case, which is the lowest value acceptable for this attribute and which determines the acceptance of the whole system;
- the planned level, which is the desirable level, or the one which the developers are aiming at;
- the best level, which is the level determined by the current state of the art, and which may be useful in defining future developments;
- the now level, which is the current level of the attribute, which has to be compared with the worst, the planned and the best levels in order to determine the necessity of improvements and their computational costs (in relation to the distance between the target and the current situation).

One suggested approach (Whiteside *et al,* 1988) that can be adopted when considering the measuring concept field in the attribute specification table is to use the following list of measurement operations in the following order:

- ask the user to perform a specific task;
- monitor user during free use;
- give user a questionnaire;
- interview users;
- survey users;
- ask user for critical incidents revealing successes or failures.

It is not possible in most cases to carry out all these procedures. It clearly depends on the available resources in terms of time, machines, experts and users and a decision has to be taken about which of the above mentioned procedures to perform. The order suggested by Gilb is generally valid but specific features of the system to be evaluated can suggest small changes according to the degree of development and the size of the whole system and the features of the most relevant components of the system. Thus, a system in a very initial state does not require to be studied through

the use of complicated questionnaires or interviews. It would be better to save time and use that time for changes and refinements to the system. On the other hand a system which is nearly completed has to be analysed as carefully as possible by exploring the whole series of measurement operations.

In order to fill in the measuring method field in the attribute specification table a list of measurement criteria can be introduced as in Table 6.1 (Whiteside *et al*, 1988)

time to complete a task;
percent of task completed;
ratio of successes to failures;
number of commands used;
frequency of help and documentation used;
percent of favourable/unfavourable user comments;
number of repetitions of failed commands;
number of good and bad features recalled by users;
number of available commands not invoked;
number of users preferring this system;
number of times users lose control of the system;
number of times the user expresses frustration or satisfaction.

Table 6.1: *Measurement Criteria*

In measuring the system performance, by considering the worst, the planned, the best, and the now level (according to the terminology introduced by Whiteside *et al*, 1988) it is important to set levels with respect to the objects listed in Table 6.2 (Whiteside *et al*, 1988):

an existing system or previous version
competitive systems
carrying out the task without use of a computer system
an absolute scale
user's earlier performance

Table 6.2: *Comparison Levels for System Performance*

The result of this usability specification is the ability to establish how the usability of a system will be determined and to provide a measure of whether or in what respects the current system meets the specification.

Evaluation techniques have been applied to a number of systems similar to the Visual Book. The IBM Computer Sciences Electronic Magazine (CSEM) is a representative example (Koons, 1992). In this system different metaphors contributed to realising a multimedia electronic magazine. Printed magazines, television, and public information kiosks were taken as starting points in order to design the interface of the final system. The usability testing was split into two parts. One dealt with the usage of various types of paper magazines, observing readers as they approached different formats of presentation and performed defined tasks using both familiar and unfamiliar publications. The second experiment consisted of similar tasks performed in an electronic environment. In both cases the number of users was limited to less then fifteen employees of the IBM Research Division and they were asked to think aloud while using the system. They were invited to express freely the tasks and strategies for achieving them together with their doubts, problems and eventually difficulties.

The result of the evaluation session for paper magazine usage was to extract three main common approaches adopted while using them:

- flipping through pages, skimming to find interesting information;
- starting from the cover and jumping to articles which they found there (as the cover contains references to the items to be found inside);
- analysing the table of contents and jumping to an interesting article.

The second phase of evaluation showed that the electronic system failed where it was not consistent with the original metaphors. For example the lack of a table of contents was clearly a problem.

Another meaningful example is the evaluation phase of the Chemistry Online Retrieval Experiment (CORE) project (Egan *et al*, 1991). In this case there was a comparison between print, hypertext (CORE) and document retrieval (PixLook) systems. The set of journals to be used was fixed from the beginning, and three

distinct sets of users (with homogeneous backgrounds) were observed performing the same tasks in different systems. Each group had half-an-hour of training. Logging programs were used to record details about the use of the systems. A group of tasks was selected as follows:

- browsing task, where the user has to navigate through the journals with a list of topics to look for;
- citation task, where the user has a specific question which can be solved by consulting a known reference;
- search task, the same as the citation task, but the reference is unknown;
- essay task, where the user has to write the introduction to a survey on the state of the art in a given topic;
- analogous transformations, (strictly related to the subject of the journals, chemistry) where starting from a given pictorial representation of a proposed chemical transformation (i.e. transforming substance A into a substance B) the user was requested to find similar ones, where the transformations are represented graphically in pictorial form.

The results were measured in terms of time and accuracy of the answers. In most cases hypertext proved to be the best solution for presenting scientific information, although disorientation and the obscuring of information by layered windows were detected from the evaluation process during the analysis of data.

6.4. Evaluation Criteria for the Visual Book

An important phase in the development of the Visual Book was the description of the evaluation process which followed the realisation of the first prototype. The focus has been on the metaphor of the book interpreted as a graphical simulation of the paper medium which provides an easy to use and powerful interface for information systems, and which offers a set of tools which support the reading and consulting process, thus imitating the system produced by the interaction between the reader and the book.

Another important aspect which results from the exploitation of the book metaphor is the particular representation of the information conveyed by this medium. In particular the importance of maintaining the same typographical features, the design rules, the pagination format and the paper appearance have been considered carefully in order to retain the whole meaning of the original text. The physical aspects of the page are intended to be encapsulated in a set of presentation rules through which visual clues give the reader semantic information about the context. This primary feature of the book metaphor has been considered to be the most relevant and to be an original contribution to the future development of the electronic design process. The effectiveness of traditional style in presenting information through visual clues such as a specific choice of font, style, typefaces, headers, footers, justification and spacing rules, can also be considered to be valid in an electronic environment through the validation of this prototype. A more formal description of the components of the graphic structure of the book is presented in chapter 4 starting from an existing definition proposed by Southall (1988).

6.4.1. Relevant Factors

It is possible to extract some relevant factors from other experiences in the evaluation of reading processes from computer (Hansen and Hans, 1988; Egan *et al*, 1991) and use them as the basis for the Visual Book evaluation:

- Page size is the unit of text visible. It influences reading by limiting the context of the visible text and in this way affects the use of short term memory. If the page is small the user will lose time and concentration while trying to view the entire text.

- Legibility is the ease with which letters and words can be recognised correctly. It has been shown to have a strong influence on reading speed. Various factors contribute to legibility: font design, spacing, contrast, edge sharpness, flicker, resolution but it is not easy to measure the way and how much they influence the legibility factor.

- Responsiveness is the speed of system response to a user's action. It can be measured as the speed with which the system begins to respond and the speed with which it completes its response. The psychological impact of a slower response can depend on the users' state. For instance, if they feel they have finished with a phase of an operation, poor responsiveness is less worrying (because users are not waiting for any specific reaction from the system) than when they are in a middle of an action (in this case users are waiting for the system to reply). In this case low responsiveness can be frustrating and may introduce errors and reduce concentration.

- Tangibility (as defined by Hansen and Hans, 1988) describes how much the system appears to the user to be visible and modifiable via physical apparatus e.g. a mouse or other kind of active pointer such as touch screens (Hansen and Hans, 1988). Usually tangible designs help in learning, remembering, and efficiently using a system. Pictorial representations and direct manipulation make it easier and faster to use a system designed for electronic documents. However text on paper still has the highest tangibility for the user.

Some other factors are the result of a combination of those listed above:

- Sense of directness is the degree of feeling that the changes on the screen are the result of the user's actions. It is connected with the illusion the user has that the displayed image is a physical object which can be manipulated as a real paper book. A sense of directness helps a user learn and internalise the interface to a system because every response by the system reinforces the user's confidence and understanding. In a system with high sense of directness users can concentrate on the task that is to be accomplished without the cognitive overload of understanding system reactions.

- Sense of engagement is the level of interest the system induces in the user. The result of a good level of engagement is a high level of concentration that makes users interested in their task. One source of engagement is the fun of seeing the system react and is related to the novelty of the system; tangibility and responsiveness are also responsible for a good level of engagement. Paper has

generally a low level of engagement because it is not interactive and is already familiar to users.

- Sense of text, is the feeling a user may have of the structural and semantic structure of the text that is being read, i.e. its spatial disposition. Readers are able to recall the position of text in a paper text (Rothkopf, 1971). This fact connects a semantic entity, the information, with a physical one, which has visual and tactile cues. Factors which can influence the sense of text are the page size, limited legibility and a low responsiveness while scrolling when looking for more text.

The Visual Book focuses on the need of sense of text and of sense of directness readers have especially when they are used to consulting paper books and are then presented with their electronic equivalent.

6.4.2. The Walkthrough and the Cognitive Jogthrough

In order to evaluate how the Visual Book addressed the factors discussed in the previous section a heuristic technique, *Walkthrough* (Rowley and Rhoades, 1992) was chosen as the most suitable for assessing a system which was still in a prototype stage and for extracting as much feedback as possible from the evaluators. An important consideration in the choice of the Walkthrough technique was the ease with which it was possible to find evaluators for it, which usually is the great problem in the applications of heuristic evaluations. The reason for this situation was that the status of being an expert in the use of similar systems in the case of the Visual Book meant simply having had experience in reading and consulting books in both paper and electronic forms. This is why plenty of people could qualify and the recruitment of the evaluator teams was not a problem.

Walkthrough techniques are heuristic testing methods used for assessing the usability of a system during the design process. Four actors play the roles of *Presenter, Evaluator, Moderator* and *Recorder* as shown in Table 6.3. The *Presenter* introduces the task to be evaluated and the path which will be followed in order to achieve it. At the same time the *Presenter* demonstrates the alternatives and

their consequences. Every uncertainty in the use of the system during the demonstration is noted by the *Recorder.* The *Moderator* runs the meeting, concentrating the attention of the audience on the walkthrough structure and solving possible questions about the process itself. The *Recorder* has to write about each step during the evaluation process, on an evaluation sheet. The *Evaluator* answers each of the questions on the evaluation sheet, as in Table 6.4 (Rowley and Rhoades, 1992), for each step leading to the final goal. The purpose of this kind of evaluation is to gather as much information as possible from experts on the behaviour of future users towards the system prototype in order to start the implementation of the real system with more knowledge on user responses and in this way avoid serious design errors. The evaluation sheet contains only a few questions which are strictly necessary to understand the reactions of the evaluators to the system and instead leaves lots of space for comments and explanations in order to leave the experts free to express their knowledge of the area. This is typical of heuristic techniques where the expertise of the evaluators is the most valuable component of the evaluation process. For this reason particular attention is paid to methods for extracting and eventually formalising as much as possible of this heuristic knowledge.

Role	Actions
Presenter	Description of the task to be evaluated, execution of all the actions required to achieve the goal state, identification of alternative paths.
Evaluator	Focus on the description given by the Presenter, ensuring an answer for each of the questions on the evaluation sheet for each step taken toward the goal.
Moderator	Conduct of the meeting, keeping everyone focused on the walkthrough and resolving any issue generated by the process.
Recorder	Writing down each step taken during the walkthrough on an evaluation sheet.

Table 6.3: *Actors and Roles in Walkthrough*

Walkthrough Evaluation Sheet

Actions/choices should be ranked according to what percentage of potential users are expected to have problems: 0= none, 1= some, 2= more than half; 3= most.

1. Description of user's immediate goal;
2. (First/next) atomic action user should take:
2a. How many users find it obvious that action is available? Why/Why not?
2b. How many users find it obvious that action is appropriate to goal? Why/Why not?
3. How many users find that other available actions are less appropriate? For each, why/why not?
4. How will the user execute the action?
4a. How many users will find problems? Why/Why not?
5. Execute the action. Describe system response:
5a. How many users find that obvious progress has been made towards the goal? Why/Why not?
5b. How many users can access needed information in system response? Why/Why not?
6. Describe appropriate modified goal, if any:
6a. How many users find it obvious that goal should change? Why/Why not?
6b. How many users recognise that a task is completed, is it obvious? Why/Why not?

Table 6.4: *The Walkthrough Evaluation Sheet (from Rowley and Rhoades, 1992)*

This technique is quite accurate and gives meaningful results but it is very time-consuming to perform. A promising alternative is the *jogthrough* (Rowley and Rhoades, 1992) which is an attempt to speed the process up while maintaining or even improving the quality of the results. This result is achieved mainly by making the process faster and in this way saving time which can be used by the evaluators for interacting with the *Presenter* by offering suggestions and constructive comments instead of performing a rigid role as defined in the original version of the walkthrough methodology.

The main changes, as shown in Table 6.5, are in the tools the *Recorder* can use. In particular logging software together with the opportunity of using a video camera can provide a more efficient recording support. Another change is made in the task of the *Moderator*: who now encourages the evaluators to suggest and ask freely about the system to be evaluated and not just about the evaluation process. These

changes result in a more suggestive and efficient method to evaluate empirically a system which is not yet completed.

Role	Actions
Presenter	Description of the task to be evaluated, execution of all the actions required to achieve the goal state, identification of alternative paths. Combination of single actions when appropriate
Evaluator	Focus on the description given by the Presenter, answering an answer for each of the questions on the evaluation sheet for each step taken toward the goal. Suggestions for improving the system.
Moderator	Conduct of the meeting, keeping everyone focused on the jogthrough and resolving any issue generated by the process. Encouragement to evaluators for making any suggestions. Free discussion.
Recorder	Logging automatically way each step taken during the jogthrough on an evaluation sheet.

Table 6.5: *Actors and Roles in the Jogthrough*

6.4.3. Applying the Jogthrough to the Visual Book

The main reason why the jogthrough technique has been proposed to evaluate the Visual Book is the practical limitations of the underlying technologies. In order to use the Visual Book system effectively it is necessary to have a high resolution screen whose quality could be comparable with the resolution of paper. The market at the moment does not provide such a device and this is why the evaluation of the Visual Book system has to find an alternative way to the direct evaluation approach. The users are supposed to be able to judge the various aspects of the system without the strong limitation of readability caused by the lack of a high-resolution screen. So, on the assumption that future screens will have the same resolution as paper, it was judged appropriate to provide the users of the Visual Book system with paper printouts in order to stimulate their reactions to the principles that the Visual Book wants to incorporate.

During the evaluation a set of other electronic books was presented to users with the purpose of making clear the context in which the Visual Book should be considered and at the same time allowing additional information to be collected about users' reactions to electronic books in general. In particular a very simple example of a scrolling book and an example of a page turner book were compared with the Visual Book, and similarities and differences were used to understand better the users' reactions to the various aspects of the Visual Book. Specific attention was paid to choosing and presenting the examples which are very similar to the Visual Book principles. For this reason they were selected from the two classes which are closest to the Visual Book style. The comparison of the Visual Book system with an element chosen from the portable books or from the cyberbook would have had no sense because of their completely different style of presentation and principles of design which make these classes incompatible, and therefore of no interest for this research. The two different examples were used to emphasise the presence of common, almost standard, aspects for electronic books, and at the same time to highlight the originality of the Visual Book.

6.4.3.1. The Context

The two electronic books used for mutual comparisons with the Visual Book were an example of a page turner (HyperTextBook, a HyperCard based book which is available via ftp [2]) and a scrolling book available on the Internet[3] as in figure 6.2. The first is an example of a technologically driven electronic book, where the page size is exactly the size of the smallest Macintosh screen and the portion of text presented in it is very minimal. The appearance, as shown in Figure 6.1, is in the HyperCard style. While this maybe visually attractive it has been designed so that people could scan the information in it before printing it out rather than for people to read it from the screen. The size of the window where the text is presented has been determined by HyperCard limitations and not by typographical or psychological considerations, it is a case where the technological issue comes before users' needs. A set of tools is available for browsing annotating, zooming and searching the book, and there is also a set of additional clues which are presented in order to help readers

2 Available from ftp.dartmouth.edu

3 Available from http://lcweb.loc.gov/loc/libserv, April 1996.

find their way through the text. The real limitation is in having a very small area to present the text. This has led to an inappropriate definition of the page concept, which is represented as consisting of two components: the original page with the text from the book and a large right margin to be used for inserting notes. In this way the space for presenting the text has been reduced even further and the result is very difficult to read, which in this specific case where the publications are novels, represents a real drawback. This particular implementation of an electronic book is an example of how important it is when designing electronic books to understand the nature and the use of the information contained in the book and how different publications have to be treated in a different ways.

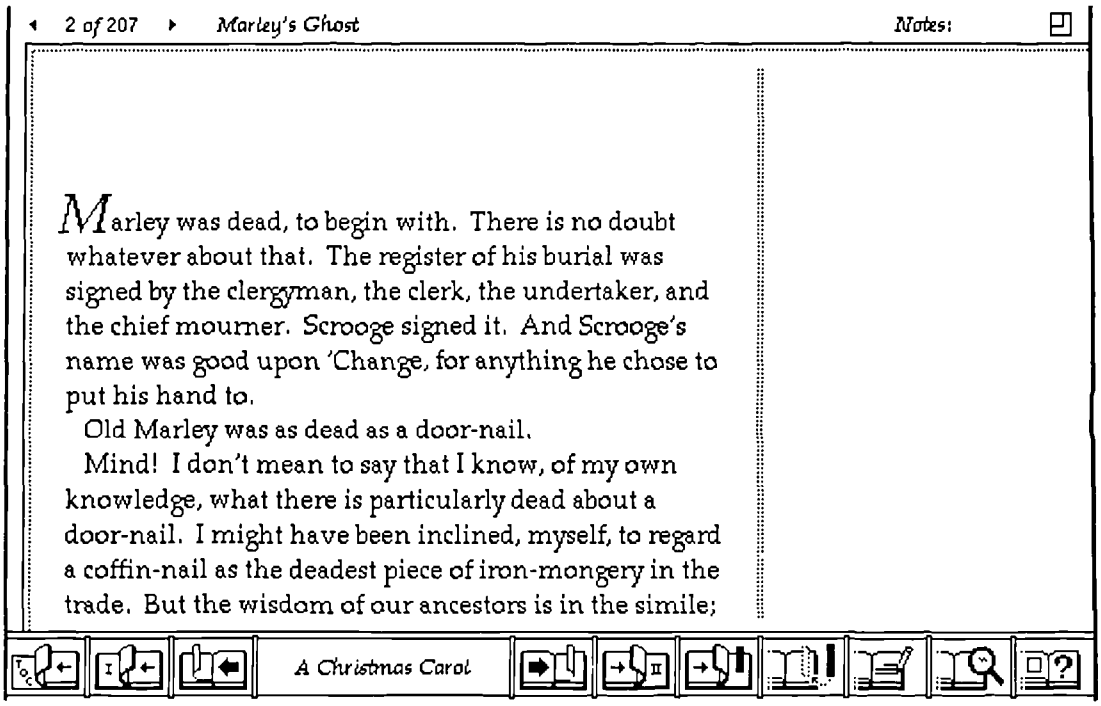

Figure 6.1: *The HyperTextBook*

The second example is the result of a requirement for fast, cheap publication of information derived from a study held by the Library of Congress. The reason for publishing this kind of electronic book was based on the opportunity of reaching a large section of the public while bypassing the time, and money-intensive traditional publishing process. The priority was not on readability and it is clear that the best

way to read the text is to print it first. The set of tools available to users is very limited and mainly dependent on the Internet paradigm of presenting information in a hypertext style. Thus, as Figure 6.2 shows, there are always three buttons at the top of the page to browse through the hierarchical structure of the book:

- Next paragraph;
- Previous paragraph;
- Table of Contents.

The text is presented in a scrolling window which contains a paragraph, which represents the logical unit for this kind of book. The risk of getting lost or losing the focus during this kind of reading is quite high. The most effective way to use this kind of electronic book is simply to print the paragraphs which a reader considers important. In this case the book metaphor has been used as the basis for building a browser which allows access to a fixed amount of information and not much attention has been paid to how this information should be presented to users.

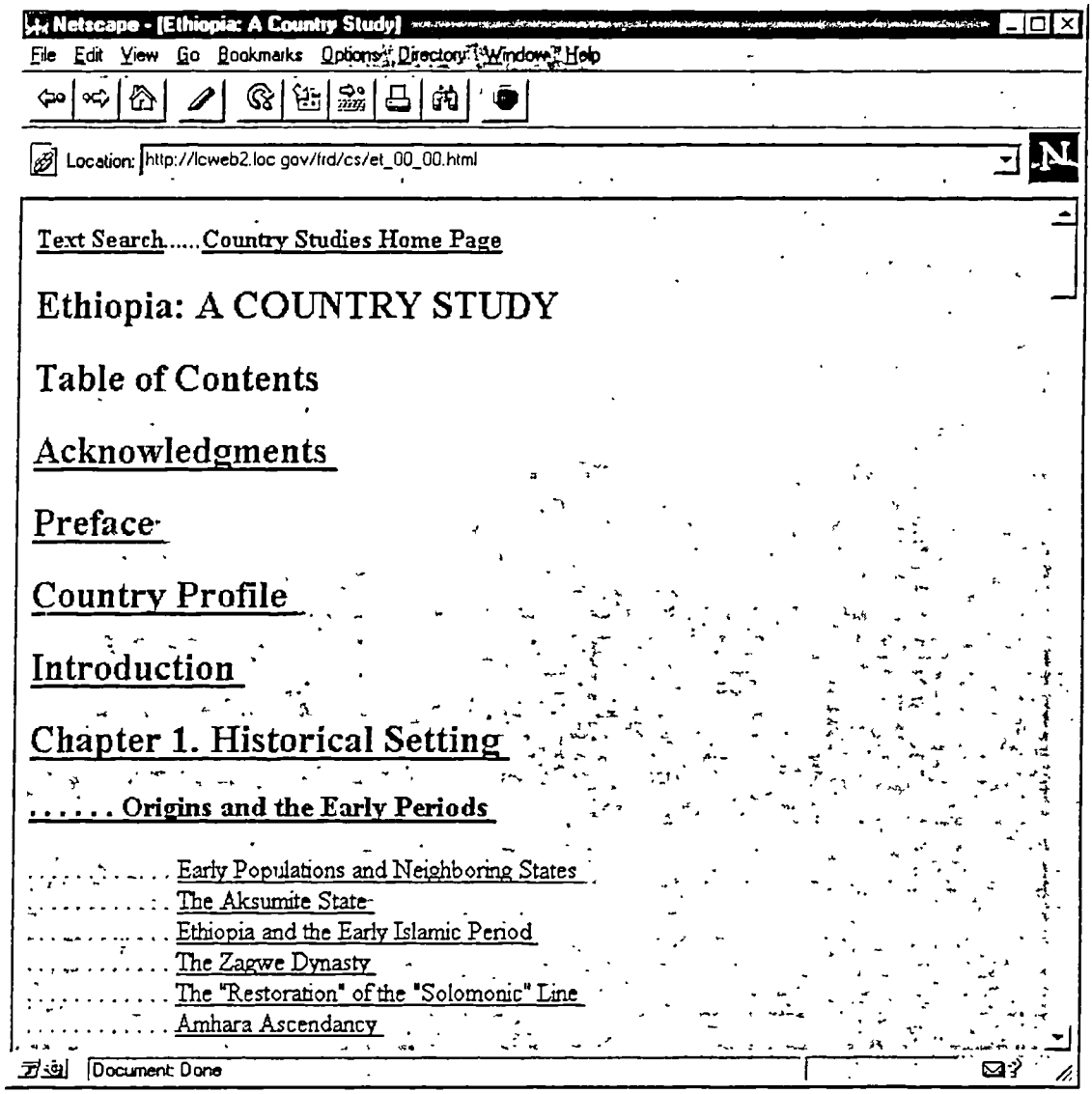

Figure 6.2: *The Library of Congress Electronic Book*

6.4.3.2. The Users

The choice of the users was made to reflect two general classes: people already actively involved in working with computers, and therefore labelled as computer experts, and people who are not particularly familiar with computers, and therefore labelled as non-computer experts. This is the same convention used in the evaluation of the Hyper-Book (Catenazzi, 1994) and this choice has been made in order to be consistent with the Hyper-Book experiment and to be able to compare the results of the Hyper-Book with the findings of the Visual Book. However, an additional issue, which became clear as soon as the experiments started, was that it is not just the fact of being or not being familiar with a computer that makes the difference. Previous experience of the Internet plays a very crucial role because of the ease with which people, while browsing the net, are presented with electronic publications which all share a common hypertext-oriented interface, although this kind of user is usually completely unaware of typographic rules and style in presentation. This phenomenon is motivated by the possibility of publishing and accessing information freely, with almost no regulation or costs. Thus everybody can be an author, publisher and editor. The result has the advantage of providing the possibility of free expression but on the other hand, currently not enough attention is presented to reader, readability and legibility issues. Although tools like Internet browsers and editors are in continuous development and are becoming more and more powerful and sophisticated, and while Web pages have evolved from static HTML-based pages to dynamic pages, users have not quite yet figured out how to use it to its best advantage. This situation has produced at least two different kinds of reaction: the technology related one, where the users of the Internet are more excited about what they can do, rather than thinking about what is really worth doing with it; and a more classic one where users of the Internet are confused by the enormous quantity and quality, often very poor, of the information which is available.

The application of this distinction to the case of electronic books results in the definition of two categories of reader: those who are interested in the information *per se* and would appreciate having it in the most readable format available; and those who are more involved in the use of new technologies, e.g. Internet browsers and editors, and therefore are mainly interested in exploring the technology rather than in using the information carried by it. In addition to the classic dichotomy

between content and the container (i.e. information and the computer) a third element should be considered: the potential of the medium underneath in terms of available new technology and its possible exploitation. Sections 6.5.1 and 6.5.2 show how different the impact of the Visual Book experiment has been on these two classes of user: non-computer experts, and computer and Internet experts.

The next section describes how the evaluation of the Visual Book has been organised in terms of the various stages shown in Figure 6.3.

6.4.3.3. The Structure of the Experiments

The Visual Book evaluation consisted of two experiments, one involving the user-oriented group (eight people) and the other with the computer-oriented group (ten people). Each of these groups was given a jogthrough session which focused on the Visual Book and integrated this with a short introduction to similar electronic books. In order to be consistent with the assumption that the evaluators were experts in the use of similar systems, two different books where used for the two groups, so that the evaluators already knew the content of the book and how to consult and use it. Each jogthrough session consisted of three exercises (tasks) to be solved by the evaluators. The exercises were chosen in order to be of increasing difficulty but inherently soluble for the evaluators and, although each of the exercises was tailored to the specific book chosen for the audience, the types of exercise were the same for the two groups. For each exercise the evaluators had to fill in the evaluation sheet and they were free and explicitly encouraged to express their opinions, comments, criticisms and suggestions. The evaluation sheet used for the Visual Book evaluation is a modified version of the original (Rowley and Rhoades, 1992), where the ranking scale has been changed to range from "nobody" to "majority of the users", to make the answers positive and avoid confusion in the evaluators, for the same reason there was no mention of the original " ...potential users which are expected to have problems" which was found to be quite confusing. The text of the evaluation sheets used for the experiments can be found in Appendix B, while Appendix C contains the text of the three exercises as they have been presented to the two groups of evaluators.

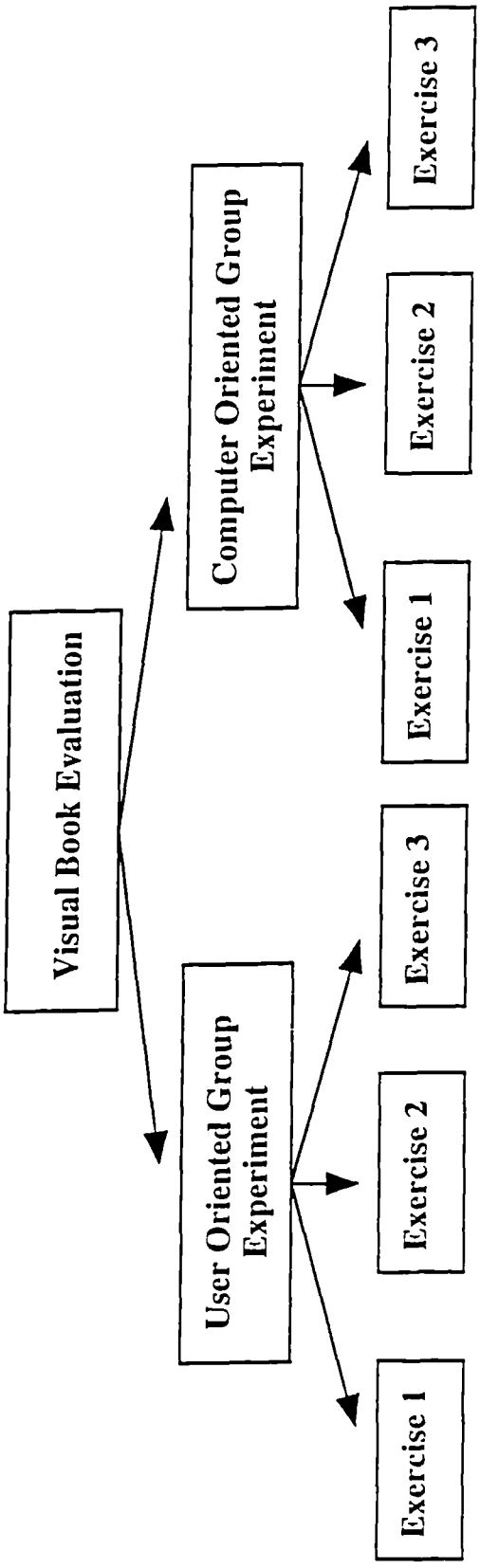

Figure 6.3: *The Visual Book Evaluation Structure*

6.4.4. Expected Results

The expectation when evaluating the Visual Book was that users should have a very high sense of directness and of text (for more details see section 6.4.1). These are the main features of the Visual Book relevant for the demonstration of the hypothesis of this thesis[4]. In this context measures of efficiency, such as technical system performance, have not been considered. More attention has been paid to other aspects such as the usability of the system, the ease of learning and use, and the final satisfaction of the user (reader). In order to validate this hypothesis the evaluation was centred on measuring the reactions of a reader who is presented with familiar objects such as books and desktop accessories. In particular the evaluation process is divided into two distinct components: the evaluation of the consistency and the ease of use of the interface based on the representation of the desktop environment composed of books, bookmarks, notepads, and writing tools; and the evaluation of the effectiveness of the representation of the content of books, where each book of the Visual Library is represented exactly as it is on paper.

In the first evaluation process the emphasis has been on the usefulness of, and the ease with which, the readers' tools can be learnt. In order to measure these parameters it has been necessary to observe readers while performing a list of tasks connected with the contents of the books, and to ask them about the final satisfaction. In particular the examination of the strategies followed by users has provided information about the design of the reader tools, how much they are used, where and why they can be helpful or fail in supporting users while performing their tasks, and so on. This part is closely connected with the Hyper-Book project and its evaluation process.

The second part of the evaluation process is more related to the previous experience readers have in consulting the paper version of the book represented in electronic format. A way to measure the effectiveness of the Visual Book

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4The aim of this research is to test whether it is feasible and appropriate to recognise and replicate the logical structure of a document, starting from the appearance of a paper document (i.e. from its layout structure) and using a sort of image rhetoric.

representation is to ask a first group of users to perform some tasks without referring to the paper version of books and to repeat the same experiment with a group of users after training with the paper version. The expectation was that in the second case users would feel more familiar with the information presented in electronic form and would be more confident in exploring the capabilities offered by the new electronic representation.

6.4.5. The Hyper-Book Experience

Hyper-Book is part of the same European project, SuperLibrary, as the Visual Book. The experience with the Hyper-Book has been used as starting point for the evaluation of the Visual Book as the two projects share the same interest in the study of the book metaphor. Hyper-Book is an alternative approach for presenting and making accessible electronic texts in a familiar and user-friendly way. An important feature of such electronic books is the possibility of accessing text in a non-linear way, following the hypertext philosophy. For that reason they are called hyper-books[5], and the environment where they are produced, the Hyper-Book Builder. The architecture of the Hyper-Book system is very similar to that of the Visual Book. Both have a module for the mark-up of the information to be presented in the book. In the case of the Hyper-Book this module is based on SGML DTDs and for the Visual Book it is a visual mark-up based on visual rhetoric as described in chapters 4 and 5. Part of the Visual Book evaluation has concentrated on providing feedback on the validity of the visual mark-up as one of the sub-hypotheses presented in chapter 1. Both also have an authoring system for the production of either Hyper-Books or Visual Books, and an interface component called Hyper-Book and Visual Book Viewer.

The Hyper-Book model has been defined on the basis of the paper book metaphor, which has been enriched with several tools which are made possible by

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5The term *Hyperbook* has also been used as a name for a Longman/Logotron product which is no longer being marketed. The choice of the name Hyper-Book was made before this product was launched. It has been retained as it seems the most appropriate term for electronic books in which interconnection is one of the main features.

the electronic environment (history facilities, searching facilities, active links, etc.) and in this sense it is consistent with the one used for the Visual Book as discussed in chapter 4. The philosophy of the Hyper-Book system is aimed at emphasising the role of *electronic text* as an essential and active component in an electronic book as opposed to the primary role of the *visual text* which is the focus of the Visual Book. The possibility of following active links in the text and running full text searches were the strength of the Hyper-Book system as well as the highly flexible publishing tools which could accept as input electronic text in various formats, from ASCII to a number of SGML DTDs.

The Hyper-Book evaluation consisted of two components: one designed to evaluate the Hyper-Book Builder, as the publishing environment within which hyper-book*s* are produced starting from a marked text, and one to evaluate the Hyper-Book as the result of this publishing process. In the case of the Visual Book the evaluation of the Visual Book Builder is not considered as relevant because it depends very heavily on the combination of the right technology available at the time of the evaluation. The evaluation of the Visual Book Viewer as the final product of the Visual Book Authoring system is the one which was expected to return indicative information on the quality and effectiveness of the Visual Book model.

The methodology used in evaluating the Hyper-Book consisted of four steps:

- an initial questionnaire to collect information about users' backgrounds;
- a training session;
- an evaluation session;
- a final questionnaire so the users could express their opinion in terms of usability and utility.

The results obtained from the Hyper-Book evaluation are already a good indication of how the book metaphor can work efficiently for different kinds of user. The Hyper-Book experience has also highlighted the preference of users for some of the Hyper-Book specific features such as:

- the navigational tools were all considered useful and easy to use;

- the search functionality which both groups of computer and non computer experts found very helpful.

There was also the request from users for some of those features to be made more sophisticated (e.g. the search and editing facilities) and to maintain or reconsider some original paper book features, such as page numbers in the ToC. The very positive results of the experiment also provided some valuable feedback for future improvement of the system. The Visual Book experiment has tried to keep the distinction, where possible, between interface and system architecture issues in order to make the interpretation of the feedback easier.

6.5. Results

The experiment was divided into two sessions, one involving a group of non-computer experts, which have been labelled as the User-Oriented group, and one with computer experts, labelled the Computer-Oriented group. The groups consisted of students of Information Science and Computing Science, respectively. In both cases the Visual Book was used to present the content of a book which was relevant to their subject field and which some of them already knew in the paper version. Details of the questionnaires and the books used can be found in Appendix B.

6.5.1. User-Oriented Group

The first experiment involved the user-oriented group, also labelled as the content oriented group, i.e. a group of eight evaluators whose interest was focused on the content of the electronic book rather than on its structure. The group consisted of two sub-groups of non-computer experts, a group of Information Science students who were presented with a book (see section 6.4.3.1) they had been using for their course and a smaller group of Information Science graduates who did not know the book already but had some interest in its content. A complete set of the responses can be found in Appendix C and the analysis of these responses is in section 6.5.3.

From the interactions during the experiment and the answers to the questionnaire it was clear that both liked the Visual Book interface and understood its main

concepts. They found the Visual Book easy to use and very intuitive. In particular they appreciated the fact that the Visual Book kept certain functional features of the paper book they were used to, such as the table of contents and the index terms, making them active but respecting their appearance on paper, as a strong key to understand the way they work. The group who knew the book already also made comments on how this previous knowledge affected their reaction to the Visual Book, and suggested how a reader would have instead interacted with it without any previous knowledge. Mainly they knew already where to go and where to look for information, so they used the navigation tools less than the people with no previous knowledge. In this case the fact that the Visual Book respects the original design of the paper book has been shown to be an advantage for people who know it already, but also is a help for people familiar with paper book design in general because they have already clues on where to find tools (i.e. Index, ToC, glossary) for getting the information they are looking for.

The most interesting part of the experiment was the discussion on what additional features could be added to the Visual Book in order to make it more functional while respecting the original metaphor of the book underneath. A popular request was the introduction of an indexing engine driven by an intelligent interface which was able to distinguish between different contexts for a specific concept inside the book, in the same way that the reader of the paper book uses typographical clues. This should be able to focus the query according to the context e.g. readers can search only the ToC, or only a certain part of the book once they have a clue as to where the sought after term can be found. The future Visual Book interface would have to be aware of different contexts in the same book, understand different priorities and answer in an appropriate manner, becoming an intelligent book which is able to guide its reader through its content using mainly typographical clues.

6.5.2. Computer-Oriented Group

This second experiment gave a completely different kind of result. The group involved was a container oriented group whose attention was more on the structure of the electronic book than on its content. The main difficulty was explaining the purpose of the Visual Book to people who are used to investigating new

technologies *per se*. In order to help them understand the scenario to which the Visual Book belongs, i.e. which sort of information needs the Visual Book is designed to satisfy, an introduction to electronic books was given to the group. The book chosen for the experiment, Information Retrieval (van Rijsbergen, 1979), was also available online[6] in hypertext form, in a format very similar to that used by the Library of Congress (see section 6.4.3.1). This was considered as an appropriate way to demonstrate effectively the differences between the different presentation formats (i.e. paper, scrolling, page turner) and to highlight their advantages and disadvantages. The discussion instead kept focusing on the technological issues, pointing out how the Internet solution was the one for the future and, even if at the moment the electronic book was quite poor compared with the other two, still that was the direction to go.

The audience had a perspective on reading and books which was completely different from the other audience of information science students. They argued that in the future children will be trained directly to read from a computer and that is why they could not accept that electronic book designers were still referring to obsolete metaphors. However they then agreed on the fact that if they need to read something they prefer to print it out. Many of them also admitted that if they really need to get specific information they do not care what format it is in, and that they have been used to reading computer manuals which have been edited without any account being taken of many of the typographical features, starting with elementary pagination rules.

The main difference between the two audiences was that this one was definitely computer-oriented and could not understand the need for a user-oriented interface to electronic books. Also their concept of the electronic book was quite different from the one outlined in this research. This interpretation was more the result of an experiment in applying new computer technology to paper books, the more complex and futurist the technology the better being the resulting electronic book. This was one of the main problems in running the experiment with this group. The results of this part of the experiment have been collected in the form of comments and suggestions and not as answers to the jogthrough questionnaire because of the quite

6 Available from http://www.dcs.gla.ac.uk/~keith

negative reaction of the users to the idea of heuristic evaluation. For this reason the data analysed in the next two sections is taken from only the non-computer group. The contributions of the second group are considered and analysed further in section 6.5.4.

6.5.3. Data Analysis

The data have been analysed in order to compare them with the findings of the evaluation experiment on the Hyper-Book system (Catenazzi, 1994). This has included the use of simple statistical analysis involving the definition of a threshold of acceptance for the scores and the comparison of the results obtained in the three exercises. In addition the data has been analysed according to the criteria discussed in section 4.3 in order to assess the usability of the Visual Book Viewer. This has been based on the scheme discussed in section 6.4.1 in order to extract indications about possible changes that could be made to the Visual Book Viewer to increase its usability.

6.5.3.1. Quantitative Data Analysis

The data which were collected during the Visual Book experiment have been divided into three groups according to the particular exercise they were related to, and then translated in terms of their meaning in relation to the tasks and functionalities of the Visual Book as shown in Table 6.6.

Exercise number	**Visual Book Functionalities**
exercise 1	importance of the page layout and in particular of the page number
exercise 2	use of the ToC as a searching/browsing tool
exercise 3	use of the Index as a searching/browsing tool

Table 6.6: *Mapping between Exercises and Visual Book Functionalities*

Both the system design and the interface implementation were considered in the definition of tasks and questions and the resulting feedback was quite positive, the

evaluators were asked to answer in terms of percentage of users according to the following convention:

0 = none;
1 = some;
2= more than half;
3 = most.

In most of the questions the higher the score given by the evaluators to the Visual Book Viewer the more effective it is judged to be, with the exception of answer 4 for which the smaller the score the better is the performance of the Visual Book Viewer. Appendix C contains a list of the questions with their scores (in brackets) and their relevance to the Visual Book system.

The questions have also been grouped in terms of particular aspects of the Visual Book Viewer design and implementation, as described in section 6.4.1, according to the mapping shown in Table 6.7. The mapping has been tailored for the Visual Book evaluation on the basis of similar research which has used the same factors (Hansen and Haas, 1988).

Questions:	**Factors:**
questions 2a, 2b and 7	sense of engagement
questions 3 and 6	sense of text
questions 4, 5a and 5b	sense of directness

Table 6.7: *Mapping between Questions and Factors in the Evaluation Sheet*

These three factors have been tabulated graphically by taking into account the scores given by the evaluators to the associated questions in the three exercises. This has been done so that it is easy to compare the way the Visual Book works with tasks of increasing complexity. A threshold (t) to represent the limit of acceptance of the scores, which were assigned by the evaluators, has been set, for each of the evaluation factors[7], to the maximum score (i.e. the sum per answer, which

7 As the score of question 4 has to be considered as a negative value, only the positive scores of the other two questions (5a, 5b) enter the calculation of maximum value and threshold for sense of directness. The total score is still the result of the algebraic sum of the three combined scores.

contributes to the evaluation factor, of the total number of evaluators * 3, where 3 is the maximum score the evaluators could have assigned for each answer) divided by two, as an average score below which the result of the evaluation had to be considered negative. According to this convention the Visual Book evaluation has been completely positive for each exercise and for each factor. Exercise one was the easiest task for the evaluators and the one where the cognitive value of the use of the page number was evaluated. In this case the mapping between the book metaphor and the Visual Book is direct and hence the sense of text factor is very highly scored, as is also the case for the sense of engagement and directness. This suggests two main points:

- the interface level of the Visual Book has implemented correctly the page number concept;
- the page number concept is considered as a useful one by the evaluators so it should be considered when designing future Visual Books.

What is even more interesting is the reactions of the evaluators to more sophisticated tools inherited from the book metaphor and translated to electronic form by the Visual Book interface: the ToC which has been evaluated in exercise 2, and the Index evaluated in exercise 3. From the analysis of the chart relative to the sense of text (see Figure 6.4) and the one relative to the sense of engagement (see Figure 6.5) it is clear that the evaluators preferred the Index tool as more book oriented and more satisfying than the ToC. However the ToC then scored better in the sense of directness because of its relative simplicity when compared with the Index. It is also important to point out that the ToC and the Index have very different roles in the book metaphor, even if both are navigational tools. In particular the ToC is mainly used for skimming the content of a book when readers do not know what can be found inside, i.e. as an explorative tool. The Index on the other hand has been designed to help readers find something they know about and wish to find inside the book, i.e. it operates as a searching tool. The comparison of these two tools has to take into account this difference in roles as well as considering the interface and system aspects.

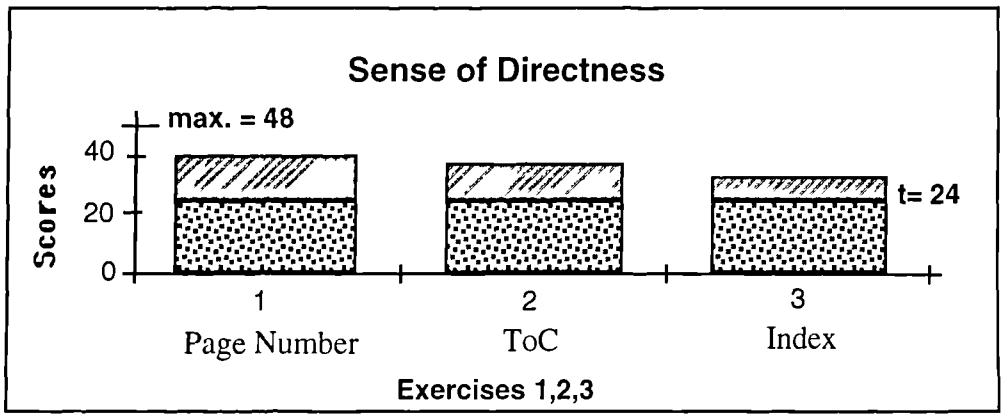

Figure 6.4: *Sense of Directness in the Three Evaluation Exercises*

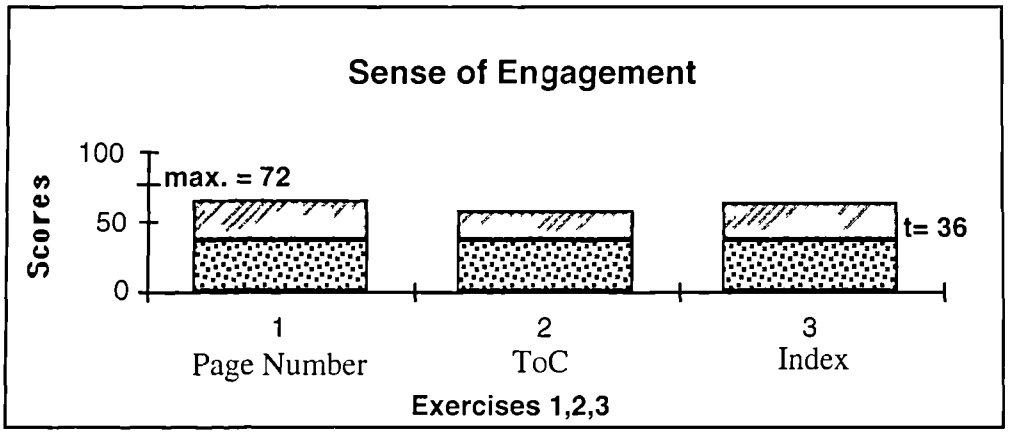

Figure 6.5: *Sense of Engagement in the Three Evaluation Exercises*

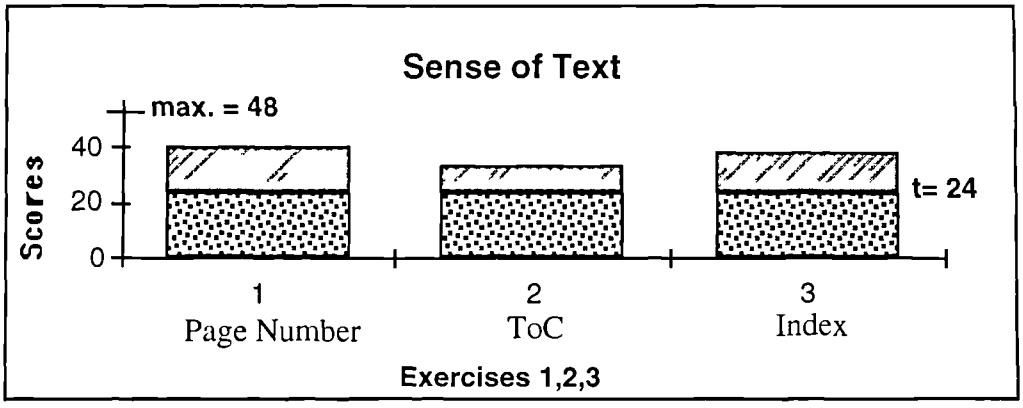

Figure 6.6: *Sense of Text in the Three Evaluation Exercises*

In general the results represented in Figures 6.4, 6.5 and 6.6 above show that the book metaphor has been well accepted and fully understood by the evaluators, in each of them the use of different patterns shows how the values are well above the fixed threshold and quite close to the maximum value. In particular exercise 1 is the one which has got the highest score for all the three factors as expected, because it is directly mapped on to a primary feature of the book metaphor. The preference for using the Index tool can be interpreted as a tendency to use more sophisticated tools especially when they are fully supported by electronic medium. Even if the ToC has been rated as being understandable and easy to use, as shown by the comparison in the case of the sense of directness, still the information contained in it is not sufficient for readers looking for a specific topic. This demonstrates that a good interface design and a successful mapping between the system and the book metaphor is not enough to make the reader happy. The information is still the main requirement and future design for electronic publications will have to consider this primary need overall. The presentation issue is also very strong, as the comparison of the sense of directness shows, the fact that the Index is not as natural as the other tools for browsing makes it less direct to use. The same happens with paper books, where the index is usually hidden at the end of the book. However in the case of the Visual Book the evaluators were more interested in the Index functionality as the medium makes it a powerful and realisable tool which should be seriously considered during the production of useful electronic publications. It is a case where the computer can help to make a paper book tool more efficient by making it more explicit and more powerful, through the interface, by moving it from the back of the book, and from the system point of view, making it active.

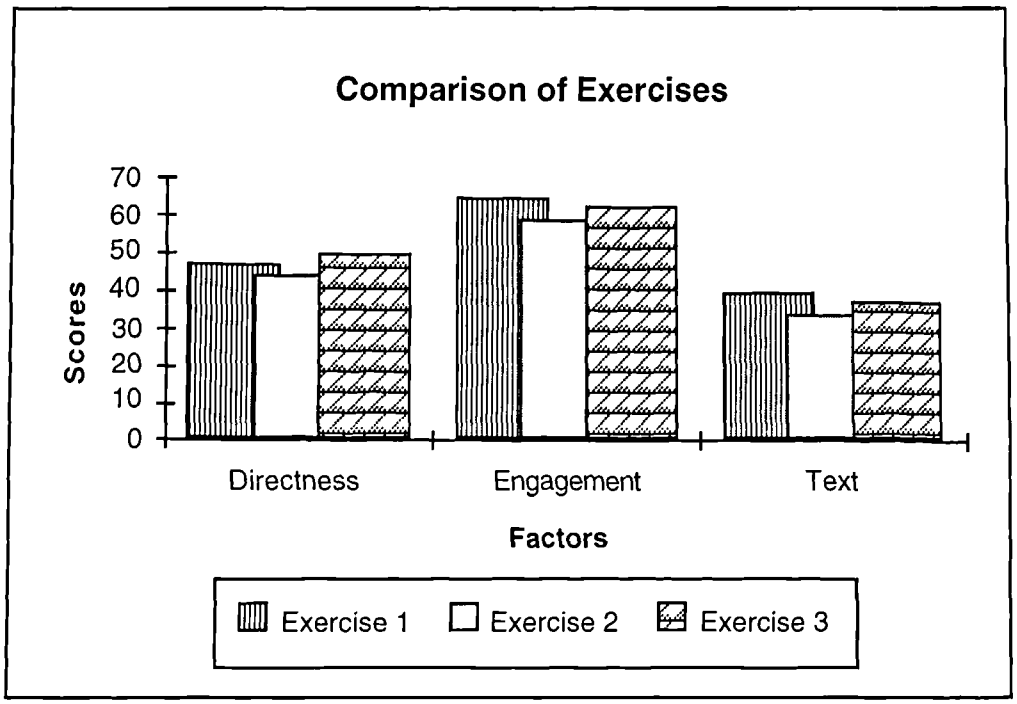

Figure 6.7: *Results of the Three Evaluation Exercises*

However it is possible to extract more information from the analysis of the behaviour of the three evaluation factors for each exercise, see figure 6.7. In particular it is evident that the sense of engagement is very high for all of them. This is partially related to the novelty of the Visual Book but also to the correct use of the book metaphor so that the evaluators found the system easy and pleasant to use, as they express in their comments, both written and verbal. The sense of directness comes second in the comparison suggesting that some changes could be made at the interface level (e.g. the icon for the go to page command could be made more immediate and the same for the Index icon) to make the system more straight forward. The sense of text is the last in the ranking and a possible interpretation of this result is the fact that the original paper version was presented together with the Visual Book adaptation and the evaluators were naturally comparing the two versions when asked to give a score to the Visual Book. This was a side-effect related to the evaluation process which needs to be considered in order to be avoided in future evaluation sessions. This analysis has provided information about the validity of a number of components of the Visual Book system, such as the architecture, the interface and even the same evaluation procedure. The next section provides a usability oriented analysis of the data

6.5.3.2. Usability Analysis

The first step in applying the scheme discussed in section 6.4.1. to the data collected in the jogthrough experiment with the non-computer expert group, was to divide them according to a set of factors as outlined in section 6.4.1. These have been divided into two groups; simple attributes such as:

- Page size;
- Legibility;
- Responsiveness;
- Tangibility;

and complex ones such as:

- Sense of directness;
- Sense of engagement;
- Sense of text.

All these factors and their applicability to the Visual Book evaluation experiment have been explained in section 6.4.1, but before applying the usability specification scheme it is necessary to define how the result of the jogthrough evaluation is going to be related to these factors.

First of all a decision has to be made on which of those factors to use and how those factors are going to be used. At first all of these were used to find out which provided meaningful feedback on the systems, while eventually suggesting future changes to it. The complex factors resulting from the interaction of the first four showed, heuristically, to be more suitable for further analysis because they could provide more information on the system as they are richer and, because they are intrinsically related to the simple ones, they will also give information about them.

The jogthrough session was divided into three exercises, starting from a very simple one where experts were asked to look for a page given the page number, then

a second exercise where experts were asked to find out about a topic using the ToC, and finally a third exercise which required the consultation of the index.

These three exercises are all related to specific functionalities of the Visual Book as shown in Table 6.6. The scores collected in the evaluation sheets are linked with the usability factors, as shown in Table 6.7, and the interaction between factors, scores, exercises and Visual Book features is summarised in Figure 6.8. The three exercises give three possible different responses about the usability of the Visual Book Viewer related to tasks of increasing complexity for the user. Thus the analysis of the data from the experiment is based on the comparison of the results of each of these three tasks in order to determine how complexity affects the usability of the Visual Book.

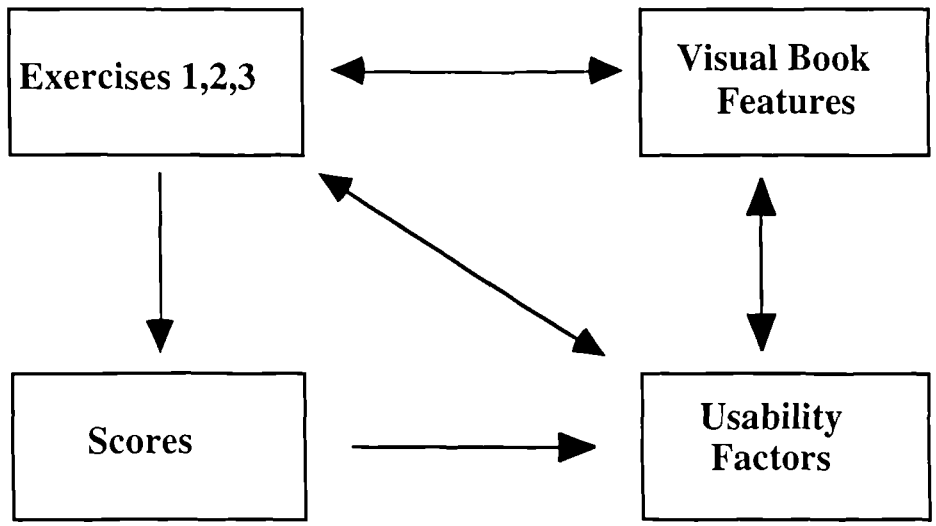

Figure 6.8: *Relation between Evaluation Factors and Evaluation Exercises*

For the first task (look for page number X in book Y) the attribute specification table introduced by Gilb (1981) and discussed in section 6.4.1 was expanded as follows (see Table 6.8 for sense of directness, Table 6.9 for sense of engagement and 6.10 for sense of text).

Attribute	Measuring concept	Measuring method	Worst Case
Sense of directness.	The time to find a particular piece of text in the Book.	Answers to questions 4, 5a, and 5b in the evaluation sheet.	Not possible to find at all, too difficult, and/or the system does not seem to react to the users' actions.

Planned Level	Best Case	Now Level
Relevant text is clearly presented by the system and it is reachable in a few steps.	Relevant text is easily reachable in one step and the system responds to the user very efficiently.	It is quite understandable and easy to reach the relevant part of the text. The response of the system is very efficient and understandable.

Table 6.8: *Sense of Directness for Exercise 1*

Attribute	Measuring concept	Measuring method	Worst Case
Sense of engagement.	Task: find alternative ways to reach the same text.	Answers to questions 2a, 2b and 7 in the evaluation sheet.	The user is not satisfied by the system performance and does not know how to plan future similar tasks.

Planned Level	Best Case	Now Level
The user is reasonably happy with the system performance and is quite confident of being able to manage similar tasks.	The user is enthusiastic about the system and finds that the system provides the most natural way to perform similar tasks in future.	The user trusts the system because it is clearly heading toward the solution of the task.

Table 6.9: *Sense of Engagement for Exercise 1*

Attribute	Measuring concept	Measuring method	Worst Case
Sense of text.	Task: find a page number X browsing the Visual Book.	Answer to question 6 in the evaluation sheet.	The user does not use the page number as a clue, or finds it very confusing and in conflict with other clues on the screen at the same time.

Planned Level	Best Case	Now Level
The page number is used exactly as in paper books.	The page number is the most intuitive clue of being in the right place.	The page number is a very natural clue while consulting the Visual Book.

Table 6.10: *Sense of Text for Exercise 1*

In exercise one, for the sense of directness (see Table 6.8) the large majority of evaluators (6 out of 8) gave the maximum score to questions 5, and 5 out of eight gave 1 to question 4 (the negative question). For the sense of engagement (see Table 6.9) six out of eight evaluators answered 3 to question 7 while the others answered 2. Five out of eight answered 3 to question 2a, and six out of eight answered 3 to question 2b; the others answered 2 to both. And finally for the sense of text (see Table 6.10) six out of eight answered 3 to question 6, the others answered 2. A summary of the results of exercise 1 is given in Table 6.11.

In the sense of text, test in exercise one, question 3 was not considered relevant because of the extreme simplicity of the task. For this reason the evaluators were left free to assign or not, a score to this question. This first exercise shows that, according to the results summarised in Table 6.11, even if there is still margin for improvement, the Visual Book system works quite well on simple tasks and it is consistent with the book metaphor, in accord with the expectations of this research.

Factor:	Related Questions:	0	1	2	3	Total:
Sense of directness:	Question 4	4	4	0	0	-4
	Question 5a	0	0	2	6	22
	Question 5b	0	0	3	5	21
						39
Sense of engagement:	Question 2a	0	0	3	5	21
	Question 2b	0	0	2	6	22
	Question 7	0	0	2	6	22
						65
Sense of text:	Question 3 (not compulsory for evaluators)	0	2	2	4	18
	Question 6	0	0	2	6	22
						40

Table 6.11: *Summary of Results of Exercise 1*

The second exercise is concerned with the use of the Table of Contents as an active tool for consulting the Visual Book Viewer. The user is requested to look for a specific topic which appears in the Table of Contents. This topic is also searchable using the search function represented by an icon in the book template, or by simply browsing the pages.

Attribute	Measuring concept	Measuring method	Worst Case
Sense of directness.	The time to find a particular piece of text in the Book.	Answer to questions 4 and 5 in the evaluation sheet.	Not possible to find at all, too difficult and/or the system does not seem to react to users' actions.

Planned Level	Best Case	Now Level
ToC stands out as an intuitive tool to get directly to the topic requested.	ToC is the first and best tool to get the requested topic in the shortest number of steps.	It is quite understandable and easy to reach the relevant part of the text through the ToC. The response of the system is very efficient and clear.

Table 6.12: *Sense of Directness for Exercise 2*

Attribute	Measuring concept	Measuring method	Worst Case
Sense of engagement.	Task: find alternative ways to reach the same topic.	Answer to questions 2a, 2b and 7 in the evaluation sheet.	The user is not satisfied by the system performance and does not know how to plan future similar tasks.

Planned Level	Best Case	Now Level
The user is reasonably happy with the system performance, specially with the ToC feature, and is quite confident in being able to manage similar tasks.	The user is enthusiastic about the system and finds that the system. with the ToC feature, provides the most natural way to perform similar tasks in future.	The user trusts the system because it is clearly heading toward the solution of the task.

Table 6.13: *Sense of Engagement for Exercise 2*

Attribute	Measuring concept	Measuring method	Worst Case
Sense of text.	Task: find the information requested in the place where it is commonly found in the Paper Book.	Answer to questions 6 and 3 in the evaluation sheet.	The user is unable to use his/her previous experience in reading books because the book metaphor has not been successful in the Visual Book implementation.

Planned Level	Best Case	Now Level
The book metaphor is working fine, the ToC feature is recognised and found useful by the users.	The ToC feature is recognised as the most intuitive clue for the reader to achieve his/her task.	The user has a good sense of the text from the graphical clues on the screen.

Table 6.14: *Sense of Text for Exercise 2*

In exercise 2 for the sense of directness, see Table 6.12, half of the evaluators answered 0 and the other half answered 1 to the negative question. In question 5a, five evaluators gave score 3 and three gave score 2 to the Visual Book. While in question 5b, five evaluators gave score 2 to the Visual Book and the rest gave score 3. For the sense of engagement, see Table 6.13, four evaluators gave score 2 to question 2a and 3 to question 2b; five evaluators gave score 3 to question 7. Finally, for the sense of text, see Table 6.14, half of the evaluators gave score 3 and the other half score 2 to question 6, with four evaluators giving score 2 to question 3. A summary of these results is provided in Table 6.15.

Factor:	Related Questions:	0	1	2	3	Total:
Sense of directness:	Question 4	4	4	0	0	-4
	Question 5a	0	0	3	5	21
	Question 5b	0	0	5	3	19
						36
Sense of engagement:	Question 2a	0	1	4	3	18
	Question 2b	0	2	3	4	20
	Question 7	0	0	3	5	21
						59
Sense of text:	Question 3	0	3	4	1	14
	Question 6	0	0	4	4	20
						34

Table 6.15: *Summary of Results of Exercise 2*

The third exercise is concerned with the use of another active component of the Visual Book: the Index. Users are asked to retrieve some information about a topic that is explicitly mentioned in the Table of Contents but which can be found in the Index at the back of the book.

Attribute	Measuring concept	Measuring method	Worst Case
Sense of directness.	The time to find a requested topic in the Book.	Answer to questions 4 and 5 in the evaluation sheet.	Not possible to find at all, too difficult and/or the system does not seem to react to users' actions.

Planned Level	Best Case	Now Level
Index is the tool which is going to work in the most efficient way, it stands out as an intuitive tool to get directly to the topic requested.	The use of the Index is clearly the best way to get to the requested topic in the shortest number of steps.	It is quite clear that more than one alternative is available for finding the topic and easy to reach the relevant part of the text. The response of the system is very efficient and clear.

Table 6.16: *Sense of Directness for Exercise 3*

Attribute	Measuring concept	Measuring method	Worst Case
Sense of engagement.	Task: find alternative ways to reach the same topic.	Answer to questions 2a, 2b and 7 in the evaluation sheet.	The user is not satisfied by the system performance and does not know how to plan future similar tasks.

Planned Level	Best Case	Now Level
The user is reasonably happy with the system performance, especially with the Index feature, and is quite confident of being able to manage similar tasks.	The user is enthusiastic about the system and finds that the system with the Index feature, provides the most natural way to perform similar tasks in future.	The user trusts the system because it is clearly heading toward the solution of the task.

Table 6.17: *Sense of Engagement for Exercise 3*

Attribute	Measuring concept	Measuring method	Worst Case
Sense of text.	Task: find the information requested in the place where it is commonly found in the Paper Book.	Answer to questions 6 and 3 in the evaluation sheet.	The user is unable to use his/her previous experience in reading books because the book metaphor has not been successful in the Visual Book implementation.

Planned Level	Best Case	Now Level
The book metaphor is working fine, the Index feature is recognised and found useful by the users.	The Index feature is recognised as the most intuitive clue for the reader to achieve his/her task.	The user has a good sense of the text form the graphical clues on the screen.

Table 6.18: *Sense of Text for Exercise 3*

In exercise 3 for the sense of directness, see Table 6.16, five of the evaluators gave a score of 0 to the negative question 4, five of them gave a score of 2 to question 5a and a score of 2 to question 5b. For the sense of engagement, see Table 6.17, five evaluators gave a score of 3 to question 2a, a score of 3 to question 2b, and a score of 3 to question 7. Finally for the sense of text, see Table 6.18, five evaluators gave a score of 2 to question 3 and six evaluators gave a score of 3 to question 6. These results are summarised in Table 6.20.

Factor:	Related Questions:	0	1	2	3	Total:
Sense of directness:	Question 4	5	2	1	0	-4
	Question 5a	0	0	5	3	19
	Question 5b	0	0	7	1	17
						31
Sense of engagement:	Question 2a	0	0	3	5	21
	Question 2b	0	0	3	5	21
	Question 7	0	0	3	5	21
						66
Sense of text:	Question 3	0	2	5	1	13
	Question 6	0	0	2	6	22
						35

Table 6.19: *Summary of Results of Exercise 3*

Exercise 3 was designed to be the most difficult in order to test how well the metaphor was working on a situation where more than one tool could be used by evaluators to solve the task. So it came as a bit of a surprise that the evaluators did not have any doubt in choosing the Index tool instead of a ToC or the Search function. Even the evaluators who were not knowledgeable about the book they were browsing showed, in the comments attached to their evaluation sheet, they were quite confident in using the Index tool. This indicates that the metaphor has been effective as the evaluators found it natural to refer to the tools inherited by the book metaphor in the same way as they would have done with the paper book in their hands.

The overall result of this analysis of the evaluation data has shown no particular weakness in the Visual Book, but the fact that the ToC tool, even if it is seen as natural and easy to use and learn, is not considered as useful for the users, (by comparing the scores in Tables 6.19 and 6.15 for sense of engagement), as the index or other browsing facilities. This will possibly lead to a redesign of the ToC tool either at the interface level, (e.g. to have the ToC always present on the screen) or at the functional level (e.g. to have an expandable or enriched version of the ToC). In order to get more information about the importance and the value of the ToC in the Visual Book system more focused evaluation could be performed even if the present

data analysis has provided enough data for drawing some conclusions about the Visual Book experiment, its success and its possible impact on electronic publishing

6.5.4. Conclusions

The experiment, in both of its forms, has shown the validity of the concepts underlying the Visual Book. It has also revealed the need for clear guidelines for producing electronic books if their designers want them to be used by real users and not just to be considered as a demonstration of their ability in using the newest technology on the market. The comments collected with the evaluation sheets also give a clear indication of the need to integrate some of the facilities provided by the computer with the Visual Book interface in order to result in a more efficient electronic book which is reader oriented. The main conclusion is that the Visual Book has to be a starting point for presenting electronic text to readers who are interested in reading and using the content of the text, rather than in knowing how to use a new technology. At the same time if the Visual Book wants to become an essential tool for its readers it has to provide more of the powerful facilities offered by the electronic medium underneath. The criticism expressed by the computer-oriented group has highlighted the real purpose of a system like the Visual Book, that it should be explicitly reader-oriented and not computer-oriented.

When comparing the results of the Visual Book evaluation with those of the Hyper-Book there is an important factor to be considered: different kinds of evaluation technique have been used, empirical (for the Hyper-Book) and heuristic (for the Visual Book), which have generated different reactions in the users and as a consequence different sets of data, so that comparison of the data is not immediate. However it is possible to extract conceptual if not practical, similarities between the two experiments and compare their impact on the overall results. The findings of the Hyper-Book experiment show that both computer and non-computer expert users appreciate the book metaphor and in particular the interpretation of the book metaphor which is at the basis of the Hyper-Book. Comments about the quantity and the quality of the functionalities provided to the readers have been mainly made by the computer experts whose expectations were influenced much more by their previous experience with the computer than as paper book readers. The same has

been observed in the evaluation experiments for the Visual Book. The computer-expert attitude represents the reaction of a group of people who do not consider their experience as readers of paper books as relevant to understanding how to read electronic books. Instead because they have a strong cognitive background in using the computer, they focus on the machine the electronic book is presented on and for this reason have different expectations. The assumption of this research is that objects such as the Hyper-Book or the Visual Book are not targetted to people with such a cognitive background and needs but to people whose main interest is still information and in having it in the best and most suitable format for being used, consulted, and/or read.

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Chapter 7:
Conclusions

7.1. Introduction

The main aim of this research has been to prove the validity of the book metaphor as a starting point for the successful design of electronic publications. The implications of this hypothesis have been analysed in chapter 1 and, in particular, the importance of the appearance of information as an essential part of the information itself has been pointed out. In order to be able to understand, as well as to propose, trends and future developments in electronic publishing it was necessary to define the basic concepts involved in the electronic publishing process together with a description of the perspective of this research and of the area in which it has been held. Therefore in chapter 2 the terminology related to electronic publishing and electronic books was introduced and its use in this research was clarified. In addition related research was reviewed and key themes identified. Chapter 3 examined available methodologies which could be used to demonstrate the central hypothesis of this work and then arrived at an appropriate method for implementing an authoring system for the production of a particular form of electronic book, the Visual Book. The design and the implementation of this system was described in chapters 4 and 5. Chapter 6 dealt with evaluation techniques and in particular the one chosen and applied to the Visual Book and the results obtained.

This chapter presents two main sets of conclusions: general ones, where the total impact of this research on the area investigated are presented, and particular ones which are related to the specific implementation of the Visual Book as a prototype for the production and presentation of a form of electronic books: visual books.

7.2. General Conclusions

The main general result of this research has been the production of a set of heuristic rules for the construction of electronic books which have been proved to work in the specific case of the Visual Book. The fact that they are quite simple and flexible means that their use does not add any overhead to the publication of electronic documentation and at the same time guarantees a good quality product from the cognitive point of view. In this way the objective of providing guidelines for the production of better quality electronic publications has been achieved. These guidelines were based on the book metaphor and respect for the paper book design as essential components of the process of electronic book publishing and this is why the result of the evaluation of the Visual Book has validated the basic hypothesis of this research as described in chapter 1:

> "it is possible to extract from the document's appearance a valid and complete representation of the logical structure of the original book and, on this basis, it is appropriate to produce the related electronic book thus resulting in a new way to convert information which already exists on paper into electronic form."

Two sub-hypotheses, directly derived from the main one i.e. "... the book metaphor is an appropriate and effective model for designing interfaces for an information system" and "... a book's appearance is a key factor in the specification of interfaces designed to present information which has been published on paper" (sub-hypotheses h1 and h2 in chapter 1) were also validated by the Visual Book evaluation and the enthusiasm of the evaluators in judging the book-like appearance of the Visual Book strongly support the need to keep physical aspects of the book metaphor in mind when designing other electronic books. Also the functional aspects related to the use of paper books (e.g. the use of an Index and ToC) proved their validity when used as

the basis of the design of the consultation tools in the Visual Book, demonstrating in this way that: ".... following from the book metaphor it is possible to propose user services which translate reading habits into an electronic form" (sub-hypothesis h3 in chapter 1).

Another important objective was to prove the necessity for a new role in electronic publishing, "... the *designer of electronic books*, as the person in charge of the final appearance of the electronic book" (see sub-hypothesis h5 in chapter 1), a person competent not only in the technological aspects of producing electronic documentation but with a background in understanding the importance of presentation issues such as pagination and the general format and appearance of the electronic document, which can be called *electronic typography*. The importance of *electronic typography*, where "... typographical rules are essential components of the cognitive model of a book, and for this reason they are relevant to the production of the metaphor of the book into electronic form" (see hypothesis h4 in chapter 1) has been proved by examining the state of the art of electronic publications and the reasons for their lack of success and comparing it with the history of the paper book through explicit analogies. All these issues have been summed up in the concept of image rhetoric which has been the focus of this research as explained in chapter 1. The results of the evaluation of the Visual Book system have proven the importance of image rhetoric as "the application of an image rhetoric to the book image facilitates extraction of its logical structure" (see sub-hypothesis h6 in chapter 1) and thus provide essential information to the designer of visual books.

The last two sub-hypotheses in chapter 1 focused on the role of the reader of the Visual Book as ".... the centre of the design process for the production of electronic books" and the appropriateness of presenting books in electronic form as "... a computer can provide active support for readers who need to solve specific tasks" (see sub-hypotheses h7 and h8 in chapter 1). Both of these were validated by the positive reactions of the first group of evaluators, the User-Oriented Group, who found the Visual Book a pleasant example of an electronic book which was well integrated with the electronic platform and expressed their opinions both verbally during the experiment and by providing written comments at the end of the questionnaires. The second group, the Computer-Oriented one, on the other hand did not agree with sub-hypothesis h7 and the central role of the reader in the production

of electronic books but proposed instead that the computer and related technologies were key factors in the publishing process. In the analysis of the results of the experiment conducted with this group, their reaction was considered as a natural one because of their very specific computer-oriented background and their comments were considered with the understanding that they were strongly biased by previous experiences where they had to accept to read and use electronic publications in any form because they were the only ones available. On the other hand the comments of this group on the role of the computer as "... an active support for readers who need to solve specific tasks" (see sub-hypothesis h8 in chapter 1) validated this sub-hypothesis fully even if this was mainly related, once more, to their background in using the computer as a tool to assist them in solving any tasks.

7.3. Particular Conclusions

The objective of demonstrating the validity of the book metaphor as the basis for the design of electronic publications has been supported by the favourable results obtained in evaluating the Visual Book. Users who were familiar with the paper version of the book appreciated the features inherited by the Visual Book (as in sub-hypothesis h2). The same happened for users who were non-computer expert in general as they already felt familiar with the representation of the object on the screen and could use their previous cognitive background to guess how the object would react to their actions (as in sub-hypothesis h3). They also found the representation to be consistent with their mental model of a book, (the majority of the evaluators indicated this in their comments which were attached to the evaluation sheet) and this helped in learning and remembering how to use the system (as in sub-hypothesis h1).

In particular users were quite happy to interact with an object which resembled a book and appreciated that its enhanced functionalities are consistent with the original one on paper. Following the philosophy of the evaluation method which was applied to the Visual Book, the cognitive jogthrough, users were also free to express, in written or verbal form, their comments and suggestions and this resulted in a few proposals to add computer related features to those already available as well as to make the ones already in place more sophisticated. The main request was for an

intelligent search function to simulate and enhance the way readers search in paper books. Such a function would combine the precision provided by the paper clues in defining the context of the search and by index terms compiled by a human indexer with the high recall provided by the full text search which can be performed very economically by using widely available and fully tested information retrieval software, of course a deep investigation on how to design properly such a powerful functionality will be necessary.

In this way they showed how the Visual Book experiment can be used not only to support the hypothesis of this thesis but also to propose and test new kinds of electronic book which all start from a visual interpretation of the book metaphor. In general the Visual Book system proved to be not just another electronic book but a valuable tool for testing a full range of ideas on electronic publication and how to represent electronic information on screen. The architecture of the system is very flexible and can therefore be adapted and used to demonstrate different interpretations of the book metaphor at different levels. The one proposed in this research has been chosen as being the most intuitive of the possible architectures and also the one which was most like a paper book. However other interpretations which are less dependent on the paper book could be considered in future investigations into electronic publishing assisted by the Visual Book system. The Visual Book Generator system is an authoring tool where it is possible to assemble the Visual Book as a visual object for the presentation of information from different sources. The basic elements of the Visual Book system are the visual pages which are visual units of information presented to the reader on the screen. Designers of the electronic publication are completely free to compose the new electronic page the way they prefer, using a drag and drop interface which let them browse in an archive of images of text and other components of the book. This version of the Visual Book authoring system, the Visual Book Generator, has been restricted to handling only images and text but the architecture of this system is open and ready to accept other forms of information. In this way the Visual Book authoring system is a flexible tool for testing different presentation styles for the production of electronic documents of high design quality.

The fact that the Visual Book Generator system and the Visual Book Viewer are two separate objects has been an advantage in at least two ways:

- the Visual Book Generator can be used to build and to test different interpretations of electronic books which need not be visual, being very simple and flexible with no strict requirements about the format of the data as input for the book;
- the Visual Book Viewer has been used to collect feedback on the way users would like to see the electronic book of the future look. This feedback can be easily passed over to the Visual Book Generator so that the production and testing process can continue.

In this way the Visual Book system is not going to be an obsolete example of an electronic book but the beginning of a set of experiments on how to produce "good" electronic books, according to the guidelines which have been discussed in chapter 4. Of course at this point it is worth re-mentioning the assumptions taken as the basis of this experiment. In particular the fact that a specific set of paper books was taken as a model for the extraction of features to be translated into electronic form, these being scientific books for readers with a scientific background, already familiar with a computer environment but not necessarily computer experts. Also it is worth pointing out that one of the main issues proposed by this research is that the Paper Book metaphor can be profitably used as a *starting point* and not necessarily as the only direction to go.

In this context the Visual Book experiment has been shown to work and has given good indications as to the future steps to be taken to make electronic publication popular, useful and widely used by a scientific audience. In fact particular attention has been paid to the design, analysis and use of some classic components of scientific paper books, such as the Table of Contents and indexes, and the results of this study, which are supported by the results of the Hyper-Book evaluation (Catenazzi, 1994), have shown that users appreciate the use of those tools when they are appropriately translated into electronic form. Other clues users are familiar with in the paper version of a book have also been preserved, such as headings and page numbers, different styles and pagination. Their role in guiding the reader was evaluated in a very favourable way by the users during the evaluation process.

The model used has been an expanded version of one originally proposed by Barker (Barker and Manji, 1991; Barker and Giller, 1991), and is completely compatible and consistent with the one used for a similar system, the Hyper-Book (Catenazzi, 1994). The reason for this choice was the necessity of having a flexible model which could include paper book related attributes together with non-textual information. This is a model which is suitable for modelling the set of features extracted by the paper book metaphor and for producing objects of various complexity from the quite plain Visual Book to futuristic cyberbooks. The version used for the design of the Visual Book system has shown all these characteristics but also some meaningful drawbacks when it comes to its use for real life production of general electronic publications. This sophisticated structure, which is able to model different kinds of interpretations of electronic publications, appears too complex to be effectively used by a wide number of designers of electronic books and also it is too intrinsically linked to the concept of the paper book metaphor to keep it as a paradigm if technology and trends in publishing should take different directions. For this reason, instead, a set of heuristic guidelines (see chapter 4) have been proposed as an output of the Visual Book experiment with the hope of helping future development in the production of "good" electronic books as defined in chapter 4.

The main difficulties when implementing the Visual Book Viewer have been practical ones, which were related to the lack of technology which was able to provide tools for displaying on screen pages with the same or comparable resolution to the paper ones. This limitation has restricted the possibility of testing on a large scale the prototype of the Visual Book, but at the same time has focused this research on a wider field such as the definition of guidelines for the production of "good" electronic books, thus avoiding the risk of ending up with just another nice prototype with no future impact on the market or on similar research projects. The study involved in the production of the Visual Book system has been instead used as a basis for elaborating and defining a set of heuristic rules (see section 4.3.2) that can be used as a basis for the definition and design of electronic publications in general.

There is of course a wide margin left for improvement and further experimentations. In particular implementation issues such as the use of suitable screens for displaying electronic information is still open to a possible technology

related solution, as well as the use of different platforms and standard formats for input data.

7.4. Future Development

One development for the future will be to *implement fully* the Visual Book Viewer prototype as soon as there is proper technology foı displaying text on screen at a resolution comparable with the one available with paper. This will finally allow the results of the heuristic evaluation process to be checked with empirical ones and in this way lend support to one of the basic hypothesis of this research. Another very immediate task will be to extend the Visual Book Viewer to consider non-textual information and dynamic types of information, such as video and sound, and ultimately to be able to use a Visual Book Viewer for presenting advanced electronic publications such as Living Books (Barker, 1996). This will also be an answer to the demand expressed during the evaluation by the users for a more sophisticated system which fully explores/exploits the sophisticated environment it is part of.

The next step in taking the results of this research further will be to start from *electronic information which has no paper counterpart* and to design it for the computer using paper design of similar publications as the inspiration. This will be used to show the validity of the results achieved to date with the Visual Book experiment and the importance of the book metaphor and of its cognitive impact on readers even when the support is no longer the classic paper one but has switched to computers, as is happening now, or, in the future, to other kinds of devices.

The Visual Book Viewer will be expanded to incorporate *more sophisticated features related to the capability of the computer*, as suggested in the evaluation of the prototype. Another additional feature will be the inclusion of user profile information to tailor the Visual Book Viewer to the needs of each of its readers, in order to make it possible to offer readers different views according to their interest and skills.

Study of the *influence of the Internet on the trends for presenting information in electronic format* will be performed in order to understand if eventual modifications

to the book metaphor paradigm have to be considered to make it compatible with the Internet paradigm or if, vice versa, the book metaphor can be extended to the Internet paradigm thus providing a consistent model with a cognitive background for the growing number of electronic publications available online.

The possible impact and effect of the use of the guidelines extracted in this research on the production of already existing electronic books are also going to be the topics of further research, to find out what and how significant could be the changes in the quality of the electronic publications, and how are they going to affect the public response to electronic publications.

In this perspective the Visual Book experiment can be extended to consider different kinds of publication which still satisfy the assumption of being consulted more than read and being targeted to scientific readers or at least to a population of readers familiar with the use of computers. This kind of experiment could be easily designed and constructed thanks to the fast development of the technology and the increasing popularity of computers which are becoming more and more popular as home technologies. This fact will increase significantly the number of possible visual books users and will make the need for good electronic interpretations even more evident.

As a consequence of this technological evolution the paradigms for reading information from the screen will probably change and a next interesting experiment will be to tailor the Visual Book to represent the new paradigms instead of the classic book oriented one. A further conceptual step will be to define more rigorously the concept of an electronic library, which is closely connected with the new electronic book definition.

On the implementation side a further step ahead would be to port the Visual Book Generator to a different platform, a PC or Unix environment, to make it more widely available and to remove machine oriented related features. This process will result in making the Visual Book Generator more flexible because it will no longer be machine dependent and will imply a detailed study of other existing standards for image storage and compression. The next step will then be the evaluation of the Visual Book Generator against similar systems on these other platforms.

Apart from all the technological changes which have already started to affect the production, distribution and use of books, the Visual Book experience has proven that the book paradigm will be able to survive and to provide valuable information on appearance and functionalities of the future book. It must always be borne in mind that " ... of all the needs a book has the chief need is that it be readable" (Trollope, A. 1815-1882).

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Appendix A: The Visual Book Formalisation

Listed below is the result of the formalisation of the Visual Book compared with the book metaphor according to the scheme described in chapter 4.

	Metaphor	**Target**
Tasks	Consult a book	Consult a book (the contents of a set of page images)
Methods	Open it, search in it, read it	Open it (selecting and clicking on it), search (browsing by clicking on active areas), read it
Appearance	3-D book	2-D image of a book

	Metaphor	**Target**
Tasks	Search a specific topic in the book	Consult a book (the contents of a set of page images)
Methods	Open the book, go to the topic page using the ToC or the Index or previous experience or serendipity	Open the book (selecting and clicking on it), search (browsing by clicking on active areas), or using the search fucntionality, realise that the topic is there.
Appearance	3-D book	2-D image of a book icons to represent: Toc; Index; turning pages; margins; flip pages search.

	Metaphor	**Target**
Tasks	Personalise the book	Add personal information to that already in the book
Methods	Add a Bookmark or write a note on the margins	Generate a graphic object to resemble and work like a bookmark, Fill in a texutal box
Appearance	3-D book, pencil and a bookmark	2-D image of a book, an AddBookmark and an AddNotes icon.

	Metaphor	**Target**
Tasks	Zooming to specific parts of the book	Get details not clearly shown on the screen
Methods	bringing the book closer to the reader or reading it through spectacles or magnifiers	Use the zoom facility
Appearance	3 - D b o o k , spectacles/magnifiers	2-D image of a book, a zoom icon

Tasks	Copying part of the text	Print part of the text
Methods	use a photocopy machine	use the print facility
Appearance	3-D book, photocopy machine	2-D image of a book, a print icon

Tasks	Consult the Index pages	Consult the Index pages
Methods	go to the index pages and browse them and go back to the pages selected form there	use the Index functionalities, and click on the active Index Pages
Appearance	3-D book,	2-D image of a book, an Index icon

Tasks	Consult the ToC	Consult the ToC
Methods	go to the ToC pages and browse them and go back to the pages selected from there	use the ToC functionalities, and click on the active ToC Pages
Appearance	3-D book,	2-D image of a book, a ToC icon

Appendix B: Jogthrough Evaluation Sheet

Listed below are the evalaution sheets (Rowley and Rhoades, 1992) used for the three exercises of the evaluation experiment.

Jogthrough Evaluation Sheet

Actions/choices should be ranked according to following conventions:
0= nobody, 1= somebody, 3 = more than half, 3= most.

1. Description of user's immediate goal:

2. First/next atomic action that the user should take:
2a. How many users do you think will find it obvious that the desired action is available? 0 1 2 3
Why/Why not?

2b. How many users do you think will find it obvious that the action is appropriate to the goal? 0 1 2 3
Why/Why not?

3. Selecting the best action:
How many users do you think will appreciate that other available actions are less appropriate? 0 1 2 3
For each, why/why not?

4. Executing the desired action:
How many users do you think will find problems in performing the action? 0 1 2 3
Why/Why not?

5. After the action has been executed. System response:

5a. How many users will find that obvious progress has been made towards the desired goal? 0 1 2 3

Why/Why not?

5b. How many users do you think will be able to access the information related to the final goal as quickly as they expect?

0 1 2 3

Why/Why not?

6. Reaction to the satisfied goal:

How many users do you think will recognise that a task is completed?

0 1 2 3

Why/Why not?

7. Planning the achievement of a new goal:

How many users do you think will find it easy to satisfy a similar goal?

0 1 2 3

Why/Why not?

The tasks required for the evaluator group at Strathclyde University, have been:

- look for page 50;
- look for "Cost and Value of Information";
- look for "Information training in Health Sector".

Referring to the text book: Practical Information Policies, by Elisabeth Orna, adopted for the students of the Information and Library Studies course at the Information Science department.

The tasks designed for the computer expert group have been:

- go to page 30;
- Find a definition for "Automatic Classification" and few examples of "classification methods";
- Find a definition for "Information Retrieval";

Referring to the text book "Information Retrieval", by C. J. van Rijsbergen in use at the Computing Science Department at Glasgow University.

Appendix C: The Results of the Experiment

Listed below are the questions used in the Jogthrough questionnaire along with their score (in brackets) and their relevance/meaning in respect to the Visual Book system.

Exercise 1 was the one about using the go to page number command:

2a	0 (0)	1(0)	2(3)	3(5)	action available (interface issue)
2b	0(0)	1(0)	2(2)	3(6)	action appropriate (system design)
3	0(0)	1(2)	2(2)	3(4)	users find actions less appropriate (both interface and design issue)
4	0(4)	1(4)	2(0)	3(0)	users with problems (both design and interface)
5a	0(0)	1(0)	2(2)	3(6)	obvious system progress (interface and design)
5b	0(0)	1(0)	2(2)	3(6)	possibility to achieve the goal (interface and design)
6	0(0)	1(0)	2(2)	3(6)	recognise that the task has been achieved (\design and interface)
7	0(0)	1(0)	2(2)	3(6)	learning for future use (design).

Exercise 2 was concerned with the use and the validity in the Visual Book of the ToC which had been viewed as an important tool which was inherited from the book metaphor:

2a	0 (0)	1(1)	2(4)	3(3)	action available (interface issue)
2b	0(0)	1(2)	2(3)	3(4)	action appropriate (system design)
3	0(0)	1(3)	2(4)	3(1)	users find actions less appropriate (both interface and design issue)
4	0(4)	1(4)	2(0)	3(0)	users with problems (both design and interface)
5a	0(0)	1(0)	2(3)	3(5)	obvious system progress (interface and design)
5b	0(0)	1(0)	2(5)	3(3)	possibility to achieve the goal (interface and design)
6	0(0)	1(0)	2(4)	3(4)	recognise that the task has been achieved (\design and interface)
7	0(0)	1(0)	2(3)	3(5)	learning for future use (design).

Exercise 3 was concerned with the use and the validity in the Visual Book of the Index as a searching tool which was inherited from the book metaphor and was made more functional by the electronic version:

2a	0 (0)	1(0)	2(3)	3(5)	action available (interface issue)
2b	0(0)	1(0)	2(3)	3(5)	action appropriate (system design)
3	0(0)	1(2)	2(5)	3(1)	users find actions less appropriate (both interface and design issue)
4	0(5)	1(2)	2(1)	3(0)	users with problems (both design and interface)
5a	0(0)	1(0)	2(5)	3(3)	obvious system progress (interface and design)
5b	0(0)	1(0)	2(7)	3(1)	possibility to achieve the goal (interface and design)
6	0(0)	1(0)	2(2)	3(6)	recognise that the task has been achieved (\design and interface)
7	0(0)	1(0)	2(3)	3(5)	learning for future use (design).