EXPERT SYSTEM FOR CATEGORIZATION OF MUSEUM VISITORS

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Abstract: *In the past few years, the process of lifelong learning has become more important. A tour of an educational exhibition is an interesting and attractive activity for a person receiving an education. A museum, art gallery, zoological or botanical garden or even a technological park can all be perceived as an educational exhibition. If we want the exhibition tour to provide an educational benefit to the visitor, we need to offer him adequate information about individual exhibits. The exhibition has to be personalized, that is tailored to the various kinds of visitors. This paper deals with the issue of categorizing museum visitors using ICT, specifically an expert system which is a part of a "virtual guide". Based on an initial analysis of a visitor, the virtual guide proposes a tour through the exhibition so that it brings the visitor the maximal educational benefit while at the same time offers information about the displayed exhibits in such a way that is most interesting and comprehensible.*

Keywords: information and communications technology (ICT), museum, virtual museum (VM), virtual guide, tour route personalization, visitor, categorization

1. INTRODUCTION

A museum is an institution that conserves a collection of artefacts and other objects of scientific, artistic, cultural, or historical importance and makes them available for public viewing through exhibits that may be permanent or temporary (Alexander, 2008).

ICOM (International Council of Museums, established 1946, resides in Paris, it is an international professional organization with a status of UNESCO consultant) defines a museum as "a non-profit, permanent institution in the service of society and its development, open to the public, which acquires, conserves, researches, communicates and exhibits the tangible and intangible heritage of humanity and its

environment for the purposes of education, study and enjoyment". The goal of the museum is to present a given topic in an interesting and engaging way. In order to do so, it maximizes the use of its exhibits and available technology. Likewise, it is important for the presented exhibition to have an educational function.

To achieve that function, the exhibition content has to be presented in a way that is interesting and comprehensible for the potential visitor. The range of museum visitors is wide and so it is necessary to customize the tour to some extent. The standard way to do this is a differentiation of informative texts, either as various legends to the exhibits or as printed textual guides. Another step is a personalized tour with a live guide or the introduction of audio guides, used mostly by foreign visitors. With the availability of modern information and communications technologies (ICT) museums enter a new era and the topic of personalization (customization to a particular visitor) is being discussed more often. Among the most common ICT means used in museums in the Czech Republic are information kiosks, topical interactive games, personal guides in communication devices (tablets, smartphones, communicators) or robotic guides.

Virtual museums are a new domain. Thanks to the Internet, a virtual museum allows the visitor to tour the exhibition right from the comfort of his home. From the beginning, there was interest in adapting such a tour to the particular visitor. Thus, the term *virtual guide* came into existence. A virtual guide is software which strives to give the visitor a tour through the virtual exhibition according to his requirements.

Yet another step is the logical interconnection of the real and virtual museum in one unit, the so-called *augmented museum*. In this case it does not matter whether the visitor is physically present in the museum or is there only virtually.

As a part of a project, I wish to create a virtual guide through an exhibition. It should be a software that guides the visitor through the exhibition based on the characteristics given by the user when entering the museum. The virtual guide should present not only suitable exhibits, but also appropriate information related to them. The emphases is placed on the educational benefit of the tour.

It is crucial for the system to "know" the exhibition visitor. This requires an existence of an application which will be able to characterize the visitor and choose an optimal tour route as well as the content of the tour.

2. RESOURCES

In order to create a useful and effective museum exhibition, all its creators, designers and curators have to be well acquainted with the target group. Without understanding the target audience the exhibition cannot succeed because it will not be able to communicate with and foster the interest of visitors. The spectrum of museum visitors is very diverse and there is no general and universal classification.

Visitors, however, have some common features upon which we can build our categorization:

- **socio-demographic characteristics**: age, sex, occupation, education, the type of community the resident is from, local or non-local residents;
- **museological characteristics:** motivation for the visit (professional, informational), knowledge of the topic, potential of the tour to engage;
- **range characteristics:** individual visitor, (various types of) groups of museum visitors, frequency of visits, timescale of museum visit;
- **psychological or physiological characteristics:** reception, intelligential, memory, imaginative, visual, auditive, motoric.

It can be stated that every significant author writing about personalization of museum exhibition created his/her own classification system of visitors.

Eilean Hooper-Greenhill identifies target groups which include (Hooper-Greenhill, 1999):

- **families;**
- **school parties;**
- **other organized educational groups;**
- **leisure learners;**
- **tourists;**
- **the elderly;**
- **people with** visual, auditory, mobility or learning **disabilities.**

She then suggests a partition of museum resources, to target, attract and entertain these different groups.

Dean generalizes museum visitors in three broad and much simpler categories (Dean, 1994).

- **Casual visitors**: people who move through a gallery quickly and who do not become heavily involved in what they see.
- **Cursory visitors** show instead a more genuine interest in the museum experience and collections.
- **Study visitors**: A minority of visitors who thoroughly examine exhibitions with much more detail and attention. They are learners who will spend an abundance of time in galleries, read the text and labels, and closely examine the objects.

Serrell (1996) also divides visitors into three types:

- **the transient;**
- **the sampler;**
- **the methodological viewers.**

She notes that currently museum evaluators are using terms like "streakers, studiers, browsers, grazers and discoverers" to characterize museum visitors' styles of looking and exhibits. But she concludes that this type of categorization is not useful for summative evaluation, suggesting that it is a subjective method of classification, and that it is not fruitful to try and create exhibitions that serve these different styles of visiting. She suggests instead that a more objective means of classification needs to be found, such as the average time spent in the exhibition space.

Based on visitors behavior in physically enclosed space, Veron and Levasseur identified four different visiting styles using metaphors form animal motion behaviors (Veron 1991):

- **The ant visitor,** who spends a long time observing all exhibits and moves close to the walls and the exhibits avoiding empty space.
- **The fish visitor,** who walks mostly through empty space making just a few stops and sees most of the exhibits but for a short time.
- **The grasshopper visitor,** who sees only exhibits he/she is interested in. He/she walks through empty space and stays for a long time only in front of selected exhibits.
- **The butterfly visitor**, who frequently changes the direction of the tour route, usually avoiding empty space. He/she sees almost all exhibits, but times vary between exhibits.

Umiker-Sebeok presented four major visitor types with respect to their interpretation of the exhibition space (Umiker-Sebeok 1994):

- **The Pragmatic** is interpreting the exhibition as a classroom or workshop and is interested in "useful" information.
- **The Critical** is interpreting the exhibition as a museum and is interested in the aesthetics of displays, the structure of the collection and the classification of exhibits.
- **The Utopian** is interpreting the exhibition as an encounter session and his/her main goal is the social interaction.
- **The Diversionary** is seeing the exhibition as an amusement park and his/her goal is to have fun during the visit.

McCarthy (McCarthy 2006) determines these categories based on learning styles:

Imaginative – learns by listening and sharing and prefers interpretation that encourages social interaction.

- **Analytical** – prefers interpretation that provides facts and sequential ideas.
- **Common sense** – likes to try out theories and discover things for themselves.
- **Experiential** – learns by imaginative trial and error.

Also Gardner (Gardner 1996) uses learning styles:

- **linguistic** – written material;
- **logical-mathematical** – diagrams, schemes;
- **spatial** – maps;
- **musical** – audio, music;
- **bodily** – manipulation;
- **interpersonal** – social context;
- **intrapersonal** – alone.

These are some examples of classifications that were considered when creating the "virtual guide" system. Of course, there are many different ways of categorization of visitors, but none of them were suitable. By comparing the categories listed above I created my own categories of visitors.

3. CATEGORIES OF VISITORS

For the first phase of this project I decided to divide the museum visitors based on these three criteria: age, social integration and expertise (the extent of knowledge from the field presented in the exhibition).

Table 1.

The original categories of visitors

Context	Category				
Social integration	Individual	Homogeneous couple	Inhomogeneous couple	Homogeneous group	Inhomogeneous group – family
Age	3–6 years	6–12 years	12–18 years	18–65 years	over 65 years
Expertise	Layman	Expert			

Source: Own elaboration

In theory such division presents 50 variations when creating the algorithm for the guide. To create so many various "paths" seems very complicated, nevertheless not

all combinations are probable or plausible. Furthermore, in the first phase I want to focus on individual visitors only. I presume that each visitor will have his/her own guide, which opens another area for further research. A group of visitors does have a bit dissimilar behavior and exhibition requirements than an individual. Moreover, an exhibition algorithm to suit couples of diverse ages (for example grandfather and grandson, mother and child) should be calculated in the near future.

Beside that, another important variable is the visitor's purpose of the exhibition visit. For that reason, it is necessary to create yet another category The purpose of the visit. This purpose influences the number as well as the type of viewed exhibits, which not only further affect the length of the tour, but also the form and the content of presented exhibits.

Table 2.

The purpose of the visit

The purpose of the visit
Quick overview – inciting the interest, motivation (RP)
Fundamental knowledge (ZP)
In depth research (HS)

Source: Own elaboration

4. THE CONCEPT OF THE EXPERT SYSTEM

The planned expert system for categorization of visitors is one of the modules of the virtual guide. The modular structure of the system ensures flexibility and will allow future interconnection to other museum systems, especially to the already existing database of the exhibits. At the beginning of creating the concept of the virtual guide system, I was concerned with its openness. The whole system should be able to function in a virtual as well as in the real environment where the range of museum exhibitions is extensive. (The term museum can be understood as, for example, a zoological or botanical garden, art gallery or even a technological park.) It can even serve as a simulation tool in the design stage of a new exhibition.

The whole system consists of three modules: Besides the Visitor module, there is Exhibit module (It is a database system of exhibits. The exhibit is represented by its form – physical manifestation and content – information about the exhibit.) and Guide module, which chooses the best tour route and level of presented information to the visitor based on the categorization of that visitor and available information about exhibits.

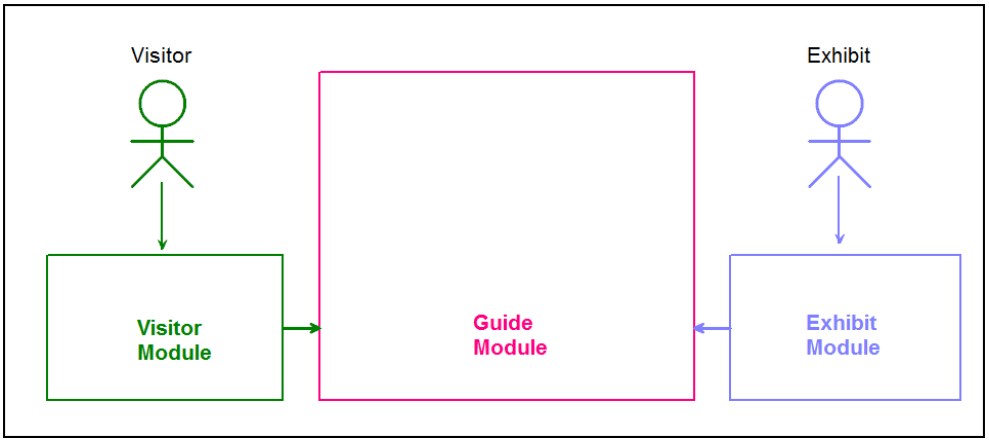

Figure 1. The virtual guide system

Source: Own elaboration

4.1 Visitor module

This module is a diagnostic expert system based on test questions which determine the type of visitor. For the needs of the diagnostic expert system, I specified a hierarchic model breakdown of visitors.

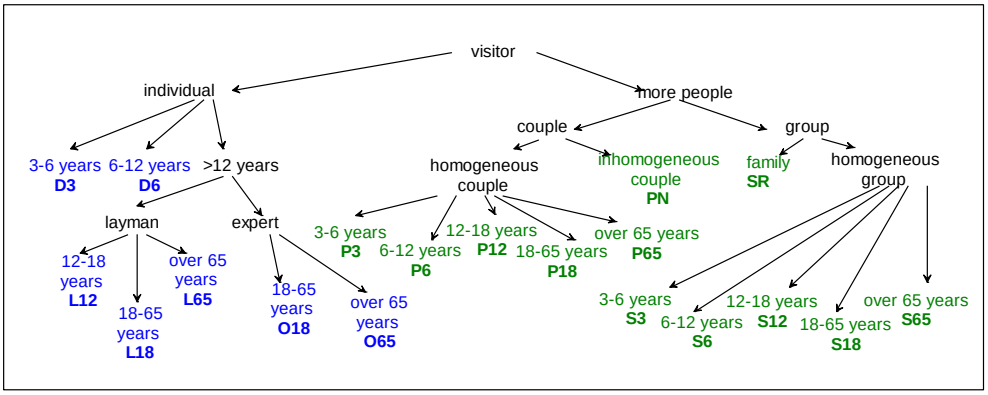

Figure 2. Hierarchy of visitors

Source: Own elaboration

Since the system testing will be performed in an environment of a virtual museum, we can consider individual visitors only. The hierarchic model is pictured in Figure 3.

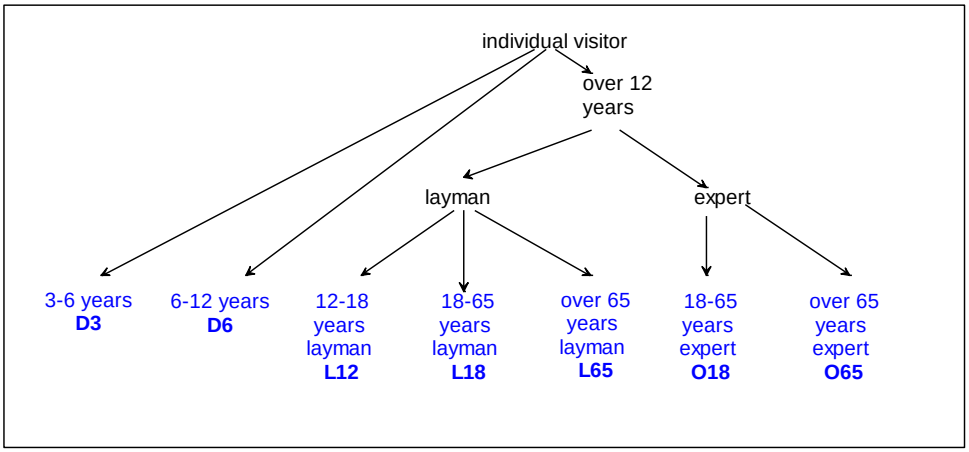

Figure 3. The new scheme of the hierarchy of visitors

Source: Own elaboration

Using the Frame script the structure of diagnoses will be as follows:

FRAME individual visitor PART_OF kategorizace
indicators: [age, 3-6, age 6-12, age12-18, age18-65, over65, expert, layman]
discriminators: []

FRAME 3-6 years PART_OF individual visitor
indicators: [age3-6]
discriminators: []

FRAME 6-12 years PART_OF individual visitor
indicators: [age6-12]
discriminators: []

FRAME over 12 years PART_OF individual visitor
indicators: [age12-18, age18-65, over65, expert, layman]
discriminators: []

FRAME layman PART_OF over 12 years
indicators: [age12-18, age18-65, over65, layman]
dikrominátory: [nesvítí_světla, nefunguje_rádio]

FRAME expert PART_OF over 12 years
indicators: [age12-18, age18-65, over65, expert]
discriminators: []

FRAME 12-18 years layman PART_OF layman
indicators: [age12-18]
discriminators: [layman]

FRAME 18-65 years layman PART_OF layman
indicators: [age18-65]
discriminators: [layman]

FRAME over 65 years layman PART_OF layman
indicators: [over65]
discriminators: [layman]

FRAME 12-18 years expert PART_OF expert
indicators: [age12-18]
discriminators: [expert]

FRAME 18-65 years expert PART_OF expert
indicators: [age18-65]
discriminators: [expert]

FRAME over 65 years expert PART_OF expert
indicators: [over65]
discriminators: [expert]

Each layer is consistent with one question asked by the system. The graph shows that each visitor will be asked only two questions, but because the purpose of the visit plays an important role, there will be one more question. It goes without saying that the expert system will not ask different visitors the same questions. To ask children from the D3 and D6 groups about their level of knowledge or purpose of their visit is irrelevant. It is very important to minimize the number of questions. Too many questions could discourage the visitor from using the virtual guide.

Table3. The anticipated purpose of the visit by categories

	Quick overview (RP)	Fundamental knowledge (ZP)	In depth research (HS)
3-6 years (D3)	X	X	
6-12 years (D6)	X	X	
12-18 years layman (L12)	X	X	X
18-65 years layman (L18)	X	X	X
Over 65 years layman (L65)	X	X	X
12-18 years expert (O12)		X	X
18-65 years expert (O18)			X
Over 65 years expert (O65)			X

Source: Own elaboration

5. IMPLEMENTATION

1. phase – creation and debugging:

- Creation of virtual museum web pages.
- Creation of individual system modules. All modules are placed on the same server as a virtual museum.
- The expert system of Visitor module acquires information through a simple form that the visitor fills out when entering the museum pages. The output of this module will be used in the Guide module.
- Filling the virtual museum database of exhibits – Exhibit module. The creation of individual information layers needs to be done with the help of

an educational specialist so that each information layer is appropriate for its audience.

- In the learning phase the neural network (part of Guide module) will use as inputs the classification of visitors and suitable tour routes as outputs. During the tour the visitor can change the proposed tour as well as the level of exhibit information layer. His route will be recorded for possible later editing of the rules of passage.
- In order to obtain relevant data, it is necessary in this phase to have many various visitors take a tour through the virtual museum.
- When leaving the web page of the virtual museum, the visitor can leave feedback in the presented form. This will be added to the data about his tour route and will serve to eventual improvements of the system.

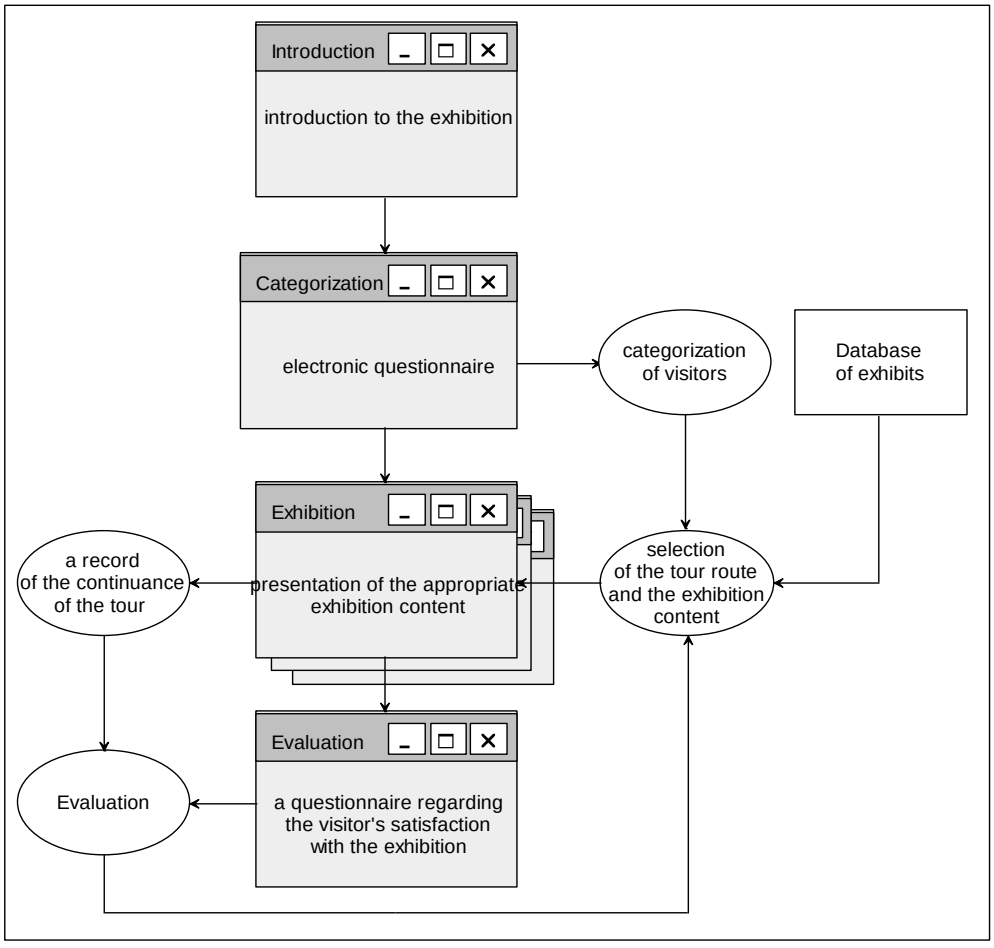

Figure 4. A scheme of the system in the 1. phase of development

Source: Own elaboration

2. phase – testing the educational function

- Guide module adjustment based on real data gathered from the records of visitors tour routes.
- Potential modification of virtual guide web design based on the visitors' reactions.
- Testing of educational functionality of the system on two groups. The first group will be 1st grade students of a primary school, the second group will be students of a secondary school. Part of the students will use the services of the virtual guide, while the others will go through the virtual museum by themselves. After the tour, the degree of knowledge acquired by each group will be compared.

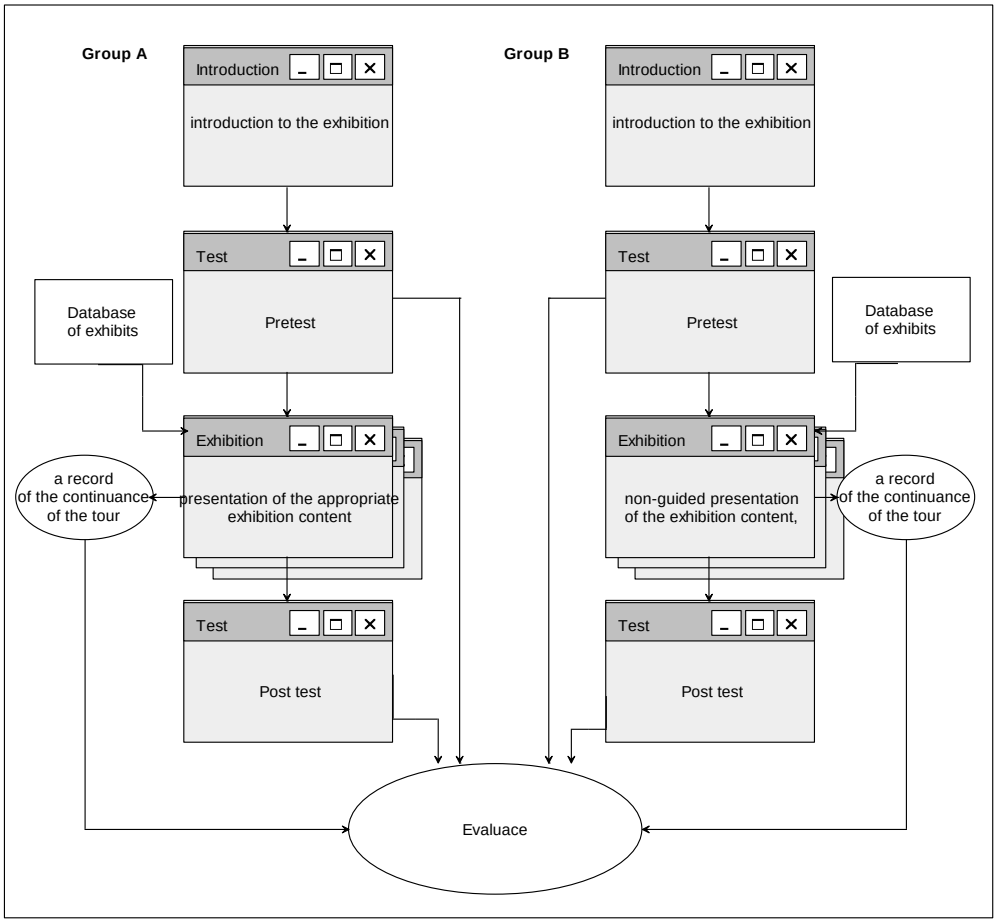

Figure 5. The scheme of the system in the 2. phase of development

Source: Own elaboration

3. phase – implementation in a real exhibition

- Adjustments for implementation in the real exhibition. Filling the database of exhibits with new records and the creation of new information layers. Also the Guide module has to be modified in order to correspond with new conditions.
- The whole system will run on the museum's central server. When entering the museum exhibition the visitor will download an application to his smartphone. For those who do not own a smartphone, a lending service will be provided. After running the application, the user will have to answer questions in order to be placed in the right category. His answers will be transferred to the server and the user will receive a map with a plan of the tour route on his smartphone. The application will direct the user through the exhibition to the appropriate exhibit. When at the exhibit, the visitor will place his device on the NFC panel or will download the displayed QR code and the appropriate information layer of the exhibit will be displayed on his device screen. After he is done viewing the information layer, the application will direct him to another exhibit.
- The visitor will still be able to change the tour route as well as the information layer of the exhibit.

6. CONCLUSION

One of the museum's mission is to educate its visitors. One way to accomplish this mission is to offer an individual approach to the visitor. Different visitors require different information. Modern ICT offers tools that enable the creation of personalized tours. The adaptive guide system is one of those tools. It is vital to choose an appropriate categorization of visitors for such system. However, as there is no universal classification system, it is necessary to develop my own and verify it in practice. The expert system will then take care of the visitor category determination and its output will be used by the Virtual guide as a source for selecting the appropriate tour route. Currently, the expert system is being developed in FEL-EXPERT environment. When the expert system is finished, it will be tested and debugged in the virtual museum. After its educational function is verified, it will be implemented in real museum exhibition, where it will work as an application for a smartphone. In the future I plan to expand the categorization of visitors to groups as well, so that the system is more complex and allows working with various groups of visitors.

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