Using & Re-using Archive Information for Multimedia Applications: the virtual museum of Italian computer science history

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Abstract

The quality of content is a key attribute for assessing the global quality of a museum application. Unfortunately, producing good content, especially in multimedia digital form, is expensive and time-consuming. One way to reduce the costs without sacrificing quality is to exploit the concept of information reuse. The idea is to use (portions of) the same multimedia material in different applications, possibly adapting it for different contexts, for different categories of users, and for different delivery channels (e.g., on-line and off-line). Information reuse does not come free. To be effective, it requires a well-organized environment in which information can be easily stored, inspected, retrieved, and adapted for different purposes. This paper describes the approach adopted in the project "The Virtual Museum of Italian Computer Science History", funded by the Italian National Council of Research (CNR). In this project, all the digital material (documents, images, video interviews, etc.) is stored in a digital archive based on a multimedia database with a WWW front-end. The archive is designed for specialists only: members of the editorial board of the project; researchers in the history of science; application developers (who are looking for interesting content to include in their CD-ROMs or Web sites). Each research group involved in the project extracted and adapted from the digital archive the multimedia material needed to build a different hypermedia application in two "versions" - WWW and CD-ROM. These applications, both on-line and off-line, strongly reuse (portions of) the digital archive content, but organize and present it with a totally different style, to address the needs of non-specialists (e.g., people who have some interest, or curiosity, on the history of Italian computer science).

Introduction

Producing good-quality multimedia material is expensive and time-consuming; thus, a challenging issue is to support information "reuse" (Garzotto 1996), i.e., multiple use of the same multimedia material in different applications, in different contexts of use, and for different categories of users. In principle, developing new applications by "sharing" multimedia contents requires less time for their development and costs much less than developing their content totally from scratch.

Unfortunately, information reuse does not come free. To be effective, it requires development of a well-organized *editorial environment* in which multimedia information can be easily classified, stored, inspected, and retrieved for different purposes. It also requires some kind of *integration* between the editorial environment and the application development environment, as well as systematic *design methods* so that it is easier for developers to re-use the same base of information for building different applications. This paper will describe the technical approach adopted in the project "The Virtual Museum of Italian Computer Science History" to address the above issues.

From a cultural perspective, this project originated from the idea that, although computer science is a young, ever evolving discipline where everything becomes obsolete in a few years, its history is part of the memory of our society, and many lessons can be learned from it. We should therefore avoid the risk of forgetting the events of its evolution and the testimony of the people that made this history, which are not purely anecdotal, but which have intrinsic cultural and social value (De Marco 1999).

In acknowledging this, CNR - the Italian Research Council - launched in June 1996 the project "Museo Virtuale della Storia dell'Informatica in Italia" (Virtual Museum of Italian Computer Science History). The project's purpose is to exploit information technology in order to preserve and to disseminate the cultural heritage concerning the history of computer science in Italy, which would otherwise be lost in a few years, without any possibility of recovery. The project focuses on the "infancy" of Italian computer science, between the mid-fifties and the end of the seventies, when computer science was in its infancy and where Italy played a key role.

The core knowledge which witnesses this period is composed, broadly, of various types of information: about persons, from academy and industry, who were main actors in the scenario of those years; about scientific, industrial, and social events which took place; about institutions, industrial or academic, which promoted computer research and applications during that period; about computer machines; about (primitive) software programs and (mainly numerical) applications; about specific technical results. To document all these various aspects, the project team has been collecting various kinds of material related to the period of interest: documents, scientific papers and books, pictures, computer pieces, historical photos. Since the actual actors of that period are a key source of information, the project also performed several interviews with (a few) living persons, from industry or academy, who were among the protagonists in the field of Italian computer science at that time. These interviews, besides being a live testimony of that period and providing a great deal of useful information, gave us many indications on how and where to collect additional material which we would have never discovered otherwise.

All the collected material was analyzed from a critical and historical point of view, classified, and organized. After its digitalization and conversion into the most popular computer formats, it was archived in a digital archive developed with standard database technology. The investment in these activities of gathering, producing, digitalizing, and storing multimedia content was vast and could not be justified by pure preservation needs. A key requirement of the project was also to disseminate among a wide audience the knowledge of our scientific and technological development in computer science, which is for the most part unknown. The first step to achieve this goal was to make the repository content publicly available on line, so that anybody could explore and retrieve the stored material via any standard WWW browser.

The on-line digital archive stores a large amount of "row" content in different digital formats. For the amount of information available, its content organization and its interface style, the on-line archive is mainly suitable for specialists, e.g., historians who have some research goal, journalists who need some specific information, and the like. Still, we also wanted to stimulate a larger interest outside the context of pure specialists, e.g., for people who need to explore the archive material for education purposes, or just for curiosity or personal interest, rather than for some specific work task. Users of this type have different requirements with respect to specialists (as we will discuss more precisely in section "The hypermedia applications"). As such,

they need some customized versions of the archive, with different contents, access mechanisms and visual interface features. To address their needs, the project developed a set of "customized" applications, all based on portions of the knowledge sources stored in the digital archive, "revisited" in terms of organization, presentation, interaction control, and access style. The various applications address some specific themes, and have been delivered in two versions: one on-line, available via any WWW browser, and one off-line, on CD-ROM (the latter, allows for a more efficient fruition of video material that, currently, is slow on the Internet).

Thus, in this project the reuse of multimedia material occurs at two levels: 1. between the digital archive and the hypermedia applications, which strongly reuse portions of multimedia content available in the database, and 2. between the two different versions of the same applications, on-line and off-line.

In the rest of this paper, we discuss the digital archive and the hypermedia applications from a technical perspective, illustrating more precisely their user requirements and their design and implementation choices.

The Multimedia Digital Archive

The multimedia digital archive has been designed to satisfy a number of requirements:

- to preserve, in digital form, testimony and material concerning the "genesis" of the field of computer science in Italy, between the mid-fifties and the end of the seventies, that would otherwise be lost; this material is intrinsically multi-media, since it includes technical notes, scientific articles, photographs, audio and video recordings, both of original historical events and of ad-hoc interviews;

- to disseminate this cultural heritage, by making the collected material publicly available for study or research, e.g., to historians, journalists, scholars;

- to allow geographically distributed "authors" to continuously update the database. The project team is composed of different "units", i.e., working groups, located in different Italian towns (Milan, Pisa, Rome, Siena) which represent some of the most important places where major events took place in the field of computer science during the fifties. Each group is in charge of collecting the material related to his/her area, and storing it in the database. Populating the

digital archive is therefore conceived of as a multi-author activity;

- to support scalability, in order to accomplish the progressive growth, with time, of the multimedia content. The acquisition of the archive material is incremental; the archive is continuously enriched with new multimedia content as the collection activity proceeds (and new material is discovered). Populating the archive may, in principle, continue indefinitely, extending, in the future, the period of interest, from the early years of Italian computer science to present day;

- to make the material easily available for developers of multimedia applications working in this field and which are targeted for a non-specialistic audience;

- to keep, at the same time, complete independence from the particular applications that can be developed.

From a technological perspective, the best candidate to support the above requirements is to develop an on-line multimedia digital archive, based on standard data base technology and accessible via any standard WWW browser. The actual content is stored in a centralized data base (currently located at CNR in Pisa) developed with a commercial object-relational DBMS (Illustra/Informix). On top of it, we have developed a WWW front end, which supports both remote update of the archive (by the various members of the editorial team of the project) and remote access, by the project members and any user who is interested in the archive content. The use of standard data base technology supports the needs of scalability, multi-user access and update, and security.

The Archive Data Schema

The archive contains various classes of information: information about personages who, with various roles, contributed to the development of computer science in Italy, their biographies, audio and video interviews and photographs; about public and private institutions that had (and partially still have) a relevant role in the history of Italian computer science; about software systems (as operating systems of the first computers) and hardware systems (as electronic computers and calculators) with historical and technical cards, photographs, audio and video recordings; and, finally, about events that have marked the fundamental steps in the development of computer science in Italy. The data base schema describes these various classes of information and models the relationships between them. Figure 1 shows a simplified version of the schema to provide an intuitive idea of the data organization. As a matter of fact, the multimedia digital archive is much more complicated
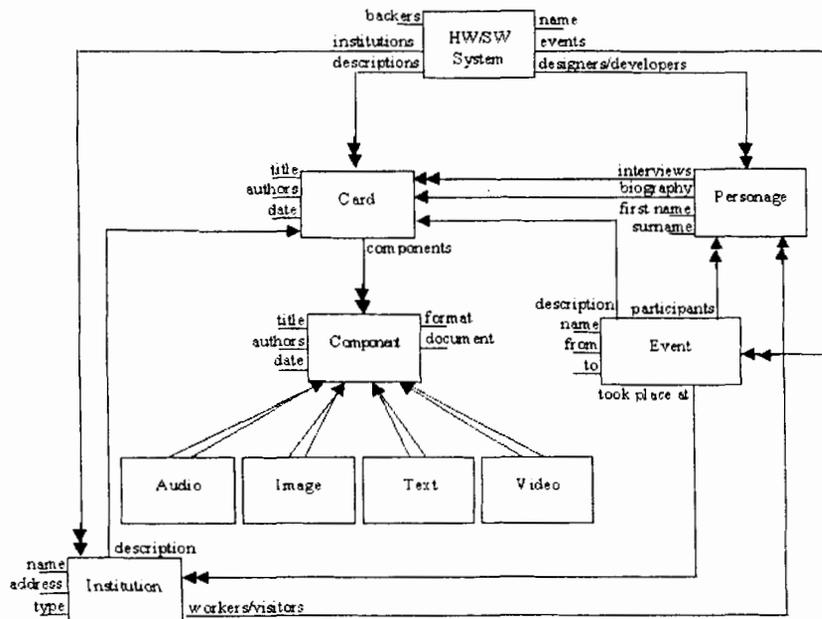

Figure 1. The Multimedia Digital Archive Schema

than the one presented here. For example, the HW/ SW System class is divided into Hardware and Software classes and the Hardware class, in turn, has the functional units as components.

It is important to notice that the multimedia digital archive is able to keep the same document in different formats. For example, the same video recording can be stored in AVI, MPEG and Real Video format. The availability of the same documents in distinct formats supplies users of the stored information with the possibility of finding the documents of interest in the format better suited to their own requirements. This availability required greater employment of effort in the first phases of the Project, but, from the reuse perspective, has been an investment for the future. First of all, storing the same material in multiple standard formats guarantees better chances of long-term preservation and more potential for reuse of the stored material in the future. In the multimedia scenario today, standards are many and ever evolving, and it might not be obvious which will win. There is the concrete risk that what is stored today in some specific digital format will not be able to be reused (and even 'read') in the future, as a standard may become obsolete and technology will not be able to support it. The more formats we provide, the greater probability we have of being close to future standards and of making this material available for the posterity. Furthermore, having the same content in multiple formats makes it easier to reuse now for the development of the archive interface and of non-specialist applications, since each project partner has been able to find the suitable format to his/her own application without further efforts. For example, the developers of the hypermedia applications for non-specialists (see section 'The hypermedia applications') use video recordings in AVI format and images in Bitmap format, while the developers of the archive WWW interface used a format with a higher compression ratio (Real Video for video recordings and JPEG for the images). The same advantages can be exploited by all users that, in the future, may access the multimedia digital archive.

The Archive Interface

The archive can be managed both from local and from remote locations through the submission of SQL commands or by using an Internet/WWW interface for the loading of the data and the retrieval of the information (http://faure.iei.pi.cnr.it/~serena/MuseoInformatica/Museo.html). The first functionality, provided by an *administration module*, allows 'authors' to insert, delete and update data through simple forms. The second functionality, provided

by a *retrieval module*, is used by the archive 'visitors' and permits guided browsing through the entire archive content.

The *administration module* can be used only by 'authors', i.e., authorized users (typically, the members of the project editorial board) who have the right to add new material, to update and, eventually, to cancel data already inserted in the archive. Access to this functionality is controlled by a password that prevents access by non-qualified users.

Data are inserted in the archive by filling in a simple form. The interface provides support to the user during data loading, in order to reduce the possibility of errors. This is obtained through a controlled set of fields, scrollable choice lists, menus and automatic checks of data consistency. On-line help is also provided. Figure 2 shows, as an example, the form that an 'author' has to fill in order to insert a new personage in the archive.

Typical users of the *retrieval module* are experts of computer science or of the history of science, and developers of multimedia applications. All of them
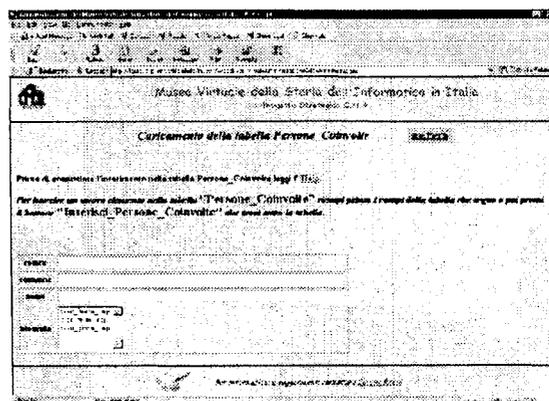

Figure 2. A page to insert a new personage in the digital archive of the Virtual Museum of Italian Computer Science History

use the archive as a 'repository' of material from which they can extract the contents, either by using a query mechanism or by browsing the information stored in the archive. The first mechanism is obtained through the use of the SQL query interface of the multimedia database. In a successive version we plan to offer a user friendly interface for the formulation of content-based queries.

The simplest mechanisms that the user employs to see the information stored in the archive is based on browsing. The system has a number of macro-categories of contents (Audio Documents,

Bibliography, Documents with historical soundness, Institutions, Events, Images, Personages, Cards, Hardware Systems, Software Systems, Textual Documents, Functional Units and Video Documents) that can be used as a starting point; successive steps are performed by following the links starting from these categories, and correspond to the database schema relationships. Multimedia presentation tools allow one to visualizethe information dynamically extracted from the digital archive. This dynamism is a particularly interesting aspect since new information inserted in the archive will be automatically visualized without further efforts.

If a user is, for example, interested in a given personage, he can access the Personage category and choose the person about which he is searching for information. The information presented depends on what is available about the personage; for example, a guided tour presenting the chosen personage can present his/her photograph first, then his/her biography (see figures 3 and 4). Moreover, the user can see interviews of the personage (as figure 4 shows), access the events to which he/she has taken part, the institutions in which he/she has worked or visited, and the software and hardware systems on which he/she has worked.

At any time, the user can change category and see, for example, the events that have marked important steps in the history of Italian computer science.

The hypermedia applications

The hypermedia applications developed in the project have different purposes with respect to the multimedia archive. The latter is designed for pro-

fessional use. Its intended users are members of the editorial board of the project, who need to insert new material or update the existing one; or researchers in the history of science, who are looking for material which has some interest for their studies; or application developers, who need interesting content to include in their CD-ROMs or Web sites. As such, the digital archive stores *all* the material collected during the project, in a number of different formats and versions. The content is organized using technical criteria, to optimize storage allocation. The interface tries to maximize the efficiency of a specialist's access, based on queries and goal-oriented exploration.

In contrast, the hypermedia applications, both on-line and off-line, are mainly designed for non-professional use. Their main requirement is to promote some interest in the early years of Italian computer science, to stimulate reflection, especially by the young generation, on what happened in industry and academy in those years and how it relates to the present. Intended users are "casual" visitors who are mainly motivated by curiosity or people who have some interest on the history of Italian computer science, either for education purposes or just for personal culture.

Part of these users may need to be stimulated to use the system. In general, they do not require the availability of the whole body of information stored in the archive. Textual descriptions of "concepts" (biographies, events, machines, etc.) can be short for these users (the archive instead also stores long detailed presentations about each subject). They are particularly attracted by visual content (images) and above all, by live, interactive material such as video interviews (where more curious and anecdotal information can be discovered). In terms of
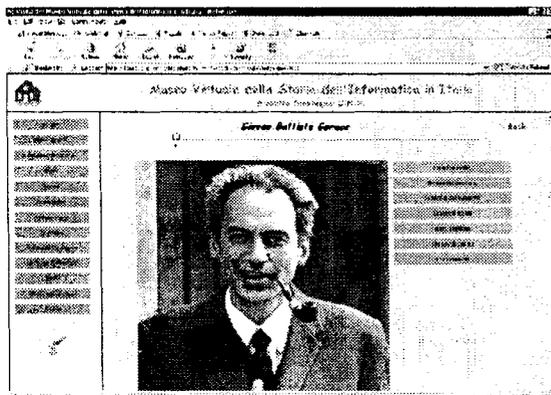

Figure 3. A personage in the digital archive of the Virtual Museum of Italian Computer Science History
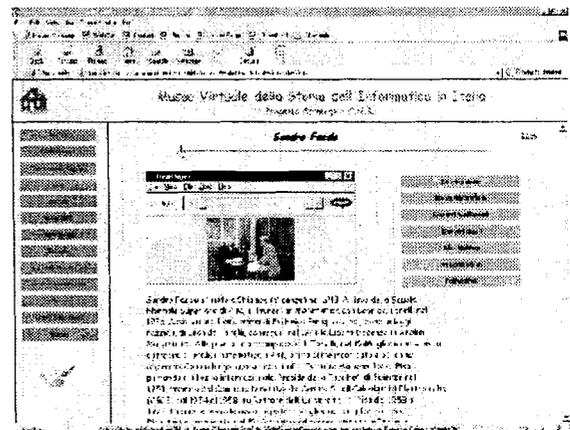

Figure 4. Another personage in the digital archive of the Virtual Museum of Italian Computer Science History

their way of interacting with the system, these users tend to have an explorative, "looking around" attitude, rather than trying to achieve a well-focused goal.

To address these requirements, the hypermedia applications, no matter whether on-line or off-line, reuse portions of the digital archive, selecting the most interesting ones for the intended users, in the most convenient forms and formats. The selected material must be re-organized, in order to provide composite information objects and navigation structures which result natural and effective for non-specialists. The visual interface and the interaction mechanisms must be designed in order to be appealing and attractive, e.g., by means of an intriguing layout, some visual metaphors, and a high degree of interactivity on active media.

The hypermedia application schema

The content organization and the navigation structures of the hypermedia applications are the same for the on-line and the off-line versions. To specify them, we adopted the vocabulary of HDM (Garzotto 1993; Garzotto 1994b; Garzotto 1995a), the Hypermedia Design Model. HDM distinguishes among the in-the-large schema, where the macro-aspects of the content and navigation structures are described, and the in-the-small schema, which defines structural properties at a finer level of detail. Figure 5 presents the in-the-large schema.

In figure 5, rectangular boxes represent classes of entities of the application domain (e.g., personages, events, computer systems, single question-and-answer fragments of video interviews). An entity of a given class may contain some constituents, called "components", which are denoted by square boxes and represent semantic "parts" of the entity (e.g., sub-topics of a given topic). Usually, components correspond to pages (or computer full screens) in the final on-line or off-line implementation of an application.

Lines describe (bi-directional) navigational links, corresponding either to semantic relationships among domain entities (e.g., between a person and the institution where he/she worked) or to structural relationships among components of the same entity. The set of entities and links among/inside them represent the so-called *hyperbase*, where the main sources of material are represented.

Some examples of the in-the-small specification of the various entity types are the following:

Person

• component Description: includes Name, Short Text Description, Image
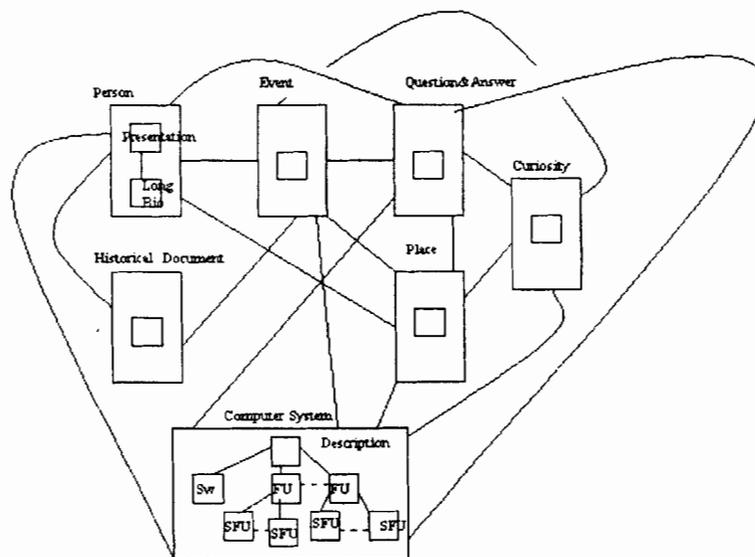
Figure 5. The Hyperbase in-the-large of the hypermedia "The Virtual Museum of the History of Italian Computer Science"

- component Long Bio: includes a Long text Description of the person

Computer System

- component Description: includes Computer Code, Date, Use (commercial or scientific), Computer Generation, Short Presentation, one or more Images

- component SW (software): includes a Short Description of the software developed for the system

- component Functional Unit (FU): includes Computer Code, Functional Unit Name (e.g., Arithmetic Unit), one or more Images, Short Description

- component Functional Unit (FU includes Computer Code, Functional Sub-Unit Name (e.g., Arithmetic Unit), one or more Images, Short Description

Q&A (question and answer)

- component Q&A: Interviewed Person Name, Institution Name, Question - transcription, Answer - transcription, Video Fragment

The conceptual design of the applications includes the definition of "collections" (Garzotto1994a) that represent sets of entities, or sets of other collections. Members of a collection can be homogenous or heterogeneous. They can be grouped together for different reasons: because they have the same nature (e.g., "all interviews"); because they are mutually related by some semantic relationship (e.g., all places where a given person worked); because they are all useful for a given user task (e.g., have a quick overview of the most important information on a given theme"). Collections have a distinguished element called "center" which provides an overview of the collection content and the entry points (links) to access collection members.

The main collections are listed in the following table, where we indicate the types of objects grouped by each collection. All collections are homogeneous, i.e., they group elements of a given type, except those named "Guided Tour on Theme X_i" (on the bottom of the table). These are heterogeneous and groups information objects of different types that are related to a given theme (e.g., "The arrival of the first computer from the U.S.").

Navigation is quite rich in the hypermedia applications. Users can choose where to start accessing

Entity Type ⇒ Collection ⇓	Person	Place	System	Historical Document	Q&A	Event	Curiosity
All persons (alphabetic order)	√						
Persons by Place	√						
Persons by Event	√						
Persons by system	√						
All computer systems (alphabetic order)			√				
Systems by generation			√				
Systems by development place			√				
Systems by person			√				
Sw products			√				
All Events (chronological order)						√	
Events by year						√	
Events by place						√	
All places (alp. order)		√					
Q&A by subject (alp. order)					√		
Q&Q by Person					√		
All Curiosities (alp. order)							√
Curiosity by subject							√
All historical documents (chronological order)				√			
Historical document by event				√			
Guided tour by Theme X1	√	√	√	√	√	√	√
Guided tour by Theme Xn	√	√	√	√	√	√	√

Structure Table: The structure of the collections in the hypermedia applications of the Virtual Museum of Italian Computer Science History

to the hyperbase by navigating within and across collections; they can browse within the hyperbase by traversing semantic and structural links; they can jump from different portions of the hyperbase by returning to some collections and choosing different elements.

Within a collection, the browsing style combines "by index" and "by guided tour" navigation. "By index" means that from an entry point (i.e., the collection center) users can reach any element in the collection directly. "By guided tour" means that users can visit the collection sequentially, starting from the first element.

The hypermedia application visual interface

The lay-out design of the interface, i.e., the visual arrangement of the elements on the screen, which is minimalist and "severe" in the digital archive, is instead intriguing and "rich" in the hypermedia applications.

Examples of screens are shown in the following figures, taken from the CD versions of the hypermedia application concerning the early history of computer science in Milan and Pisa.

Figure 6 shows an entity of type "product", presenting the computer "CRC-102-A", used at that time for scientific calculus (this is one of the smaller ones built at that time, even so, it required an entire room for its storage- compare its size with todays laptops!). Textual presentation is on the left side, a photo (the first of a set) on the right. Users can interact with the page in several ways: in-the-small, by scrolling the content or displaying the pictures one after the other, and in-the-large, by navigating to a different page (Garzotto 1995b). Different categories of navigation links correspond to dif-
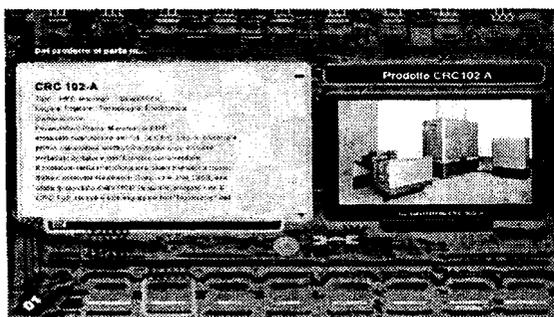

Figure 6. The description of a computer in the Milan-Pisa CD-ROM hypermedia of the "Virtual Museum of Italian Computer Science History"

ferent areas on the screen. Links representing semantic relationships are located in the top area; collection links to move to the various collections (see definition above) are located on the bottom. A visual cue, based on a set of lines resembling computer circuits, suggests which collection the currently displayed page belongs to (in our case "computer systems"). Other collection links, represented by the square and circle icons just below the area separating the picture from the text, allow the user to move from one element to the next and to the previous one in the current collection. To help users understand the meaning of links, each link is associated with a short explanation, which appears as the user rolls over the link button with the mouse.
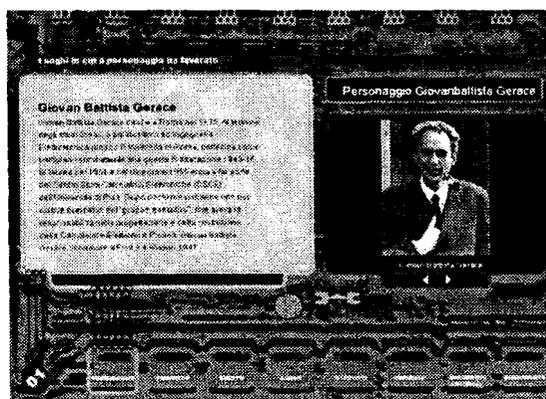

Figure 7. The personage "Giovan Battista Gerace (compare it with figure 3 in section "The multimedia digital archive", where the same person appears in the digital archive)

Figure 7 shows the description of the personage Giovan Battista Gerace. It is useful to compare it with Figure 3 of section "The multimedia digital archive", where the same personage appears in the digital archive. Some of the content has been reused in the hypermedia application: the short textual description, the personal data, and the photo, and has been combined together on the same screen, and presented with a very different interface.

Figure 8. shows the entry point (i.e., the "center") of the collection "Persons – by – place (Milano)", listing some of the main actors of the Milanese computer science life of the fifties. By pointing to a name in the list, the photo of the selected person appears in the right window.

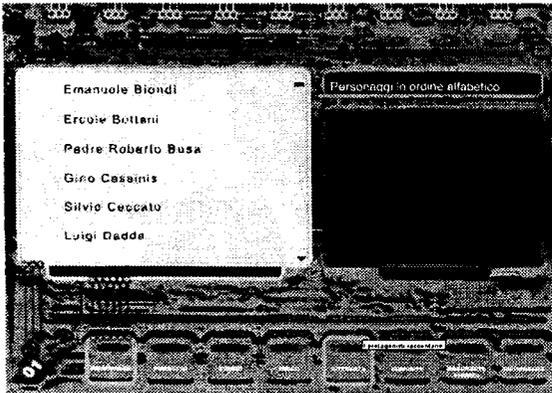We can observe that the lay-out style is "modern", even "metal", and adopts the visual metaphor of a

Figure 8. The entry point to the collection "Personages by Place (Milano)"

computer mother board. The gray background shows, in the shadow, micro circuits and board units. The idea of circuits and CPU units are also suggested by the buttons, the lines separating or connecting the various areas on the screen, the frame around the content fields. Colors are strong and contrasted, with a careful use of gray, black, white, intense red, intense yellow, and "electric" blue.

Conclusion and future work

This paper has presented the approach adopted in the Project "The Virtual Museum of Italian Computer Science History" for the reuse of multimedia documentation in the creation of interactive multimedia applications.

The experience gained in the project for the creation of the multimedia archive - together with the applications for its access and management - and for the development of different hypermedia applications both on-line and off-line (e.g., on CD-ROM) brings us to the following conclusions:

• The cost of the production, selection, organization, etc. of the multimedia material is largely dominant with respect to the cost for the development of the applications.

• The possibility of reusing, even part of the material produced, provides a significant reduction in the cost of the development of a new application. This reduction is much more significant when different versions of the same application are produced (such as the CD-ROM and WWW versions) or when updates of the application are created (e.g. when new material becomes available).

• The possibility of reuse is strongly dependent on the availability of a well-organized environment, like the digital archive developed in the project. This acts as a multimedia repository of the collected material, supporting hypermedia developers to search and to retrieve, in a very effective way, what needs to be reused for application development. The digital archive also acts as an editorial environment, which makes the process of storing new content and maintaining the overall body of knowledge sources easy, efficient, and well organized.

• A multimedia repository where data are stored in different formats, guarantees that the digitized material can be acceded in the long term. This makes *reuse over time* possible. The problem of format obsolescence is extremely important and critical, especially in the case of archives containing historical data: the solution adopted in the project is also based on the adoption of procedures for the updating of existing material, thus making possible the insertion of new data formats when necessary.

The work done so far has also evidenced the need for further research work in order to obtain an optimal solution. In particular, we are considering continuing our research activity in the following areas:

• In many cases, it is useful to enable the reuse of parts of applications, besides the multimedia contents. Research work is needed to understand how *reuse of application components (modules)* can be done, how subparts of an application can be extracted.

• Related to the previous aspect, there is the need of creating an archive of reusable application components. This also requires the definition of appropriate mechanisms for the selection of the relevant application modules (query mechanisms) together with a suitable query formulation interface.

• The final and most ambitious goal is to provide a strong integration of the application with the multimedia repository. This means that data are stored in the archive and the application acquires them only when needed, by using query by content mechanisms instead of directly accessing the objects. This approach makes possible the development of applications whose content can be updated continuously, as soon as new material becomes available.

Acknowledgment

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