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# Evaluation of Hypermedia Systems in Museums

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## 1 POI Systems in Museums

The number of multimedia and hypermedia applications in museums is rapidly increasing. Most applications are point-of-information systems presenting additional information on artefacts which are shown in the museum or offering background knowledge on subjects covered by the museum. Publications dealing with such applications are mostly bare descriptions of contents, technical realisations or user interfaces. There are very few studies dealing with use and acceptance of such systems by visitors.

In order to decide whether hypermedia applications should be installed museums have to regard costs and benefits: does the rather expensive development of a special application pay in the sense of making the museum more attractive to visitors? Attractiveness, in turn, is the question of usability and acceptance of the application. Therefore evaluation studies which have to deal with ergonomical, didactical, and psychological questions are necessary.

## 2 Evaluation of POI Systems

### 2.1 Methodology

Evaluation of computer applications normally starts from the tasks of the users. In POI Systems there is no such given task. Goals and intentions of the users are made up by themselves. Therefore evaluation of POI systems has to concentrate on the questions of what users really do with the system and how they assess it. Methods which are to be used for this purpose must not be expensive in order to provide a reasonable relation between costs for evaluation and benefits for POI applications in the museum.

Subjective methods like questionnaires and interviews are important, because acceptance of the system is a crucial factor. Both questionnaires and interviews can be used to find out the users' assessment of usability, information contents, and design of the system. While questionnaires need rather no personnel for distribution and few for evaluation, interviews require a higher amount of personnel. Thus interviews are often too expensive. On the other hand, questionnaires which are filled in without supervision are not fully reliable.

Objective methods like observations and logfile recordings are best for studying the users' behaviour. However, observations usually require additional personnel and thus are too expensive. Logfile recording requires no additional work. If format and content of logfile records are designed in such a way that evaluation can be done automatically or half automatically, this methods offers a very good relation between the work which has to be invested and the answers which can be obtained.

Other methods of evaluation like guide-oriented judgements by experts or experimental methods are either not appropriate or too expensive. Therefore evaluation of POI systems in museums should mainly rely on logfile recording in combination with questionnaires. Additional observation may be useful.

## 2.2 Evaluation studies in museums

Only a few evaluation studies of POI systems in museums have been reported. Noschka-Roos and Lewalter (1993) examined the use of a touchscreen System "Renewable Energy Sources" in the German Museum of Master Pieces of Science and Technology, Munich, by interviews and observations. Observation of the users' actions was done by using a second screen and recording by hand. Their proceeding followed closely Wanning's study (1991) of an interactive video system in the Resistance Museum, Copenhagen. Fahy, Poulter, and Sargent (1993) performed a task oriented experimental evaluation of a hypermedia front-end. Nebenzahl's study (1993) is the only one in which logfile recording was used in order to count the touches on different buttons and the time spent on different pages.

Most of these studies made little use of technical means like logfiles. Observations and interviews required much personnel, experimental studies even more. Thus the costs for such studies exceed the limits of most of the museums which apply POI systems. Therefore we tried to find out how POI systems can be evaluated with minimized efforts.

# 3 POI Applications in the German Salt Museum

## 3.1 Lüneburg - a large city around 1600

This application provides information about the development of the city, about economical, social, and cultural life within the city, and about remarkable buildings and places based on a map from 1574. There are three different views of the map (overview, full view, zoom view for details). 35 pages of information about the city as a whole belong to the overview, 73 pages of information about buildings and places to the zoom view. Each page contains the map or a zoomed part of it on the left and a text field on the right. (Fig. 1)

All pages can be called up by selection from a hierarchical table of contents. It is possible to change between pages by buttons following sequential order (next / previous) or by hotwords (hypertext links). There are about 280 of such hyperlinks and about 80 additional hotwords which display additional information in popup boxes. In zoom view objects on the map can be clicked upon in order to display the text belonging to an object. Many pages contain buttons for the display of pictures (about 50), and some of the pictures carry buttons for tracks of sound like church bells or organs (about 10). The application is controlled by a trackball.

## 3.2 Salt. A hypermedia presentation of the German Salt Museum

This application provides information about salt minerals (origin, formation, structure, appearance, occurrences etc.). It is divided in 3 parts each of which is subdivided in 3 chapters. Each chapter contains between 2 and 48 pages with a total of 107. Each page contains a text on the right which is illustrated by a photograph, a diagram, or an animation on the left (Fig. 2). Selection of chapters is done hierarchically in two steps. Pages can be displayed in sequential order within chapters or by following one of about 65 hyperlinks. Standard controls at the lower part of the screen allow to restart the system, to display a map of contents, to select between German and English language and to go one step up or one step back. The application is designed for control by touchscreen. Due to

some technical problems a trackball had to be used during the the first period of evaluation which will be described subsequently.

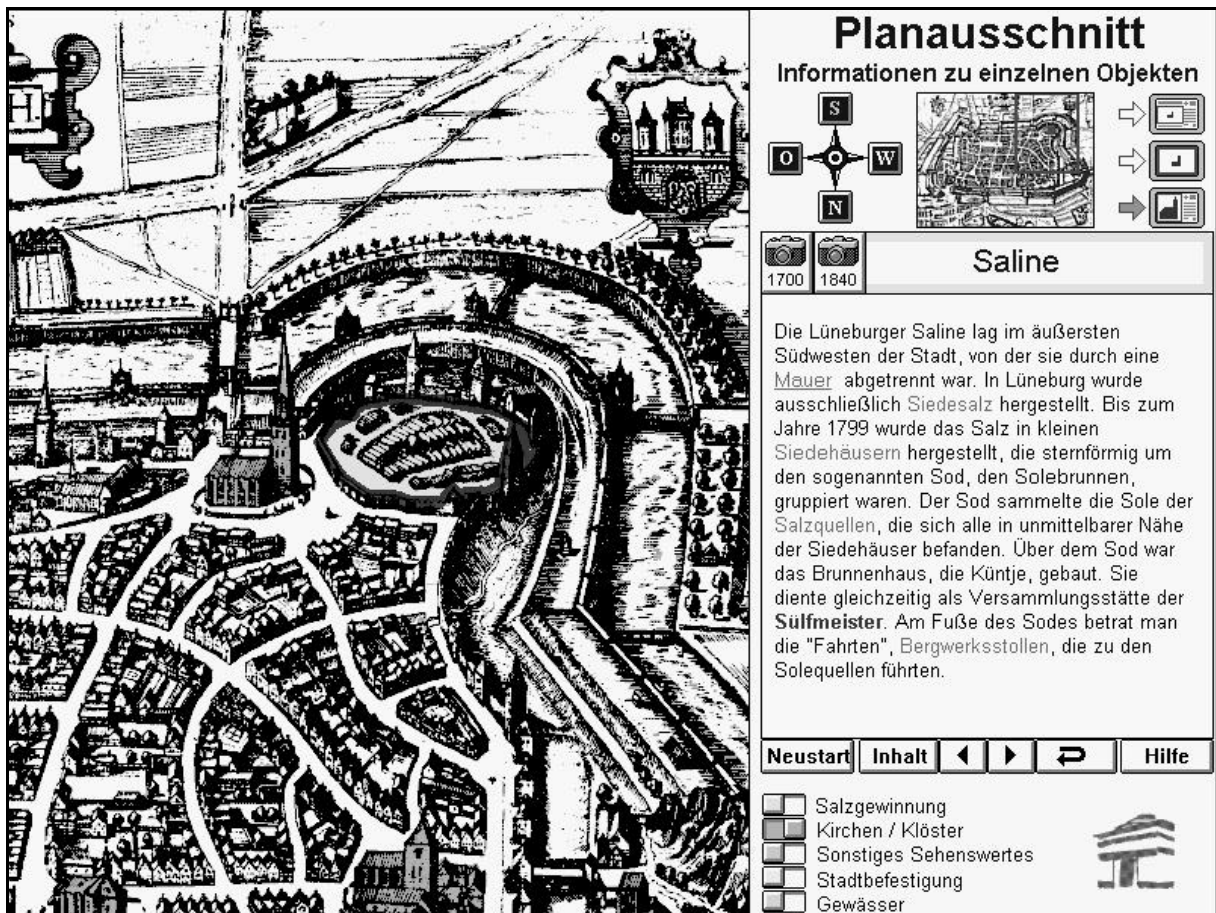


Fig. 1. Screen page of application "Lüneburg" in zoom view.

## 4 Evaluation of POI application in the German Salt Museum

### 4.1 Proceeding

Both applications have been developed by evolutionary prototyping in interdisciplinary co-operation between the Museum's staff, computer scientists, and external specialists. Prototypes have been presented to experts from different museums and tested in public use in the German Salt Museum. By informal observation and by discussions with experts and visitors some problems in interaction and presentation could be solved. For example, visitors expected the application to react when pressing the trackball button, whereas the application followed the interaction style of Windows by reacting when the button becomes released. Thus visitors held the button down for quite a long time waiting in vain for something to happen. Therefore we changed all virtual buttons to react on button-down instead of button-up. A few minor errors became apparent during this first phase of testing, too.

In a second phase both systems ran without supervision in the exhibitions. Every action of the users was recorded in a logfile. Each logfile entry consisted of five items: the time of the event (in seconds since midnight), the nature of the event (e.g., click, double click, holding button down for a while), the target of the event (e.g., button, hotword, photograph), the page displayed when the event

occurred, and the page displayed after the event. Logfiles are plain ASCII text and can easily be loaded into a database for evaluation.

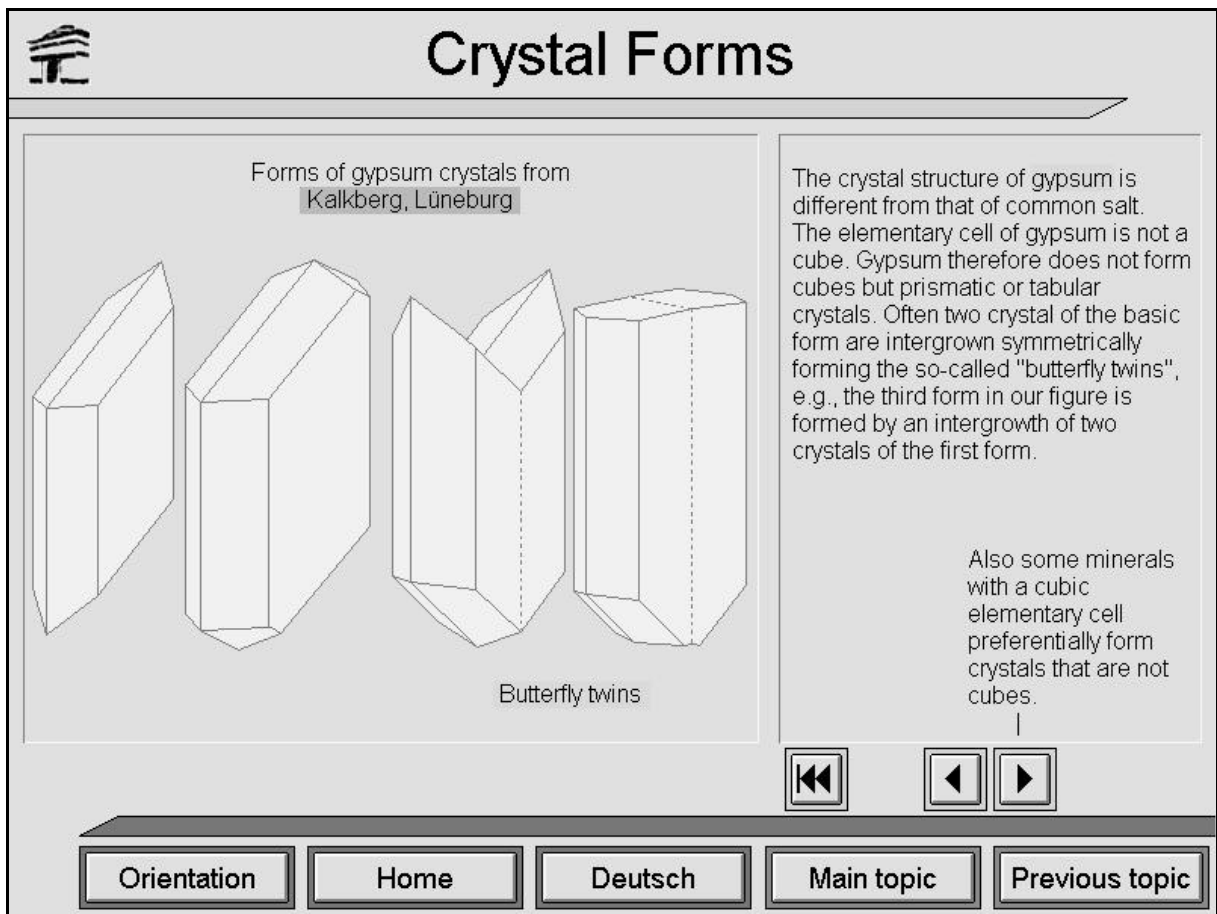


Fig. 2. Screen page of application "Salt."

The application "Salt." was developed as part of a special exhibition on salt minerals. This exhibition was one of a series of exhibitions which were sponsored by the State Government of Lower Saxony within the scope of the project "Museum of the Future - Possibilities and Limits of Modern Forms of Presentation within Museums". In each exhibition of this project the visitors' assessment has been tested by questionnaires. The questionnaire of the exhibition on salt minerals consisted of 24 questions. 7 of these questions related to the POI applications (see below).

#### 4.2 Data from logfiles of application "Salt."

Logfile recording has been tested during 67 hours of operation in June and July 1994. After some improvements for easier analysis of the logfiles recording has been done for six weeks (94-08-12 to 94-09-22)

which means 320 h of operation. About 1350 persons visited the exhibition during this period. 27077 user actions have been recorded. Due to the number of pauses of different length between user action (Table 1) we may assume that after a pause of more than 2 minutes there is another user at the terminal. Following this assumption we had at least 479 persons using the system.

Total duration of use of the system was 34.5 h which is only about 11% of operation time. Visitors spent between 0 sec (isolated user action) and 37 minutes at the terminal with an average of 4 min 20 sec and a median of 2 min 36 sec (Table 2).

Pause t after event (t in seconds)	Number of events in intervals of			
	5 sec.	15 sec.	30 sec.	1 minute
0 ≤ t < 5	17533			
5 ≤ t < 10	5663			
10 ≤ t < 15	1879	25075		
15 ≤ t < 20	744			
20 ≤ t < 25	340			
25 ≤ t < 30	153	1237	26312	
30 ≤ t < 45		163		
45 ≤ t < 60		50	213	26525
60 ≤ t < 75		29		
75 ≤ t < 90		15	44	
90 ≤ t < 105		18		
105 ≤ t < 120		11	29	73
120 ≤ t < 150			16	
150 ≤ t < 180			13	29
180 ≤ t < 210			23	
210 ≤ t < 240			19	42
240 ≤ t < 270			9	
270 ≤ t < 300			12	21
300 ≤ t < 360				24
360 ≤ t < 420				17
420 ≤ t < 480				11
480 ≤ t < 540				15
540 ≤ t < 600				8
600 ≤ t				312

Tab. 1: Pauses after user actions

Duration of use (t in seconds)	Number of visitors in intervals of			
	5 sec.	15 sec.	30 sec.	1 minute
0 < t < 5	39 8%			
5 ≤ t < 10	10 2%			
10 ≤ t < 15	8 2%	57 12%		
15 ≤ t < 30		25 5%	82 17%	
30 ≤ t < 45		23 5%		
45 ≤ t < 60		23 5%	46 10%	128 27%
60 ≤ t < 90			33 7%	
90 ≤ t < 120			40 8%	73 15%
120 ≤ t < 180				56 12%
180 ≤ t < 240				40 8%
240 ≤ t < 300				31 6%
300 ≤ t < 360				32 7%
360 ≤ t < 420				23 5%
420 ≤ t < 480				16 3%
480 ≤ t < 540				16 3%
540 ≤ t < 600				15 3%
600 ≤ t				49 10%

Tab. 2: Duration of use per visitor

The number of interactions per user ranges between 1 and 904 with an average of 57 and a median of 27 actions (Table 3).

Recorded events e per visitor	Number of visitors in intervals of		
	10 events.	50 events.	100 events.
0 ≤ e < 10	111 23%	324 68%	
10 ≤ e < 20	87 18%		
20 ≤ e < 30	54 11%		
30 ≤ e < 40	36 8%		
40 ≤ e < 50	36 8%		
50 ≤ e < 60	29 6%		
60 ≤ e < 70	25 5%		
70 ≤ e < 80	9 2%		
80 ≤ e < 90	12 3%		
90 ≤ e < 100	10 2%		
100 ≤ e < 150	28 6%		45 9%
150 ≤ e < 200	17 4%		
200 ≤ e < 300			13 3%
300 ≤ e < 400			3 1%
400 ≤ e < 500			4 1%
500 ≤ e			5 1%

Tab. 3: Number of recorded events per visitor

65% of user interactions had a result (effective actions), 35% had none (errors). 45 % of effective actions were navigations with buttons like forward or backward, another 17 % selections of chapters by menu buttons. Navigation with hotwords took only 1 % of effective user actions in total. Nevertheless, on pages which carried hotwords, navigation with hotwords was up to 10 % (for details see Heinecke, Bumann and Kerstan, 1995).

The number of calls of different pages and the duration of stay is shown in Fig. 3. Pages with black marks are menu pages which only contain buttons with titles of parts or chapters for selection. The first number after the C indicates the number of jumps to the page by menu buttons or forward button, the second number the total number of jumps to the page. The first number after the D indicates the total time of stay on the page, the second number the average time of stay on the page.

### 4.3 Logfiles of application "Lüneburg"

Bumann and Kerstan (1994) analysed the logfiles of application "Lüneburg" of the month of September 1994. We shall not present the results here in detail as they are mostly similar to those of application "Salt.", but focus on the differences between both applications. For application "Lüneburg", the duration of use per visitor is longer. The duration of stay on a page is considerably longer with an average of 17 seconds compared to 7 seconds for application "Salt.". The total number of calls of a page of application "Lüneburg" range between 3 and 83 (pages for menus, contents, or help excluded). For application "Salt." the extremes are 26 and 488.

### 4.4 Questionnaires

Visitors have been asked to fill in questionnaires between middle of July and end of September. 100 questionnaires have been sent back. Distribution of sex was nearly 50 to 50, distribution of age nearly according to that of the visitors of the museum in total. Figures 4 and 5 show the ratings.

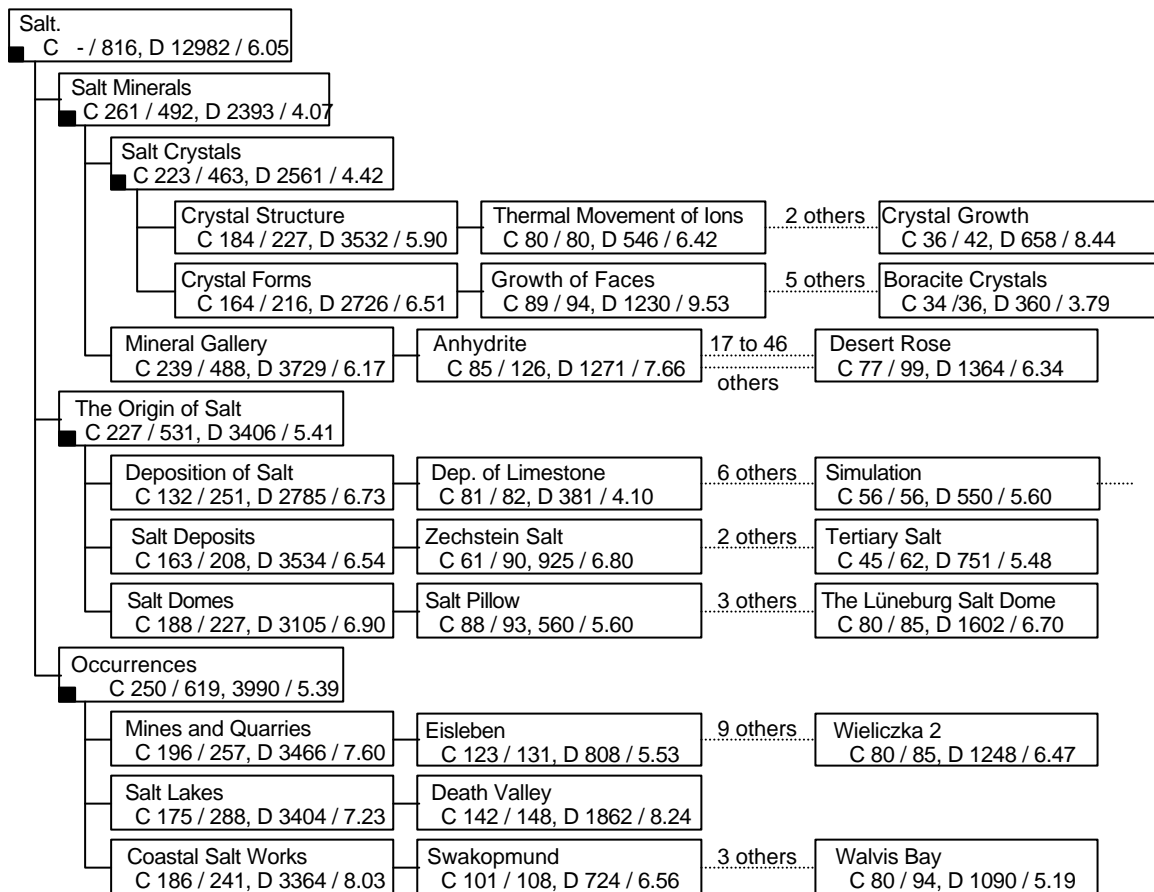


Fig. 3. Incidents of call and duration of stay on different pages.

## 5 Analysis of Results

Many people seem to try getting an overview by "turning pages" very fast in sequential order (forward button takes 36 % of all user actions, application "Salt."). Perhaps they are only interested in the system but not in its contents. They just play around for a short while and leave the system very quickly (half of the visitors after less than 2.5 minutes, application "Salt.").

On the other hand, people using the system more intensively make use of all possible interactions. On pages which are called not so often, the use of the forward button decreases and the use of hotwords and other means for navigation increases. The longer one users stays at the terminal, the more he or she uses other types of interaction than the forward button.

Clicks on areas or objects which are not sensitive don't result in reactions of the system and might be called errors. These errors concentrate on some objects which are obviously mistaken for buttons or for other sensitive objects. We re-designed some of these objects so that users might distinguish them from buttons more easily. As logfile of the re-designed version haven't been evaluated yet, we cannot judge at present whether the new design incorporates software-ergonomic improvements.

As error clicks also concentrate very near around buttons, we assume that some people have problems in positioning the cursor by using a trackball. As application "Salt." is currently in use with a touchscreen at the Bavarian State Exhibition 1995 "Salt makes History", we shall soon be able to compare trackball and touchscreen use.

From the incidents of call (Fig. 3) we assume that the spatial order of menu buttons for part or chapter selection has no influence on the frequency of selection. The highest number of selections has

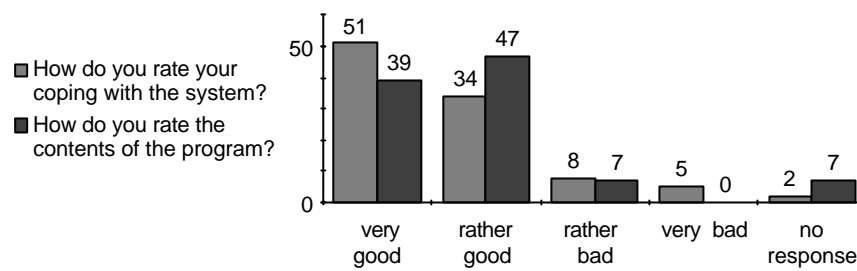


Fig. 4. Assessment of application "Salt." by visitors

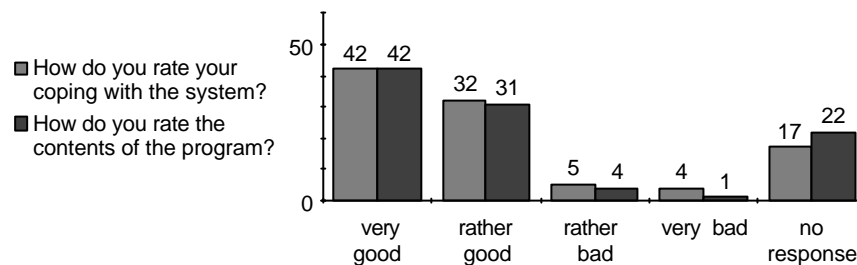


Fig. 5. Assessment of application "Lüneburg around 1600" by visitors. Number of abstentions derives from the fact that many visitors visited only the special exhibition containing the application "Salt."

been recorded for Mineral Gallery (sequence upper button - lower button), the second one for Mines and Quarries (sequence lower button - upper button). Of course, the number of calls may be influenced by the attractiveness of the subject. In order to test the actual influence of spatial arrangement we shall re-order the menu buttons in a few months and compare the logfiles.

As both the duration of use per visitor and the duration of stay per page is longer in application "Lüneburg" than in application "Salt." it seems that more complex applications with many ways of interaction and longer texts are more attractive. On the other hand, we ask within the questionnaires which application the users liked more and got a 41 to 17 preference for "Salt."

The ratings in the questionnaires are by far better than we had expected after evaluation of the logfiles. To us it seems to rather be a proof for the attractiveness of POI systems as new media in museums than for the quality of installed applications. As long as POI systems aren't still ubiquitous in museums they are attractive by novelty appeal.

## 6 Conclusions

Logfile recording is a valuable means for evaluation of POI systems in museums, provided that logfiles can be analysed easily. This can be achieved by using a standard database which supports detailed queries. Analysis of logfiles can give hints for ergonomical improvements of the user interface. Logfiles are also capable of showing user preferences with respect to media and / or contents.

Questionnaires and observations can be used additionally in order to study different groups of users. For future studies we shall make use of existing control cameras in order to correlate logfile recordings to different types of users with respect to age, sex, and single visitor vs. group of visitors.

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