An Open Adaptive Virtual Museum of Informatics History in Siberia

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Abstract: In the paper, the SVM project, which is under development at the A.P. Ershov Institute of Informatics Systems and is aimed at development of an open adaptive virtual museum of informatics history in Siberia, is described. It is assumed that this museum can be used as accessible annals of the Siberian computer science history, which can be written by active users. As an open adaptive virtual museum, SVM is full of great teaching and learning opportunities for a wide audience, from schoolchild to professional researcher.

Keywords: Informatics history, Open adaptive virtual museum, Siberian School of Informatics

1 Introduction

The history of informatics (or computer science), as the history of any other science, is an important and inseparable part of this science. During previous years, the teaching of the history of computer science was introduced into the computing curriculum of many Western universities. A special IFIP Joint Task Group has published a comprehensive report containing a number of valuable methodological instructions [10].

At the same time, informatics history of the Eastern Europe and the USSR was practically unknown in the Western Europe, although some works on this problem have been published [5, 8]. In 1996, the IEEE Computer Society, in connection with the 50th anniversary of its founding, presented the Computer Pioneer Award (see Figure 1) to sixteen scientists from Central and Eastern Europe countries. Among those included the outstanding Russian scientist academician Alexej Lyapunov (see Figure 2) who "developed the first theory of operator methods for abstract programming and founded Soviet cybernetics and programming" [3].

Research in programming in Siberia has been started after Alexej Lyapunov and his disciple Andrei Ershov (see Figure 3) had arrived to the Novosibirsk

Academgorodok (at the beginning of the 60s of the last century). Academician Andrei Ershov and his disciples have founded the Siberian School of informatics that was the third one in the USSR, after Moscow and Kiev. Now, many years after its founder Andrei Ershov died [1], it keeps on playing an important role in spite of all these difficulties endured by the Russian science and education. This gives us an opportunity to investigate independently formation and development of informatics in Siberia, namely, in the Novosibirsk Scientific Centre, against the Russian and world scenes.

Figure 1 Computer Pioneer Medal

In the paper, our project SVM of the virtual museum of informatics history in Siberia is described [12, 14, 20].

During about fifty years, informatics as a science developed in Siberia very much, but for this period some active participants and witnesses of its development died, many facts have been forgotten and something is not known yet. So, it is very interesting to study and to represent in structural form, using some methods of informatics itself, the history of informatics that is a result of activities of the current generation of people. We assume that the SVM museum will be open and can be used as accessible annals of the Siberian computer science history, which can be written by active users.

Now the electronic or virtual museums available via the www are being widely developed along with traditional ones (see, for example, [9, 15, 17 – 22]). Moreover, there is a standard computer-to-computer protocol for information retrieval that specifies communications between a client and server for purposes of searching and retrieving of the cultural heritage information [16].

However, most of the museums presented now in www are traditional hypermedia systems and give the same information and navigation to all users.

At the same time, the SVM museum is intended for use by different categories of users, and museum visitors with different preferences, goals, knowledge and interests may need different information and may use different ways for navigation. Therefore, we give a particular attention to adaptation problems in our project.

SVM provides a free common access to pages of the true history of computer science in Siberia. As an open adaptive virtual museum, it is full of great teaching and learning opportunities for wide audience from schoolchild to professional researcher.

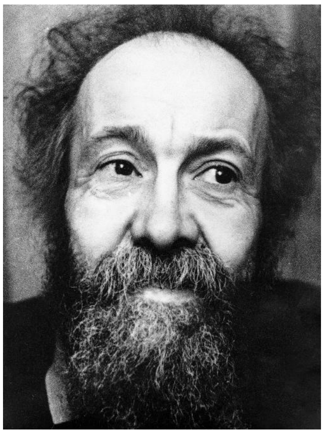

Figure 2 Alexej Lyapunov

The rest of the paper is as follows. In Section 2, we outline the history of informatics in Siberia. The conception of open adaptive virtual museums is discussed in Section 3. The structure of the virtual museum SVM and we briefly consider its content in Section 4. In Section 5, we describe the users of SVM. The user interface and interface adaptation of the SVM museum appear in Section 6 and 7. Section 8 is a conclusion.

2 Andrei Ershov and Siberian School of Informatics

Academician Andrei Ershov (19 April 1931 - 8 December 1988) was one of the Soviet pioneers in the field of theoretical and systems programming, a founder of the Siberian School of Computer Science.

His significant contributions to establishing informatics as a new branch of science and a new phenomenon of the social life are widely recognized in Russia and abroad. More than thirty years ago, he began to experiment with teaching programming in the secondary school. Initially unrecognized, these attempts evolved into the notion of computer literacy [6] and resulted in introducing a course on informatics and computing machinery in Soviet schools [7].

A.P. Ershov's fundamental research on program schematology and theory of compilation inspired a large number of his students and successors. He investigated a broad spectrum of systems programming problems: implementation of DO statement in programming languages; hash addressing with application to the common sub-expression elimination; program schemata over distributed memory; the theory and algorithms for global memory optimization, etc. His book "A Programming Programme for the BESM Computer" was one of the world's first monographs on automatic programming.

Figure 3 Andrey Erchov

In 1958, the Department of Programming was organized at the Institute of Mathematics in Novosibirsk and the late Academician Andrei Ershov was appointed its head.

The first project of the Department was a design and implementation of the Algol-like algorithmic language ALPHA [4]. The ALPHA system was the first in the world optimizing programming system (an optimizing compiler) for the languages more complex than FORTRAN. The Algol-60 system simultaneously developed by Hawkins and Huxtable in the UK, with functional capabilities similar to those of the ALPHA system, was never implemented. It is worth noting, because at that time many specialists contested the very possibility of constructing compilers for the languages more complex than FORTRAN. The ALPHA system turned out to be a constructive proof of this possibility, which essentially removed barriers on the way of designing new languages with more rich semantics.

Figure 4 Andrey Erchov with his disciples (from left to right): Viktor Sabelfeld, Igor Pottosin, Vadim Kotov, and Victor Kasyanov

In 1964, the Department was transferred to the newly organized Computer Center headed by Academician Gury Marchuk, former (and the last) President of the USSR Academy of Sciences. The Department was growing, extending research from the compiler design to broad aspects of system programming, theoretical informatics, experimental computer architecture, AI and educational informatics. As a result, the Siberian School of Informatics has been formed [1].

In 1990, on the basis of the Department, the Institute of Informatics System headed by Vadim Kotov (see Figure 4), a disciple of Andrei Ershov, was organized. In 1995, the Institute became A.P. Ershov Institute of Informatics Systems.

3 Conception of Open Adaptive Virtual Museum

With the advent of the digital age and the Web, museums and cultural heritage institutions are rethinking their roles [13].

An increasing number of museums make the decision to maintain a website (a *digital museum*) in order to provide useful information and attract new visitors. The advantage of digital museums is clear. The visitors of a digital museum can enjoy cultural relicts without a restriction of time and place, and complete safety of artifacts is guaranteed. The visitors have the opportunity to see precious cultural relicts that cannot be exhibited in a conventional way for reasons of safety or security. Furthermore, with the help of multimedia interaction, the visitors can even “touch” or “manipulate” the objects, which would be important for professionals.

Along with the “classic” digital museums, which are websites of real museums, there are so-called virtual museums [9, 15, 18-22]. A *virtual museum* in this context refers to a repository of digital cultural and scientific resources that can be accessed and used in any time from anywhere via the Internet. It means it is a website (a digital museum) that can but does not have to have any corresponding real museum and contains virtual exhibits being multimedia digital representations of any artifacts without a restriction on their nature or current state.

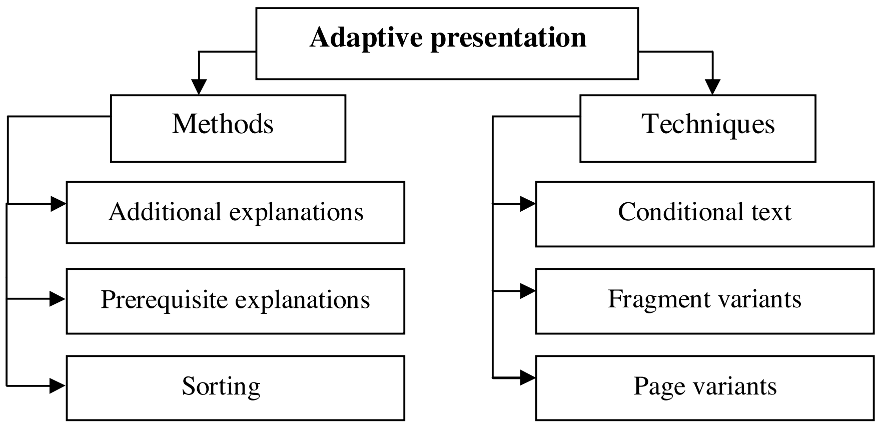

Figure 5 Adaptive presentation

From the viewpoint of museum visitors, a real museum is an environment for excursions and expositions. On the other hand, museums are cultural heritage institutions intended to support collecting, research, making catalogues and exhibiting artifacts, but museum visitors cannot take part in this important museum work. We believe that virtual digital museums can be “open museums” that allow extending this museum work to a wide range of virtual museum users. We assume that it is useful that a museum user can propose a presentation of some real artifact as a virtual exhibit to an open virtual museum. In addition, an open virtual museum may also have a facility to supply exhibits with author descriptions, to offer guided tours around the museum, and to make a curatorial exposition. These possibilities are very important for modern history museums.

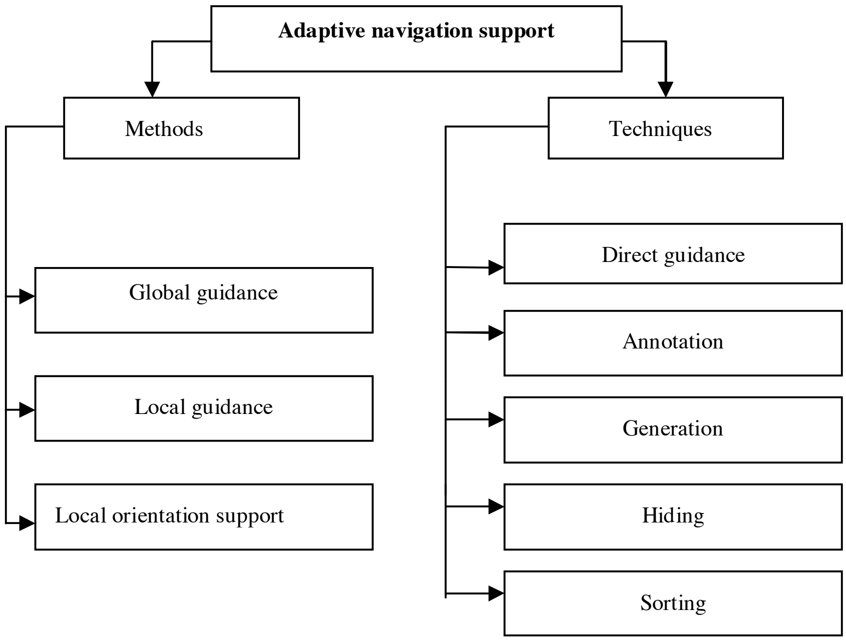

Figure 6 Adaptive navigation support

An *open virtual museum* [12] is a hypermedia system intended to be both an accessible repository for artifact collections and a cultural heritage institution supporting the collective work of many people, which are interested in collecting, annotating, organizing, research, making catalogues and exhibiting these artifacts.

Adaptive hypermedia is an alternative to the traditional “one-size-fits-all” approach in the development of hypermedia systems [2].

Adaptive hypermedia systems (AHS) are all hypermedia and hypertext systems, which reflect some specific features of the user, such as preferences, knowledge, and interests in the user model and use this model for adaptation of different visible system aspects to the user.

AHS provides adaptive presentation (adaptation of the hyper-document content) and adaptive navigation support (adaptation of the hyperlink structure).

The aim of adaptive presentation methods is adaptation of the page content that the user addresses to her/his knowledge, preferences, interests, goals and other characteristics. The main methods of adaptive text presentation are additional, prerequisite and comparative explanations, explanation variants and sorting

(Figure 5). They used the following techniques for implementation of these methods: conditional text, stretchtext, fragment and page variants, and frame-based technique.

The aim of adaptive navigation support methods is to help users to find the way in the hyperspace by adapting the hyperlink presentation to the goals, knowledge and other characteristics of the user. Adaptive navigation support methods are used to achieve the following adaptation goals: to provide global and local guidance, global and local orientation support, and managing personalized views (Figure 6). To implement these methods, the following techniques are used: direct guidance, link sorting, hiding, annotation, generation, and map adaptation.

At the abstract level, AHS consists of the three components: domain model, user model, and adaptation model.

The domain model (DM) describes the information content and link structure of application domain at the conceptual level (using a set of concepts and concept relationships represented as a directed acyclic graph).

The user model (UM) represents user's preferences, knowledge, goals, browsing history, and other relevant aspects. The system acquires user's information in two ways: explicitly (from the user) or implicitly (tracking the user interaction with the system). The main part of UM is representation of the user's domain knowledge using DM concepts (by means of the overlay model).

The base of adaptive functionality of AHS is the adaptation model (AM) consisting of adaptation rules that form connection between DM and UM and determine the representation of the generated information.

Open adaptive virtual museums can support accessibility and active use of digital cultural and scientific resources for everybody without a restriction on time and place. They can bring several benefits:

Collective work of many people that are interested in collecting, annotating, organizing, research, making catalogues and exhibiting any artifacts;

The museum is an arena where many physical constrains do not apply, where technology can allow each visitor to organize virtual artifacts into an individual exhibition or tour;

Virtual exhibitions that cannot be organized otherwise, e.g. a comprehensive exhibition of an artist whose works are distributed all over the world in public and private collections;

Private collections and artifacts can be made available for public, taking into account various levels of anonymity for the owner – anonymous, semi-anonymous (i.e. available for discussions under a nickname), non-anonymous, available for a visit, etc;

Exhibitions on demand can be organized for visitors;

Adaptive guided tours can be provided for each individual visitor taking into account her/his interests, preferences and constraints (like time).

4 Architecture of the SVM Museum

At present, databases (DBs) of our web-based museum SVM provide storage and processing of the information about the following objects: publications, archive documents, projects, data about scientists in informatics, scientific teams, various events concerning informatics history, conferences, and computers (see Figure 7). All the above objects are the *exhibits* of our virtual museum.

Every exhibit has the following main attributes: a Unique Universal Identifier (UUID) of an object, a name, sometimes a date, a brief description (or an annotation), a full description (or a file), a name of a person who presented this exhibit, the date of its addition, the possibility and permission of its modification and participation in exhibitions.

We can represent a set of exhibits united according to the thematic, chronological, or typological criteria as an *exhibition* or a *tour* (or an *excursion*). Both an exhibition and a tour have the following attributes: UUID, a name, a name of a person who created it, brief description, and reference(s) to the file(s) representing it contents. The main differences between an exhibition and a tour are the following:

- A tour is composed of one section (a file), while an exhibition can consist of several sections (exhibitions or sub-exhibitions).
- A tour is a story about the museum (elapsing in time) followed by demonstration of its exhibits in a definite order. A tour, for example, may be a clip or a presentation for MS PowerPoint and may be not only in the on-line mode but sometimes off-line. In contrast to a tour, an exhibition consists of exhibits that a visitor is looking at by himself and only on-line. Usually, they provide several ways of navigation, including a free movement among exhibits.

All exhibitions (and tours) are divided into *permanent* and *temporary* ones. They designed a *hall of exhibitions* and *a hall of tours* as accessible to all users of the museum.

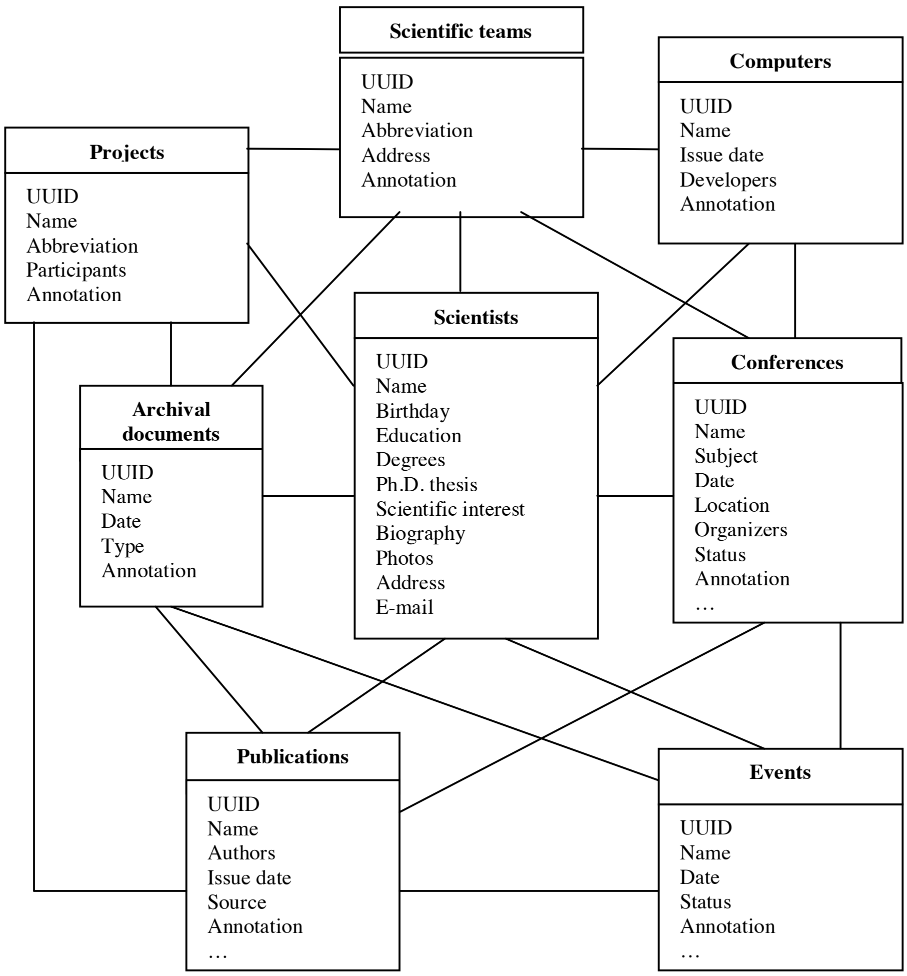

Figure 7 The net of exhibits

There are also restricted halls in our museum (see Figure 8): the library, the archive, the chronicle, the halls devoted to scientists in informatics, scientific teams, projects, computers, conferences, the hall of new exhibits and the hall of preparation of exhibitions and excursions. These halls are accessible only to registered users of the museum.

The *library* consists of books, articles and so on. In addition to the general exhibit attributes, each library exhibit has a list of authors and other attributes.

The *archive* consists of text, graphic, audio, and video materials. The *chronicle of events* contains a description of the most remarkable events of informatics history in Siberia.

The *hall of scientists in informatics* presents information about the prominent scientists in informatics. In addition to the general information, it provides the following data about scientists: their education, scientific degrees, titles and posts, scientific interests, the text of the biography, photos, the main publications, and projects.

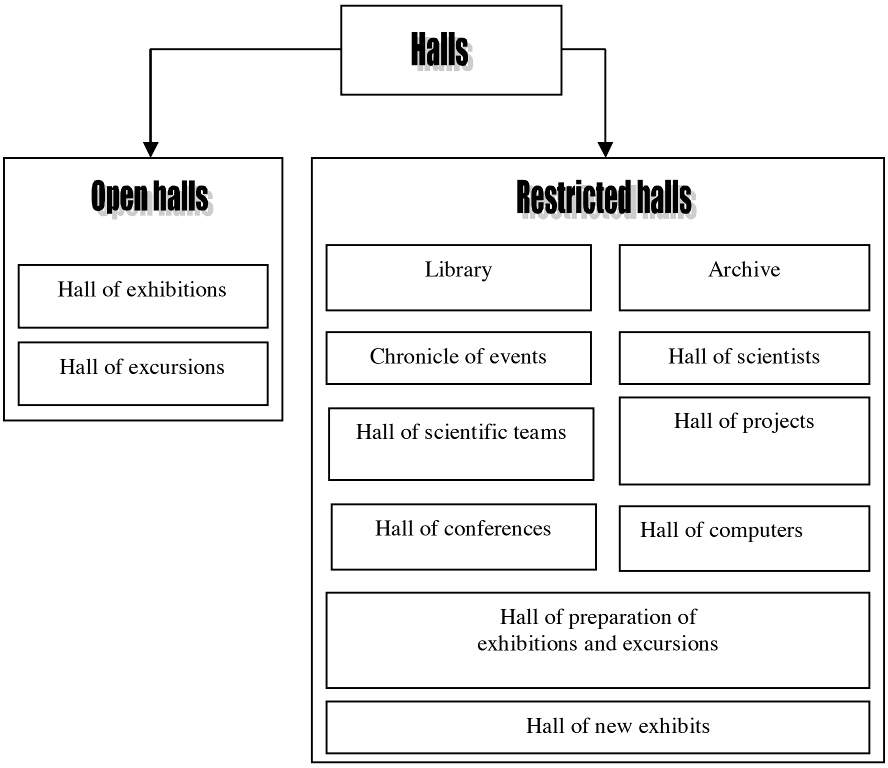

Figure 8 Architecture of SVM**:** halls

The *hall of scientific teams* presents information about groups, laboratories, and institutes. Along with the general attributes, each team has its address, etc.

The *hall of projects* provides information about projects in informatics, including the dates of its beginning and finishing.

The *hall of computers* shows the computers that the Siberian Division of the Russian Academy of Sciences used and created. In addition, each exhibit has the name of the designer and the photo.

The *hall of conferences* contains the following information about each scientific event: where and when it was held, its status, and the general exhibit information.

They place new entries to the museum (added by users) in the *hall of new exhibits*. Exhibitions and excursions created by users of the museum are being composed in the *hall of preparation of exhibitions and excursions*.

5 Users of the SVM museum

All users of our web-based museum are divided in two main categories: unregistered users (*visitors*) and registered ones (*specialists*) with different level of access to information resources (see Figure 9).

Visitors have access only to the part of museum information that is open for public access (e.g., in the form of excursions and exhibitions). In this case, all resources are accessible only for review and search. Visitors are divided in two subcategories depending on their level of knowledge in subject domain: *beginners* and *experts*. Beginners have an opportunity to look only at tours, and experts can also look at exhibitions and electronic conferences of users.

Specialists have access to reviewing all information resources of our museum, including restricted halls closed for public access; they can also take part in electronic conferences and write in a visitors' book. All specialists are divided in two main groups depending on their level of access to resources: *simple specialists* and *museum employees*.

A group of simple specialists consists of *volunteers*, *tour guides,* and *exhibition curator/designers*. Volunteers have permissions to add new exhibits of any type. Tour guides may create their own tours, and exhibition curators/designers can create new exhibitions. Simple specialists have no permissions to modify the museum databases.

They present a group of museum employees as a hierarchical structure, with a *director* (or the *senior manager*) at its very top. He has full authority to administrate the museum DBs, including DB of museum users.

The second level of the hierarchy consists of *managers* (or *administrators*) of the corresponding museum resources. The director appoints them – the head of exhibitions, the chief tour guide, the chief librarian, the chief archivist, the chief historian, the chief biographer, the chief expert on scientific teams, the chief planner, the chief engineer, the chief secretary. They have full authority to administrate DBs of the corresponding resource types. They also control specialists working with DBs of corresponding types of resources.

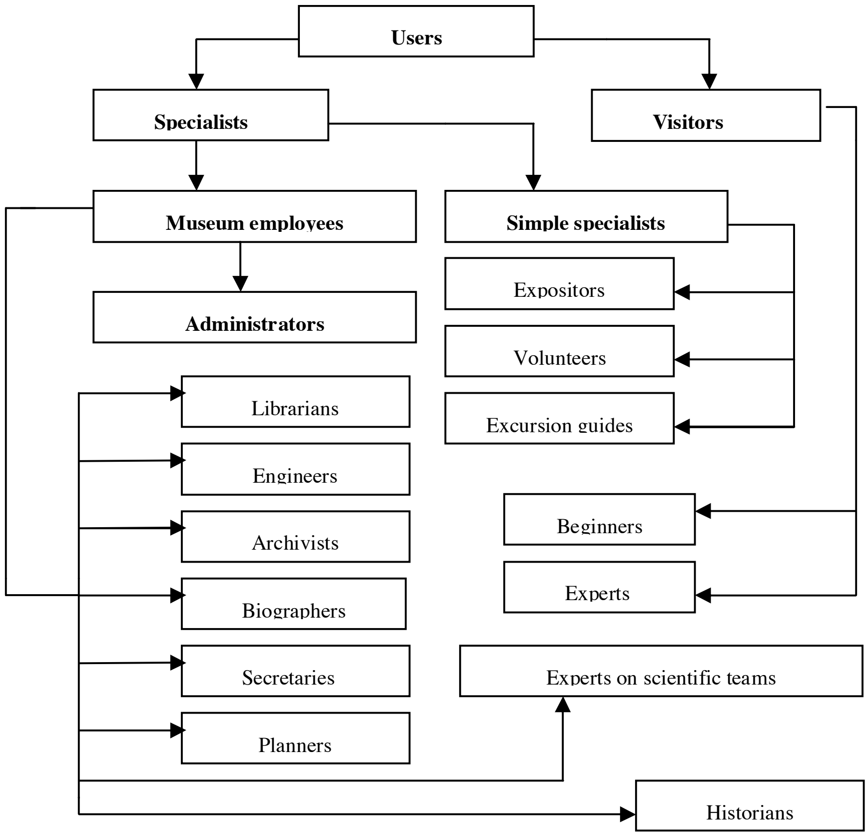

Figure 9 Users of the SVM museum

The third level of the hierarchical structure includes museum employees appointing by the managers of the corresponding types of resources: librarians, archivists, historians, biographers, experts on scientific teams, planners, engineers, and *secretaries*. They have limited rights to change DBs of the corresponding resource types.

6 User Interface

Current implementation of the DBs of our virtual museum provides storage and processing of data about the following objects: publications, archival documents, projects, events, scientific teams, informaticians, computers, and conferences. At present, the hypermedia interface of the DB for information filling of our virtual museum has been designed and implemented. It allows one to review, search, insert and update data on above objects and to link them together. An interface for registration and authentication of the museum users and for user electronic conferences has been implemented.

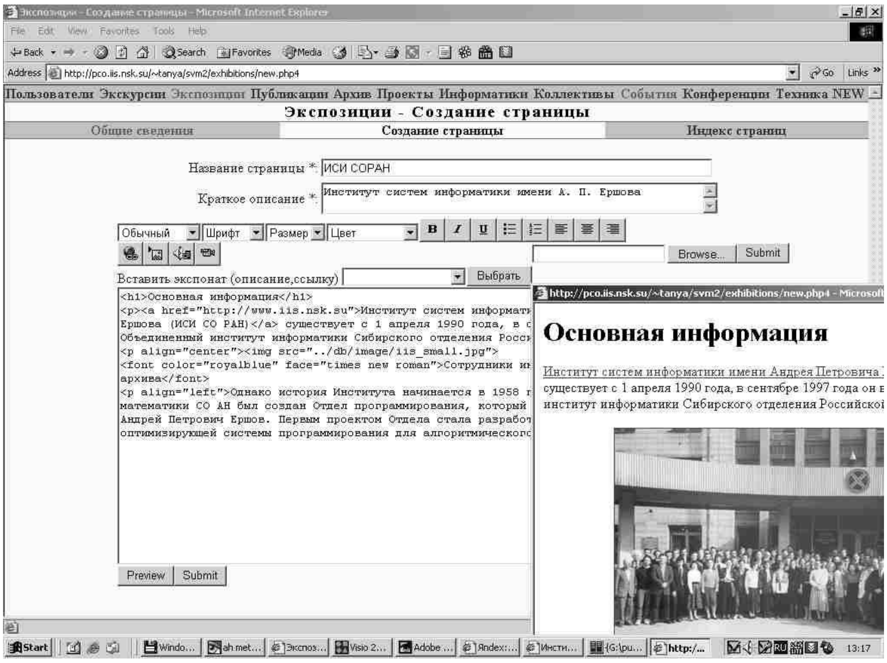

Figure 10 The interface for insertions and updates

The following main functions are supported by the interface: registration of a new visitor, search mechanism by key criteria, interface for insertion and update, interface for interconnection between objects, interface for holding a user electronic conference.

The registration of a new visitor consists in filling a special form. It contains obligatory (a user name, e-mail, a password for entry to a system) and supplementary (a country, an index, an address) fields. If users want to contribute information to the museum (to add exhibits, make up excursions or exhibitions), they should mark the corresponding points in the registration form. A login (a user name for entry to the system) is generated automatically by a special algorithm and sent to the user by email. The director or a corresponding administrator completes the registration of a new specialist.

A search mechanism by key criteria is implemented; there is an opportunity to carry out a pattern search over all DBs. It is possible to choose the form in which the search results are represented. Brief information about objects and a reference to complete one is put out as a search result.

An interface for insertion and update is implemented for all resource types of our museum (see Figure 10). Data input is realized with filling of the corresponding forms depending on the resource type: forms for input of the general and additional information, and forms for linking objects together. UUID is automatically generated and assigned for every new added object. The following information about added object is automatically stored in the DB: the name of a person who added the object, the date of addition, possibility of modification and taking part in exhibitions, modification permissions. An interface for data modification is implemented via data edition in the corresponding fields of the form.

An interface for interconnection between objects and linking them together is implemented. Interconnection between objects is implemented as a choice of corresponding objects (that are needed to connect with this object) from a list of all possible objects (for each object type). Information links between objects are generated as hyperlinks from the given object to objects connected with it.

An interface for holding a user electronic conference is implemented. Unregistered users can only view the conference information, while registered ones can send information to the conference. This interface supports all standard functions of electronic conferences: sending a new message, receiving an answer and search for messages according to some key criteria.

7 Interface Adaptation

For adaptive information, presentation in our museum SVM we use both the adaptive presentation methods, such as additional and prerequisite explanations and sorting, and the adaptive navigation support methods, such as direct guidance, link sorting, hiding, annotation, and generation. The model of a registered user of the SVM consists of tree parts: the model of categories, the model of knowledge and the model of preferences (see Figure 11).

The model of categories is supported for all registered users, the model of knowledge and preferences - for all categories of users except the group of museum employees. The model of categories represents the access permissions to the museum information resources. They implement it as a static stereotype model (a set of attribute-value pairs). The names of types of the DB resources are used as attributes of the model; the access permissions to these resources (view, insert, modify and their combinations) are the attribute values. A stereotype of the same name, characterized with specified attribute values, corresponds to each user category.

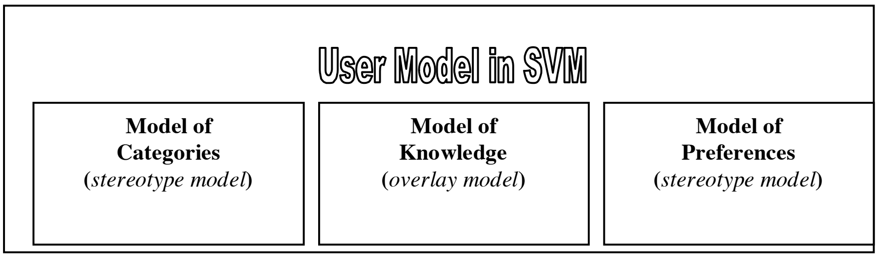

Figure 11 User model

They use the model of knowledge to model the user domain knowledge. It is supposed to implement a model of knowledge as an overlay model based on the structural domain model. They use a structural model for representation of presented by the museum information as a structure of interconnected concepts and relations between them (acyclic graph). The overlay model is intended to present the user knowledge as an overlay of the domain model. The overlay model for a user is a table structure. This structure determines the values of the following attributes: knowledge of concept (studied, not studied), reading (read, not read), ready for reading (ready, not ready) for each domain concept. The overlay model is a dynamic one: it is automatically updated when a user reviews the information.

The model of preferences represents different user preferences, in particular, a method of information presentation (using only a text, graphics, audio, video and so on). A static stereotype model implements it. The attributes of this model are the methods of information presentation mentioned above, and their values are true or false.

8 Conclusion

The conception of an open adaptive virtual museum that supports accessibility and active use of digital cultural and scientific resources for everybody without a restriction on time and place has been considered, and the SVM project of an open adaptive virtual museum of informatics history in Siberia has been presented.

The main purpose of creating SVM is to save historical and cultural heritage, the history of creation and development of computer science in Siberia. One may use it as accessible annals of the Siberian computer science history, which can be written by active users.

SVM is also intended to provide a free common access to pages of the true history of computer science in Siberia, and therefore to increase cultural and educational level of people. It can also serve as an important teaching and learning tool for a wide audience, from schoolchild to professional researcher. The museum is an arena where many physical constraints do not apply, where technology can allow each visitor to organize virtual artifacts into an individual exhibition or tour. For example, it can be an individual gallery and museum to every teacher, where that teacher is a curator.

The solutions here considered can be used in the development of other virtual museums related to modern history or needed in the collective work of people from different places. They can also be useful in the development of digital websites of real museums to support integration of knowledge and skills of museum workers from different museums.

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