SIAR: A User-Centric Digital Archive System

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Abstract. This paper presents the SIAR (*Sistema Informativo Archivistico Regionale*) project supported by the Italian Veneto Region, the aim of which is to design and develop a digital archive system. The main goal of the SIAR project is to develop a system for managing and sharing archive metadata in a distributed environment. In this paper we report the activities that led to the design and development of the SIAR system, underlining the fundamental role played by the user during this process. Indeed, in the SIAR project the archival users provide continuous feedback that allows us to shape the system on a user-needs basis.

1 Introduction

Digital libraries (DL) are in a state of rapid evolution. Although they are still places where information resources can be stored and made available to end users, current design and development efforts are moving in the direction of transforming them into systems able to support the user in different information centric activities. In the context of digital libraries we need to take into account several distributed and heterogeneous information sources with different community background such as libraries, archives and museums and different information objects ranging from full content of digital information objects to the metadata describing them.

Digital libraries are heterogeneous systems with peculiarities and functionalities that range from data representation to data exchange while taking in data management along the way. All these aspects need to be taken into account and balanced to support end users with effective and interoperable digital libraries. In this work we restrict the wide spectrum of research aspects studied by the Digital Libraries to focusing on the archives and specifically on the conceptualization, design and development of a *Digital Archive System* (DAS); in particular, we emphasize the role of the users throughout this process.

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SIAR (*Sistema Informativo Archivistico Regionale*) is a project supported by the Italian Veneto Region the aim of which is to design and develop a DAS. The main goal of the SIAR project is to develop a system for managing and sharing archival metadata in a distributed environment. Archival metadata are geographically distributed across the Veneto Region and they are preserved in several local archives; the SIAR objective is to develop an information system able to create, manage, access, share and provide advanced services on archival metadata [4].

The SIAR project is the result of an effective synergy between computer science and archival competencies that put the users in the center of the process of ideation, design and development of the DAS – i.e. the SIAR system. In each step of the design and development of the SIAR system there was continuous feedback from the users. We have considered the software engineering practice in order to point out six main phases that characterize the development of the SIAR project.

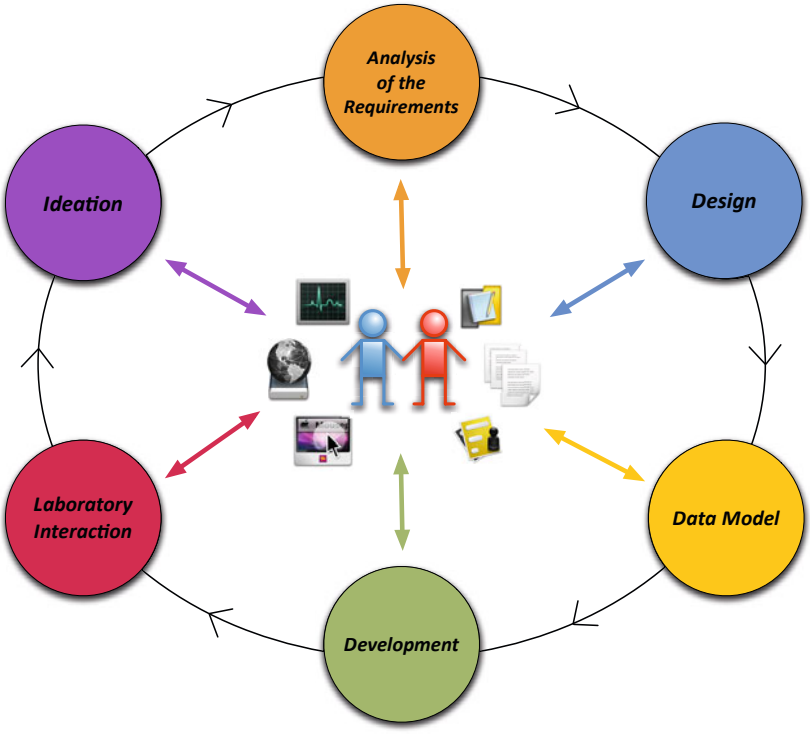

Fig. 1. The six main phases carried out within the SIAR project

In Figure 1 we can see the collaboration between computer scientists and archivists in the center of the six main phases that led to the realization of the

SIAR system. At the same time, it also represents the continuous feedback with the users in each one of the six phases:

Ideation: in this phase we defined the goals of the project and the direction that it has to follow. This phase also defines the way in which the project is carried out – e.g. how archivists and computer scientists have to work together or who the users of the system are. In this phase the very nature of the archives and archival description was taken into account and we analyzed the state of the art of digital archives.

Analysis of Requirements: in this phase we defined the minimum set of requirements that the SIAR system has to fulfill in order to meet archivists and general user needs.

Design: in this phase we set the content and functional configuration parameters of the SIAR system by defining the resources that are exploited by the system and specifying the aspects of the system functionality perceived by the end-users.

Data Model: in this phase we defined two new data models based on organization of nested sets. We discussed with the archivists the functionalities and the possibilities of using these set data models to define an innovative methodology to model the archives and the archival descriptions.

Development: in this phase we instantiated the defined data model by adopting standard Digital Libraries technologies well-suited to meet the archival requirements.

Laboratory interaction: in this phase the SIAR system was tested and its functionalities were tried out by the archival users. Their suggestions and criticisms were taken into account to understand which requirements are satisfied by the SIAR system and where it needs to be revised.

This paper is organized as follows: Section 2 describes the ideation phase and also highlights the main characteristics of the archives and archival descriptions. Section 3 points out the requirements that the SIAR system has to fulfill. Section 4 introduces the design choices made in the SIAR project. Section 5 introduces the main features of the data model on which the SIAR system relies and section 6 briefly presents the architecture of the SIAR system. Section 7 reports the outcomes of the laboratory interaction phase where the SIAR system was tested by a group pf archival users. In section 8 we make some final remarks.

2 Ideation

The ideation phase took into account the very nature of archives and archival descriptions. The role of archival users is crucial for understanding the characteristics and peculiarities of archives and thus, for addressing the issues that arise when we move from traditional archives to digital ones.

One of the most important aspects is that an archive is not simply constituted by a series of objects that have been accumulated and filed with the passing of time. Instead, it represents the trace of the activities of a physical or juridical

person in the course of their business which is preserved because of their continued value. Because the archival documents are strongly connected with the creation and preservation environment the archives have to keep the context in which their resources have been created and the network of relationships between them in order to preserve their informative content and provide understandable and useful information over time. Archives are in fact made up of series which in turn can be organized in sub-series which are formed of archival units. This implies that each of these entities can only be correctly identified and interpreted in relation to the entity they belong to and from which they inherit certain characteristics [17]. The prevailing solution in the development of DAS was to represent these relationships with hierarchical metaphors which collocate each entity in a hierarchical relationship of subordination with the entity it belongs to – i.e. the archive is modeled by means of a tree structure.

In this context, archival description is one of the most important tools that we have to consider when we have to deal with archives and it is defined in [12] as "the process analyzing, organizing, and recording details about the formal elements of a record or collection of records, to facilitate the work's identification, management, and understanding"; archival descriptions have to reflect the peculiarities of the archive.

In a digital environment archivists are used to adopt a metadata standard to encode archival descriptions which is called the Encoded Archival Description (EAD). EAD is a standard released by the Library of Congress in partnership with the Society of American Archivists[1]. It fully enables the expression of multiple description levels central to most archival descriptions and reflects hierarchy levels present in the resources being described. Furthermore, EAD reflects the archival structure and holds relations between entities in an archive. In addition, EAD encourages archivists to use collective and multilevel description, and because of its flexible structure and broad applicability, it has been embraced by many repositories [11].

Thanks to these features EAD allows the archivists to represent and manage the fundamental characteristics of archives even in the digital environment. On the other hand, EAD allows for several degrees of freedom in tagging practice, which may turn out to be problematic in the automatic processing of EAD files, since it is difficult to know in advance how an institution will use the hierarchical elements. The EAD permissive data model may undermine the very interoperability it is intended to foster. Indeed, it has been underlined that only EAD files meeting stringent best practice guidelines are shareable and searchable [13]. Moreover, there is also a second relevant problem related to the level of material that is being described. Unfortunately, the EAD schema rarely requires a standardized description of the level of the materials being described. Therefore, access to individual items might be difficult without taking into consideration the whole hierarchy. Moreover, sharing and searching archival description might be made difficult by the deep hierarchical structure of EAD files. Indeed, each EAD file is a hierarchical description of a whole collection of items rather than

[1] `http://www.loc.gov/ead/`

the description of an individual item. On the other hand, users are often interested in the information described at the item level, which is typically buried very deeply in the hierarchy and might be difficult to reach.

This approach does not allow us to change the metadata format used for describing the archival resources and it binds together the structure of the archive and the archival descriptions. In this way an archive is treated by a DAS as a monolithic unit that does not allow the very flexibility that archival users require [8]. Furthermore, the plain adoption of the EAD approach turns out to be a barrier towards the effective adoption of standard Digital Library technologies such as Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH) [15] [8]. As described in [9,1], both the variable granularity and the cross-language access as well as the variable granularity exchange of archival metadata is precluded by this approach.

In the SIAR project we chose to take into account both the positive and the negative aspects of archival practice and in particular of the EAD in order to envision an innovative DAS which allows us to represent and manage the fundamental characteristics of archives and at the same time to overcome some well-known issues.

3 Analysis of the Requirements

The SIAR system is a *Digital Archival System* (DAS) that has to take into account the characteristics of the archives and their resources. The representation and management of an archive and its resources cannot be apart from the retaining of the inner archival hierarchical structure and the relationships between the archival resources defining the context of an archive. The first requirement pointed out by the archivists directly derives from archival practice: the *hierarchical* structure in which the archival resources are organized has to be preserved as well as the relationships between them in order to be able to reconstruct the *context* in which they were created and preserved.

In particular, in a digital environment an archival system has to manage the descriptions of the documents represented by means on archival metadata. From the interaction with the archival users we understood that archival descriptions should adopt flexible and, if possible, extensible metadata format in order to deal with the heterogeneity of the archival resources. A DAS has to be able to manage different archival metadata formats at the same time. There can be the chance that a document has to be described in multiple ways by means of different metadata formats.

The archivists pointed out that an archive is not only composed of documents and archival descriptions, but it also comprises the organizations, institutions, corporate body, families, people and preservation institutes that contribute to creating an archival resource – i.e. producer subjects – and to preserving and making it accessible – i.e. preservation subjects. Each one of these subjects has to be described by means of a proper metadata format. The archivists highlighted the importance of these descriptions and their relationships with the archival

resources that they produce and preserve. We call these descriptions *authority files* and they can be seen as access points to the archival resources. A DAS has to be able to represent, encode and manage the authority files in whichever metadata format they are encoded and it has to allow the possibility of defining relationships between the various authority files and between these files and the archival descriptions.

The description of archival resources and the authority files requires a major human effort. For this reason the possibility to access, update or delete a description or a resource has to be granted only to those who are explicitly authorized. Furthermore, there are relevant privacy issues such that the consultation of an archive has to be controlled and limited if necessary. Access with variable granularity has to be granted to the archival resources. Furthermore, a DAS has to be able to exchange archival descriptions with different degrees of coarseness and belonging to whatever level of the archival hierarchy without having to exchange the whole archive. Furthermore, it is required to have a mechanism available for reconstructing the archival relationships of an exchanged description whenever this is necessary.

In the archival context, especially when we consider a multitude of small- or medium-sized organizations that need to describe and manage their own archives, it is very important to envision a DAS which is economically sustainable. The context in which the SIAR will operate is polyhedral and composed of many small- or medium-sized archival entities that consider the economical sustainability of a system as a primary goal.

4 Design

The design phase took into account the requirements that an archival system has to fulfill as well as the state of the art technologies adopted by digital archives. We have analyzed the possibility of adopting well-known and diffused Digital Library technologies such as the OAI-PMH, in order to support the archival necessities. The design phase was crucial for maintaining the system aligned with respect to the information and functional needs of its end-users.

The main purpose of the design phase is to set the content and functional configuration parameters of the SIAR system. The former parameters define the resources that are exploited by the system, like repositories of content, ontologies, classification schemas and authority files. The latter parameters specify aspects of the system functionality perceived by the end-users like, for example, the result set format, the query language, the user profile formats and the document model [6].

The work between computer scientists and archivists was fundamental to define a trade-off between the technological possibilities and constraints and the archival necessities. A consistent part of the work focused on the definition of the metadata formats for archival descriptions and for production and preservation subjects – i.e. authority files. Therefore, in the SIAR system together with the archivists we designed an extensible metadata format for the archival description

which relies on the Italian catalog of archival resources [17] developed in the context of the National Archival Portal[2]. This choice allows us to use different kinds of metadata formats and at the same time to export the SIAR metadata towards the National Archival Portal. In this way we set the ground for the use of a well-defined and widely adopted metadata format that at the same time can encompass most of all the necessities of the archivists.

An important task was the selection of the technologies we choose to rely on in the SIAR system; we evaluated the possibility of using the OAI-PMH protocol to grant variable granularity access and exchange of the archival descriptions and to make the SIAR system interoperable. We pursued this choice by defining a data model which is compliant with the protocol inner functionalities and characteristics.

5 The Data Model

In order to define a data model for the archives we have to carry out two main activities: a *descriptive activity* and a *design activity*. The former requires documenting the archives and their documents; the latter requires creating data structures to meet the defined set of requirements.

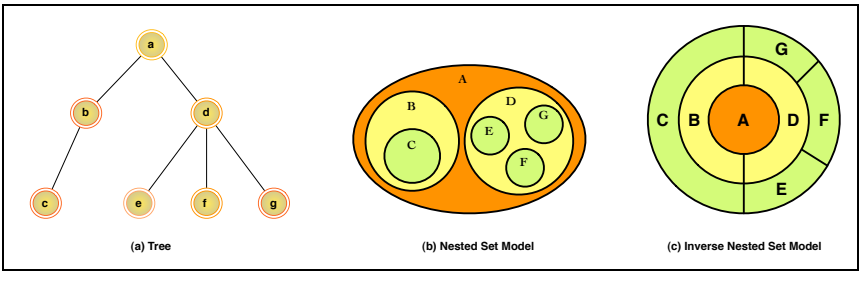

Fig. 2. (a) A tree. (b) A graphical representation of a NS-M. (c) A graphical representation of a INS-M.

We defined the NEsted SeTs for Object hieRarchies (NESTOR) framework [10,2,5] which is composed of two set data models called *Nested Set Model* (NS-M) and *Inverse Nested Set Model* (INS-M); these two set data models allow us to model hierarchically structured resources by means of an organization of nested sets that is particularly well-suited to archives. The foundational idea underlying these set data models is that an opportune set organization can maintain all the features of a tree data structure with the addition of some new relevant functionalities. We define these functionalities in terms of the flexibility of the model, rapid selection and isolation of easily specified subsets of data and

[2] The National Archival Portal is a project developed by the Directorate General of the Ministry of Cultural Assets and Activities.

extraction of only those data necessary to satisfy specific needs. In Figure 2 we can see a graphical representation of the two set data models composing the NESTOR framework; they are related to the well-known tree data structure. The first model is the NS-M and it is represented by means of a Euler-Venn diagram which helps us to understand their main characteristics. In the NS-M every node of a tree is represented by means of a set and the hierarchical relationships between the nodes are retained by the order inclusion between the sets. The elements belonging to a set represents the resources belonging to a specific devision of a hierarchy. The second model – i.e. the INS-M – is based on the same foundational idea of the NS-M but it reverses its logic. We represent the INS-M throughout a graphical aid called the DocBall [16] that allows us to show the relationships between the sets in the inverse model. In INS-M every node of a tree is represented by means of a set – i.e. a circular sector in the DocBall – and the relationships between the sets are retained by an inclusion order. The INS-M defines a set for the root of the tree and every other set created from the nodes of the tree are supersets of it; instead, in the NS-M all the sets created from the nodes of a tree are defined as subsets of the set created from the root. These differences allow us to point out different properties of the models and to choose the most appropriate one on a case-by-case basis.

The set data models are independent from the tree but they are strongly related to it. Together with the archivists we discussed these data models, pointing out that if we apply them to the archives we are able to maintain the hierarchical structure and the context as well as we can do with the tree data structure, but at the same time they granted us new possibilities of overcoming some of the issues that were highlighted in the ideation phase.

We analyzed with the archivists how a digital archive can be modeled throughout the set data models defined in the NESTOR framework. For instance, if we consider an archive constituted by several divisions each division contains a bunch of records, we pointed out that we can represent the hierarchical relationships between the archival divisions by means of the sets and the records belonging to them by means of elements belonging to the sets. Indeed, by adopting the NESTOR Framework we represent each division as a set maintaining the hierarchical relationships by means of the inclusion order defined between the nested sets. Each record belonging to a division is represented as an element belonging to the set corresponding to this division. In this context we consider each element as a metadata – defined in whatever format – describing an archival resource.

The data model does not impose any metadata format for the archival descriptions and it enables a clear distinction between the structural and the content elements of the archives. These features opened up new possibilities to the archivists that can design different metadata schemas well-suited to their necessities. Another key contribution of the NESTOR framework is to allow the separation between the modeling phase and the technological means chosen for its instantiation.

6 Development

The set data models can be instantiated in different ways in order to enhance their use within a specific application or service of the SIAR system. The architecture designed for the SIAR system is divided into three basic layers: the data exchange infrastructure described in [3,7], the metadata management layer described in [9,14] and the user interfaces layer.

The SIAR system architecture relies on the instantiation of the NESTOR Framework based on the joint use of some basic features of OAI-PMH. In the SIAR system we exploit the functionality of OAI-PMH called selective harvesting and its internal organization based on OAI-sets that can be used to express a hierarchical structure as an organization of nested sets [9,2].

As pointed out in [9,2,10] there is an actual integration between the NESTOR framework and the Digital Libraries technologies that allows us to represent and manage the hierarchical structure of the archives by means of organizations of nested sets instantiated by exploiting OAI-PMH inner functionalities. In the SIAR system the archive hierarchy is retained by an organization of nested OAI-sets and the archival descriptions are modeled as metadata belonging to the appropriate sets. The system can handle different metadata schemas and currently we have defined and developed a schema for archival descriptions and different schemas for the production and the preservation subjects. The data model provides us the possibility of changing the metadata format without affecting the structure of the archives or the functioning of the system. This feature was already exploited during the design and development of the system; indeed, the metadata schemas were revised during that time accordingly to new archival needs or in accordance with the new national guidelines released in the context of the National Archival Portal. Thus, this possibility eased the interaction between archivists and computer scientists, allowing us to reconsider design choices without changing the developed system in a substantial way. Furthermore, the instantiation based on OAI-PMH allows us to access and share the archival descriptions with a variable granularity and with the possibility of reconstructing the context of an archival description whenever necessary [10].

The SIAR system defines two user roles: archival users and general users. The former can create, modify and delete the metadata, whereas the second one can only consult the metadata in the system. The archival part of the user interface provides users with several forms where they can insert and modify the archival metadata. These forms are shaped on the basis of the metadata schemas that were designed. Together with the archivists we defined some visual aids to help the user in the insertion of the archival descriptions – e.g. instructions about how to compile the fields of the forms, a graphical representation of the inserted archives where archival divisions can be added to the archival hierarchy or descriptions can be added to a specific division. The insertion of new archival descriptions is guided by the system; for instance, if the root of the archive is a "fonds" the children of this node must be "sub-fonds" or a "serie" but it cannot be another "fonds". We developed several controlled vocabularies to guide users in the description process.

The SIAR system is developed as a Web application that can be accessed by means of a browser and thus it does not require any particular software or hardware infrastructure to be used. The SIAR system is thus freely accessible and usable by the archival users with the only requirement of the access to the Internet; this feature is very important from the economical sustainability point-of-view as it allows even small organizations distributed in the territory to make use of an open system for describing, managing and sharing their archival resources.

7 The Laboratory Interaction

The laboratory interaction was crucial in the development of the SIAR system because it allowed us to verify if the archival requirements have been satisfied. The laboratory was conducted by both the archival and computer science components of the SIAR project; the former presented the choices made in the definition of the metadata formats to be used for the descriptions and the latter explained how the data model and the architecture of the system were designed and developed to meet user requirements. The users that used the SIAR system were asked to insert some archival descriptions about an archive in which they are working and also the metadata regarding the production and preservation subjects. Each step of the laboratory was characterized by a continuous feedback with the users.

The archival users were able to insert all their archival descriptions highlighting some relevant aspects related to the description policies that the SIAR project has to provide. The users easily inserted several archival divisions exploiting the graphical aids provided by the user interface. They pointed out that the use of controlled vocabularies to help the insertion of the description is useful but at the same time it can be problematic. Sometimes archival descriptions have to go beyond the standard archival practice in order to describe some aspects of the archival reality that do not fit a standard model. For instance, there could be the necessity to create a sub-fonds as child of a serie and the system should allow this possibility. Another important observation regarded the definition of the authority files and their relationships with the descriptions; the users pointed out that the availability of a manual mechanism for defining the authority lists would be very useful for the archivists.

The extension of the spectrum of user privileges in the system is needed to provide a greater differentiation of user roles – e.g. a user authorized to publish the metadata, a user that can revise the inserted metadata, a user that can insert new metadata that will be revised and published later on.

A relevant topic of discussion focused on cross-language access to the archival resources; in the context of the SIAR system we have to consider that documents are written not only in Italian but also in Latin or in various forms of dialect. We need to analyze this aspect together with the archivists and verify which multilingual techniques we can adopt in the system.

The discussion with the users highlighted that the some revisions to the user interfaces are necessary; a very important aspect is to define new paths to reach and consult the archival descriptions in order to help the general user to understand and have access to the archival resources. The graphical aids developed for the insertion of the archival description should be adapted and reconsidered from the consultation point-of-view.

The system needs to be improved to become a structure not only for the insertion, exchange and consultation of metadata, but also a tool for their logical reorganization. In other words, it needs to allow archivists to also use SIAR as an aid in the phase of recognition, organization and initial description of the archival material and therefore not only as a tool for the final representation of already completed inventories. This implies that the archival structure being inserted needs to be easily adaptable and modifiable "on-the-fly" as the links between the various units and structures of the fonds become clearer in the archivists mind. The flexibility of the data model upon which SIAR is based makes it possible to dynamically reorganize the structure of the archive without modifying the descriptive metadata.

The laboratory interaction has been a fundamental step that allowed us to define the order of priorities for the future activities that have to be carried out in the SIAR project.

8 Final Remarks

The SIAR project is a relevant example of collaboration between archivists and computer scientists for the design and development of a Digital Archival System which takes into account both archival and technical needs. The continuous feedback process allowed us to shape and build the system among the users and not only for the users. The outcome of this way of working is optimum efficacy in the design and development phases and a wider adaptability of the system to new user needs.

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