

Evaluating Three Museum Installations of a Hypertext System

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This study explores the use of a hypertext system by patrons of three museums. Data on the articles accessed, the time spent in each, the number of times the index was accessed, etc., were collected from a total of more than 5000 sessions. Results show that visitors at all three museums used the embedded menus of the Hyperties hypertext system in moving from one article to another far more than the traditional index. Article selection appears to reflect anticipated interests of patrons at each museum suggesting success in traversing the database. At the third museum, the data collection was complemented by direct observation and interviews of the museum patrons. This last approach appears to be more appropriate to analyze the usage data as well as to improve the user interface and database structure.

Introduction

Interactive databases have been widely used in settings such as business offices, airline reservation counters, libraries, and supermarkets for the purpose of storing, retrieving, and manipulating data. The use of databases for browsing and educational purposes is less common, and research on the use of interactive databases in museums is nonexistent. This article describes a study of Hyperties, an interactive encyclopedia system, in three museum settings.

Hyperties* was developed at the University of Maryland for use by novices in a museum and other environments. It is a software tool for constructing and reading a database composed of articles containing text and pictures on a given topic (Shneiderman, 1987). Such hypertext systems (Conklin, 1987) have become popular, especially since the recent development of Apple's HyperCard.

*Hyperties is available from Cognetics Corp., 55 Princeton-Hightstown Rd., Princeton Junction, NJ 08550, Phone (609) 799-5005.

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Within each Hyperties article certain words and phrases, determined by the author of the database, appear in color or boldface. When selected (by using arrow keys, a mouse, or a touchscreen), a brief definition of the word or phrase appears near the bottom of the screen. The reader can then select a FULL ARTICLE on the topic. The goal of the database author is to create logical links between articles so that readers can progress from one to another in a natural manner and according to personal interests. At all times the user has the option of selecting NEXT PAGE, BACK PAGE, RETURN TO [previous article], or INDEX (see Figure 1).

One aim of designers of systems such as Hyperties is to facilitate browsing and information retrieval by novices. In over 20 experiments at the University of Maryland, student volunteers have generally needed little or no instruction. In a museum setting, however, patrons may have a broader range of backgrounds, abilities, and expectations (Marchionini and Shneiderman, 1988). This study was done to determine how readily museum visitors would use Hyperties and to see whether they would exploit the hypertext feature, as opposed to using the index, in moving from one article to the next. In related studies (Wang et al., 1988), library science students used the index more than 80% of the time and only exploited the embedded menus after gaining familiarity with the system.

At least one study (Young, 1987) has explored how users of an online help facility locate information when given the choice of several methods, such as reading a more general article versus doing a string search for a particular word or phrase or reading a specific article about the topic. It appeared that new users tended to read the more general articles and performed string searches while expert users immediately read specific articles. It is difficult to generalize such results to our study, however, as Hyperties had no "string search" feature at the time of these studies.

This evaluation of Hyperties utilization in three museum settings is divided in two parts. In part 1, a common database was used in two different museums and only quantitative data was logged by the computer. In part 2 of the

You can learn more about David Seymour by reading article on this computer. Move the blue highlight from yellow word to yellow word by pressing the left or right arrow keys. Then, to select the word in blue highlights, press the ENTER key.

FIG. 2. The title page seen by visitors at the ICP museum. A silk-screened plexiglass note with instructions for use was pasted to the cabinet at the BBK. The instructions were slightly different because the monitor was monochrome at the BBK.

INDEX OF ARTICLES Starting index entry 1 out of 26
INTRODUCTION: CHIM--AN OVERVIEW

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2. B'NAI B'RITH KLUTZNICK MUSEUM HISTORY	54
3. B'NAI B'RITH KLUTZNICK MUSEUM OVERVIEW	40
4. BISCHOF, WERNER	9
5. BOOKS WITH DAVID SEYMOUR'S PHOTOS	28
6. CAPA, CORNELL	14
7. CAPA, ROBERT	18
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9. CHIM-- AN OVERVIEW	490
10. CHIM: PHOTOGRAPHS BY DAVID SEYMOUR (1911-1956)	0
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17. MEMORIALS IN DAVID SEYMOUR'S HONOR	10
18. NEWSWEEK'S TRIBUTE TO CHIM	13
19. PERMANENT COLLECTIONS OF DAVID SEYMOUR'S WORK	1
20. PERSONALITIES PHOTOGRAPHED BY DAVID SEYMOUR	50
21. QUOTATIONS ABOUT DAVID SEYMOUR	38
22. RODGER, GEORGE	2
23. SEYMOUR, DAVID	55
24. SHNEIDERMAN, EILEEN	26
25. SPANISH CIVIL WAR	33
26. VANDIVERT, WILLIAM	12

FIG. 3a. Index for BBK database with total number of accesses for each article.

the number of seconds spent in each article. Index accesses were also recorded, but the time spent in the index was not. If the user did not execute a QUIT command at the end of a session, the screen reverted to the title page after five minutes of inactivity, and a "timed out" message was stored in the data for the last article.

Results

Data from 373 sessions at BBK and 361 sessions at ICP were recorded and analyzed. The data included:

Nonarticle-Specific Data:

- *Articles per session* — the number of articles accessed during one session (index accesses were not counted).
- *Index accesses per session* — the number of times the index was accessed during one session, excluding any access just prior to the end of the session, since such an access was necessary to execute the QUIT command.
- *Articles read per index access* — Average number of articles read per session divided by average number of index accesses per session.

INTRODUCTION: CHIM--AN OVERVIEW

1.	ARTICLES ABOUT DAVID SEYMOUR	48
2.	BISCHOF, WERNER	21
3.	BOOKS WITH DAVID SEYMOUR'S PHOTOS	26
4.	CAPA, CORNELL	52
5.	CAPA, ROBERT	112
6.	CARTIER-BRESSON, HENRI	93
7.	CHIM, A MAN OF PEACE	74
8.	CHIM, A MAN OF PEACE: PART 2	22
9.	CHIM-- AN OVERVIEW	551
10.	CHRONOLOGY OF DAVID SEYMOUR'S LIFE	71
11.	DAVID SEYMOUR 'CHIM' THE EARLY YEARS 1933-1939	45
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13.	ICP'S BROAD RANGE OF PROGRAMS	48
14.	ICP/MIDTOWN	74
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16.	ISRAEL	47
17.	MAGNUM PHOTOS	72
18.	MEMORIALS IN DAVID SEYMOUR'S HONOR	13
19.	NEWSWEEK'S TRIBUTE TO CHIM	14
20.	PERMANENT COLLECTIONS OF DAVID SEYMOUR'S WORK	11
21.	PERSONALITIES PHOTOGRAPHED BY DAVID SEYMOUR	75
22.	PHILLIPS, CHRISTOPHER	12
23.	QUOTATIONS ABOUT DAVID SEYMOUR	57
24.	REGARDS MAGAZINE	18
25.	RODGER, GEORGE	15
26.	SEYMOUR, DAVID	168
27.	SHNEIDERMAN, EILEEN	49
28.	SPANISH CIVIL WAR	44
29.	TARO, GERDA	39
30.	VANDIVERT, WILLIAM	28

FIG. 3b. Index for ICP database with total number of accesses for each article.

- *Duration of session* — the sum of the time spent in each article for which a valid time value had been recorded. In sessions that were "abandoned" the time for the last article was not included.
- *Percentage of sessions abandoned* — the proportion of sessions not terminated by a QUIT command.
- *Average time per article* — the sum of all time values recorded divided by the numbers of articles from which the time values were obtained (last articles of abandoned sessions ignored).

- *Corrected duration* — the duration of a session plus the average time per article for each article whose time value was not included in the duration.

Figures 4-7 show the frequency distribution for key data items at each museum. The average length of a session was slightly more than two minutes at BBK and approximately six minutes at ICP. The average number of articles accessed per session was 3.2 at BBK and 5.7 at

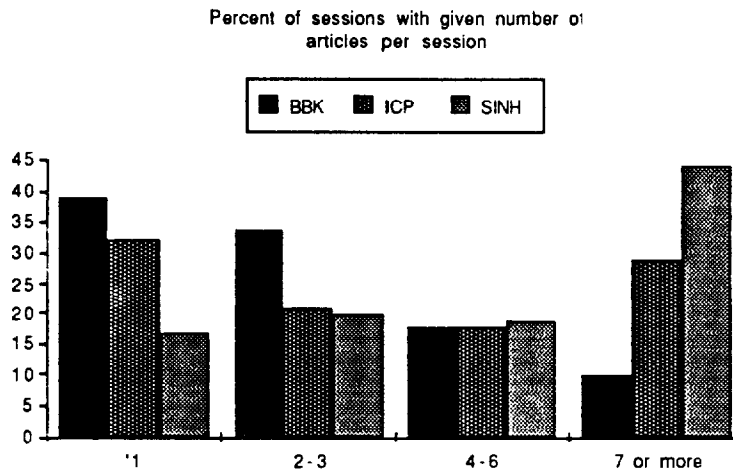


FIG. 4. A histogram showing the percent of sessions that accessed the given number of articles in the session at all three museums. Visitors at ICP viewed more articles on the average than visitors at BBK. Visitors at SINH viewed even more articles on the average than the visitors to ICP.

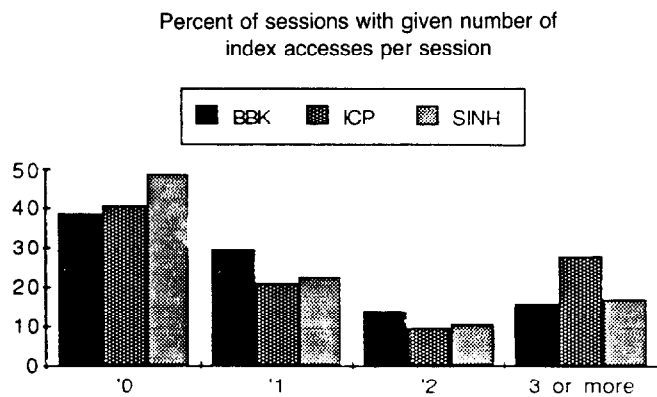


FIG. 5. A histogram showing the percent of sessions with the given number of index accesses per session. ICP visitors used the index more per session than BBK visitors, possibly reflecting deeper interest in the photographers or more sophistication with computer usage. SINH visitors used the index less per session, possibly reflecting the difficulty in making good use of the much larger index.

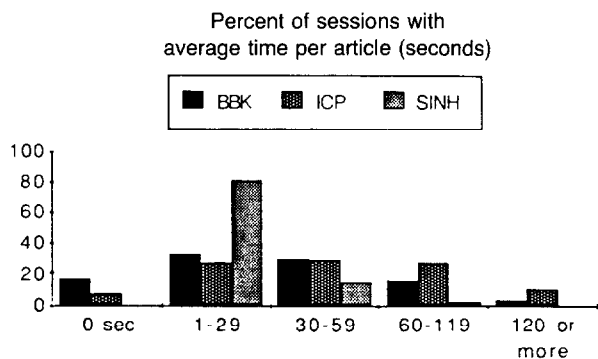


FIG. 6. A histogram of the percent of sessions with the average time per article in seconds. Visitors at ICP spent an average of 64 seconds per article versus 41 seconds at BBK. Visitors at SINH spent an average of 16 seconds per article, possibly reflecting the ease of traversal with the touchscreen, the greater connectivity, and the brevity of the articles.

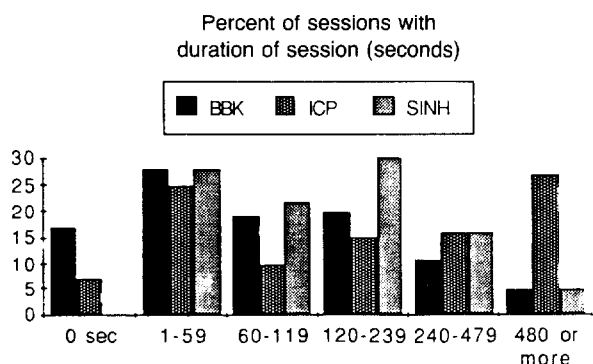


FIG. 7. A histogram showing the percent of sessions with the given duration of the session in seconds. Visitors at ICP spent an average of approximately six minutes per session versus just over two minutes at BBK. Visitors at SINH spent an average of 2.6 minutes per session. We conjecture that this reflects the ease of exploration with the touchscreen that enabled users to quickly explore a few articles (notice the brief times spent per article in Figure 6) and satisfy their information needs or their sense of the system. Also the SINH crowds may have encouraged people to move on quickly.

ICP. This difference may reflect the differing interest of the museum patrons or their skill with computers. The average time spent in each article was approximately 41 seconds at BBK and 64 seconds at ICP. We assume that the greater persistence of ICP visitors reflects a different profile of usage. Forty-seven percent of the sessions at BBK were abandoned, compared to 39% of the sessions at ICP. Articles read per index access was similar for the two museums. Note: Eight sessions were not included in the above analysis (seven at BBK and one at ICP) because they consisted of one INDEX access (no articles were read).

Article-Specific Data:

- *First access* — The proportion of sessions beginning with the index and the proportion beginning with the introduction.
- *Second article in session* — The proportion of sessions (of those containing two or more items) that had each item as their second member.
- *Second article in sessions beginning with the introduction* — The proportion of sessions, of those containing two or more items and beginning with the introduction, that had each item as their second member.
- *Second article in sessions beginning with the index* — The proportion of sessions, of those containing two or more items and beginning with the index, that had each item as their second member.
- *Third article in all sessions* — The proportion of sessions, of those containing three or more items, that had each item as their third member.
- *All articles in all sessions* — The proportion of total accesses accounted for by each item.

The first item in 80% of the sessions at ICP and in 84% of the sessions at BBK was the introduction (lead article) as opposed to the index. This contrasts with the results in Wang et al. (1988) who found that graduate library students answering fact questions used the index more than 80% of the time. At both museums, approximately 50% of sessions beginning with the introduction had the index as their second item. The second and third most popular items consisted of the same two articles at both museums.

In those sessions in which the index was selected first, the most popular article at the BBK was "Israel," while the most popular article at ICP was "Chim — an overview" (the introduction). The total accesses per article in all sessions also reflects heavy use of the index and introduction (Figures 3 and 8).

Discussion

Based on the comments of curators at both museums, Hyperties was well-received by visitors. Of course, these comments are biased and interviews with visitors should be used in future studies. As designers of the software we were interested in suggestions from visitors, curators, and colleagues to improve the system, but the data logging turned out to be insufficient for this purpose. Nevertheless

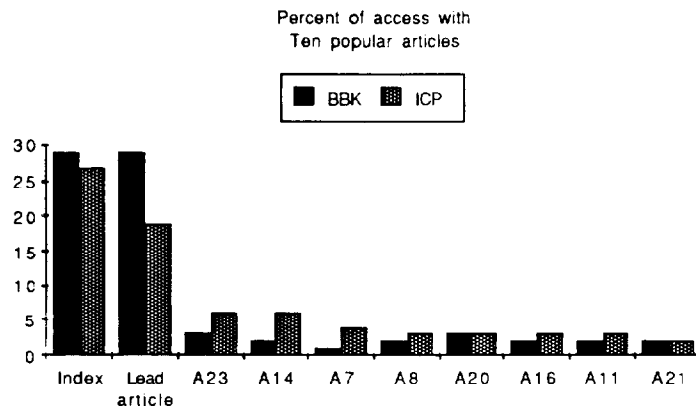


FIG. 8. A histogram showing the percent of accesses for the index and the most popular articles that were included in the databases at both BBK and ICP. The numbers refer to the article numbers as shown in the BBK index in Figure 3a. The BBK visitors viewed the lead article often and did not explore as widely as the ICP visitors.

we identified some ideas that might produce greater involvement and satisfaction. The lack of instructions on the title page of the BBK database may have contributed to the short duration of many sessions there. In addition, both databases lacked instructions on how to quit. Users had to discover the QUIT commands on the index screen to terminate the session. The authors conjecture that the longer sessions at the ICP were due to a more knowledgeable and interested user population, both with respect to the subject matter of the database and to computers in general. The ICP users also spent more time reading each article and explored a wider range of topics.

Both user groups utilized the embedded menu feature of Hyperties more frequently than the index, as evidenced by the number of articles read per index access. In addition, the distinctive distribution of articles accessed at the two museums seems to indicate that users selected articles based on their perceived content, rather than at random. Visitors at BBK, for example, were more likely to read the articles on Israel and on the museum itself, while visitors at ICP were more likely to read articles about the various photographers profiled in the database.

The problem of "abandoned" sessions could have been reduced by adding QUIT to the commands that appear at the bottom of each screen when an article is displayed, and by mentioning the quit procedure in the instructions on the title page.

There are a number of pitfalls that must be avoided if one wishes to use the data collected in this study to evaluate a particular database. The average duration of a session, for instance, is not reliable since there is no way of knowing whether one session was the work of one individual or of a series of people. The heavier volume of visitors at ICP may have accounted for part of the longer duration of the sessions.

The proportion of abandoned sessions may only be an indication of the clarity of the instructions. Average time per article is a more important measure of the utility or efficacy of the system, and the proportion of total accesses

accounted for by each article should give a good indication of which articles were most attractive to users.

2. Direct Observation and Log Data

The Museum

The third museum is the well known Smithsonian Institution's National Museum of Natural History. Two IBM Personal Computers are installed in the final room of the exhibit on "King Herod's Dream"—the ancient Roman port city of Caesarea, located in Israel. The exhibit focuses on the rise of urbanism in ancient times and the archaeological methods used during the past 20 years of excavations (Holum, 1988). This last station of the exhibit invites visitors to learn more about the sites that welcome volunteers and how to join a dig. This exhibit organized by the Smithsonian Institution Traveling Exhibition Service was in Washington DC from March 22 to June 19, 1988. It is now traveling to five other museums for the next two years (Los Angeles, Denver, St. Paul, Boston, and Ottawa). Two freestanding podiums house the IBM PC-AT computers. The EGA monitors, each equipped with a touchscreen, are at about waist level at a 45-degree angle. There is no keyboard. The only permanent instruction is "Touch the screen," written above the monitor.

The Database

The GOVA (Guide to Opportunities in Volunteer Archaeology) database was developed under the direction of Ken Holum (Professor of History at the University of Maryland). It consists of about 200 articles. The contents include information about archaeological digs taking place in Israel, the United States, and around the world, and practical questions about how to join a dig. A special effort was made to cover the local sites near the current exhibiting museum, and the database will be updated during its travels. The archaeological sites are organized both geographi-

cally and by historical periods. The information can also be accessed by direct selection on 11 maps.

The Touch-Screen Interface

In this exhibit a touch-screen interface is used. The museum patrons need only touch highlighted words on the screen to see the related article. A standard strategy indicates the touchable items: in the text as well as the maps only the blue words are selectable. This third study offered an opportunity to test the "touch-mouse" strategy developed at the Human-Computer Interaction Laboratory (Potter et al., 1988). In this strategy users receive feedback about the exact touch position by a cursor just above their fingers. When the cursor is on a selectable area, the area is highlighted. The selection is activated when users lift their fingers from the screen. This method produces low error rates and high user satisfaction.

Observations in the Museum—The Effect on the User Interface Design.

In this study the authors observed museum patrons using our hypertext system and the touchscreen interface in a natural environment. The main goal of this pilot study was to verify the accessibility of the information. Were patrons really able to explore the database with ease and satisfaction? The Hyperties concepts with the touchscreen interface had been thoroughly tested in the laboratory, and it was clear that the system was easy to use with about 15 seconds of demonstration or explanation, but we had less experience with an unattended public access situation.

Three observers spent four sessions of about two hours each at the exhibit, observing and discussing three potential problems: the touchscreen interface, the Hyperties mechanism, and the database structure. Each session allowed the authors to pick out the weaknesses of the system and put in place a productive mechanism of criticism and modification back and forth between laboratory and museum.

The first observation was that the suppression of our 15-second demonstration was transforming an easy to use system into a frustrating mystery game for some of these totally untutored users. The time spent at the computer shouldn't have been spent guessing and missing. Three main problems were observed: the misselection rate was still very high (the screen is touched but nothing is selected), the few lines of instructions were not clear or accessible enough to get started, and many patrons didn't figure out the two steps required to get a new article (first select a word and get a definition, then select its full article).

During the first sessions no usage data were logged by the computer. The data would have been able to show the average very small number of articles accessed and the high number of misselections, but the simple observation of the patrons and some informal interviews were sufficient to give us the hints necessary to understand why the

system wasn't working as hoped and how to improve it. In fact, direct observation and interviews worked better to improve the system than the data collection in part 1 of this study.

After implementing the changes described below, an obvious and satisfactory improvement was seen. Most of the patrons were able to traverse smoothly from article to article and focus on their reading and not on the mechanism. The authors were then able to concentrate on improving the structure of the database (contents and links) to make the information more accessible.

About the touchscreen. A surprisingly wide variety of ways to touch a screen were observed! Some users pressed hard or rubbed the screen, some touched with three fingers, some swished elegantly with a fingernail, etc. In spite of our efforts to design the screens clearly, there was confusion about where to touch. In this Hyperties application all the touchable areas were words written in blue, an easy concept only if you have read the instructions. To reduce the user's confusion on both of these issues, the authors provided better instructions and made the touch selection mechanism more forgiving. The initial selection mechanism was very accurate and easy to use with a few seconds of explanation. For the museum purpose, the touchable zones as well as the cursor, were enlarged and we installed a help line at the bottom of the screen, continuously updated according to the current step of the selection.

About the instructions. Written paper instructions attached on the side of the screens are not esthetically attractive. To give directions in the introduction article of the database seemed more appropriate. Therefore it has to be accessible to the patron coming to the screen. First, the RESTART button was made available at anytime, well separated from the others to avoid accidental hits. The time-out delay was also shorter than during the first installations. Modifying the introduction article and immediately observing the reaction of the patrons allowed us to find a more successful writing style. Patrons were more successful when they were asked to try specific examples than to read about the general hypertext concept. It is better to write "For example, if you touch the blue word "volunteer" on the third line of this page, you will get an article about volunteers . . .", than to explain that the blue words will give you more information by accessing an article about the related subject. Our observations showed the importance of the introduction article. It should give clear instructions, a brief overview of the main database topics, and also easy and clear links to the most attractive parts of the database (maps for example) (Fig. 9).

About the Hyperties mechanism. In the initial system the user had to first select a word, then select the command FULL ARTICLE to jump to a new article. This mechanism had been designed for a keyboard interface with which users simply pressed the Return-Key twice to get an article—thanks to the judicious setting of the default cursor position. In the touchscreen version that mechanism doubles the selection process time and difficulty.

Welcome to **GOVA**, the Guide to Opportunities in Volunteer Archaeology.

GOVA will tell you about **archaeological projects** all over the world (see **Map 9**) that welcomes **volunteers**. You can use **GOVA** to answer **practical questions** like **how to join a dig**, or how much it **costs**.

To Use **GOVA**, simply touch a blue word with your fingertip-- not your fingernail-- and release. For example, if you touch the blue word "volunteers" at the third line of this page, you will get an article about volunteers. To turn to the next page touch the blue word **NEXT PAGE**.

INDEX

NEXT PAGE

RETURN TO MAP 9, THE WORLD

RESTART

Touch a blue word with your fingertip

FIG. 9. This screen shows the first page of the Introduction article used at the National Museum of Natural History. The bold items appeared blue on the screen and were the touchable areas. Here, the brief definition space at the bottom of the screen has been removed. The **RESTART** is available at anytime. The style of writing for the introduction article is also different. It gives instructions and examples, and provides the links to the major database topics. In a later version we added a **TABLE OF TOPICS** command at the bottom of the screen.

The **FULL ARTICLE** command was also hard to reach in a corner of the screen and our interviews revealed that many patrons were annoyed by it. The solution was to suppress the definition and give direct access to the full article. Each selection had now a very visible and dramatic effect, the trade-off being a weaker continuity from screen to screen.

About the contents of the database. After making the software changes, it was possible to check the database structure and accessibility. To find information the user can follow links from article to article, or select an article from an index, which consisted here of an alphabetical list of the 200 articles. The authors observed that users seemed to be disoriented by the very large index and often left the index without selecting anything. In the previous experiment the index was used often. The hypothesis is that in the first database the index was small enough (two pages) to be browsed rapidly, and give the user the possibility of forming a quick idea of the topics covered by the database. With a large number of articles the index was mainly disappointing, except for some people searching for a specific city. It is believed that a table of contents will be more useful. The authors have made the table of contents accessible as an option from any page, but we won't get any feedback from this change until the exhibit is installed in the next museum—Los Angeles. The data analyzed in the next chapter was also recorded before this change.

Different Types of Use

During our stay at the museum we observed quite diverse behaviors. By making the browsing extremely simple

and rapid, it was also observed that it can become an attractive game for young children who enjoyed their power over the rapid flashing of the screen. Some other patrons come to the computer driven by their interest in new technology (the touchscreen interface or the software). The authors saw them study the software, "play" with the selection mechanism, but not always take interest in the information available. A lot of visitors just stop in front of the screen, touch it once or twice and leave. They don't seem to be interested or are exhausted—the computer is the last station of a long exhibit. On the other hand, some patrons were observed spending a long time at the computer—or even coming for a second time!—to explore several sites, take notes of names and addresses.

The Data Collection and Analysis

After improving the usability of the system, usage data was collected during four weeks. Unfortunately one of the two monitors was out of order at that time and only one of the two computers was used. All selections were recorded, allowing a more precise analysis. The **RESTART** command being available at all times and the time-out delay being reduced, most of the patrons started their exploration from the title page. Unlike for the Part I data, the authors know that each session has most likely been conducted by the same person or group of persons.

In order to collect the most complete information possible for the **GOVA** exhibit, every selection and the selection's time were logged by the computer. Since all of the user input to the computer was captured, any information about what the museum patron saw on the display could

be recreated. The authors chose to concentrate on the time spent within articles. To get this information the log files were "played through" the museum software, recreating the visitor's experience. At the same time a new condensed log file was generated that contained the pertinent information.

There were 27 days of data collected which contained 4461 sessions. A session in the GOVA exhibit starts when patrons touch the title page. The session ends either after 60 seconds of inactivity (time-out) or when patrons select RESTART. In GOVA, RESTART appears on every screen except the title page. Some sessions could not be included in the analysis. There were 143 sessions that for some reason would not replay through the museum software. The last session for each day was excluded because of the effect of the museum closing and power being cut off from the machine. Because of an oversight, if the user started GOVA by touching the screen in a certain spot, the RESTART on the next page would be selected causing a very short unrepresentative session. This oversight eliminated 730 sessions from analysis. The following results are from the remaining 3561 sessions.

In the average session, patrons looked at 8.5 articles and referenced the index 1.3 times. Thus 6.6 articles were looked at per index reference. The average time per article was 16.4 seconds. The average session lasted 162.2 seconds (2.6 minutes). However 16% of the sessions restarted automatically after timing out (after no user activity for

60 seconds), so the time spent looking at the computer during the time-out period is uncertain. Assuming they spent the 16.4 seconds from the result above, we can include this value into those timed-out sessions and conclude that the average session lasted 165.9 seconds (See Figures 4-7 for histograms).

Of particular interest is the relatively infrequent use of the index. This can be attributed to the effective hypertext writing that encouraged using embedded references. GOVA was written from scratch for the hypertext format. Also, the index was long and arranged strictly alphabetically, not by topic. Patrons would have to have a very specific interest to use the index effectively.

Data on the number of accesses for each article were also compiled. Accesses were determined by two criteria: session accesses were the number of sessions that accessed the article. If an article was accessed several times by one session, it counted as only one session access. Total access counted every time the article was visited. In addition, these two criteria were further subdivided according to where the patron was when accessing the article. Three places were identified: any place, an article, and the index.

There were eight different measures computed for each article. Sorting on each of these measures showed interesting results. The articles embedded in the Introduction page topped the list that was sorted by session accesses from any place. One would expect this result since these are pragmatically the most accessible articles. There are two

TABLE 1. This table shows the top 20 articles sorted by the number of sessions that looked at each article. Underlined articles appear on the introductory page and could be accessed with one selection. A strong interest in the sites local to the Washington, DC are as shown in this list. All these numbers consider more than one visit during one session as one access.

	Number of sessions that accessed article	Accesses from another article	Accesses from index	Average time per visit (seconds)
Introduction	3561	483	259	31
<u>Index of Articles</u>	1802	1802	0	45
<u>Archaeological Projects</u>	1379	1213	310	21
<u>Volunteers</u>	1022	1004	31	24
<u>Costs</u>	773	737	45	28
<u>Age and Health Requirements</u>	658	390	303	26
<u>How to Join a Dig</u>	603	549	68	25
<u>Accommodations</u>	487	388	115	25
<u>MAP 9: The World</u>	447	431	30	27
Periods of the past	369	368	6	15
Local sites	334	327	11	14
Academic credit	329	215	132	13
Excavation season	321	306	18	13
Baltimore	304	148	216	23
Annapolis	293	135	189	24
Mediterranean sites	292	288	6	15
Sites in the U.S. and Canada	290	278	16	15
New World Sites	270	265	11	16
Biblical archaeology	262	220	52	19
Special skills	262	258	5	20

peculiar notes though. The article PRACTICAL QUESTIONS was by far the least popular article of this group, not even appearing with the others in the top 20. The MAP OF THE WORLD, ninth in overall popularity, was the second least popular of this group, which is surprising since patrons can get an overall view of archaeological digs around the world from this eye-pleasing graphic. It appears that it takes a reference with specific information to get the patron's attention. A user would rather read about ARCHAEOLOGICAL PROJECTS than read about PRACTICAL QUESTIONS (Table 1).

Sorting by session access from the index revealed that the index was too long. All the top 20 articles selected by this method started with 'a', 'b', or 'c' except HOW TO JOIN A DIG and a map showing LOCAL SITES. The strong interest in digs in the local area was shown by most of these sorted lists. Counting by total accesses did not generate results much different from session accesses.

Sorting by the total time spent in the article revealed that while the maps were not accessed relatively often, time was spent with them once they were found. This may be a distorted result since the time for the map to display itself on the screen was longer than for an article.

The total time spent in each article was determined. To better judge which articles caught the patron's attention, the total time for each article was divided by the number of sessions in which the article was actually inspected. Sorting by this result gave an entirely different view on the ar-

ticles. Certain articles obviously required indepth reading. While five maps made this top 20 list, the map of THE WORLD did not. Except for two articles that started with 'a' and 'c', embedded references were by far the preferred way to find these articles. For example, the article on the HELLENISTIC PERIOD was accessed 61 times from another article and only five times from the index (Table 2).

Conclusions

For Museum Exhibit Designers

This study demonstrates the feasibility of using interactive databases in conjunction with museum exhibits. Hyperties is not perfect and there is a great deal more to be done to understand how to make successful applications, but the central message is that computers can contribute to an exhibit by offering an engaging, interactive, and personal experience. While only a fraction of the visitors tried the computer, many of those that did succeeded in traversing the articles and index. This study also illustrates the wide differences in database use by different visitor populations in terms of topics selected and willingness to invest time. Exhibit designers can add a computer database to provide detailed information, vary the level of presentation, offer multiple languages, or permit patrons to explore vast databases.

TABLE 2. This table shows the top 20 articles sorted by the average number of seconds that each session that visited the article spent there. The authors conjecture that these are the articles that the patrons stopped to read. Except for articles that were located at the start of the index, these articles were mostly accessed from other articles. All these numbers consider more than one visit during one session as one access.

	Number of sessions that accessed article	Accesses from another article	Accesses from index	Average time per visit (seconds)
Nabataean fine ware	1	1	0	62
Index of articles	1802	1802	0	45
Map 1: Northern Israel	180	171	21	43
Tel Dor	18	15	3	41
Caesarea's harbor	32	16	18	37
Map 2: Southern Israel	136	120	19	34
Petra	49	40	10	33
Map 11: Local sites	162	130	46	32
Hellenistic period	64	61	5	32
Introduction	3561	483	259	31
Map 5: Britain and Ireland	157	145	24	31
Map 6: Europe	102	90	22	30
Ashkelon	68	24	58	30
Life on a dig	145	127	21	30
Mount Ebal	31	29	2	29
North Straiton	42	40	2	29
Published listings	200	194	10	28
Map 3: Middle East	152	137	28	28
Costs	773	737	45	28
Karnak	86	79	8	28

For Researchers Interested in Methodological Issues

Although log data was useful in creating some portrait of usage patterns, the direct observation and rapid iterative refinement led to the most dramatic increases in usability of our system in the museum environment. While the authors were tempted to proceed more slowly and make incremental changes while collecting data, this process would have taken many months. Dozens of changes were made in a few weeks and although no statistical data is available to confirm the conjectures, the authors feel quite confident that the system was dramatically improved by their efforts at the Smithsonian.

In future studies, the authors encourage more data collection about who the users were. Age, gender, interests, goals in using the computer, previous interests with the database topic, and previous experience with computers would be worthwhile information to correlate with usage patterns. Converse's recent study of a shopping mall directory (Converse et al., 1987), found that certain user groups (the elderly) avoided the system, and 20% of users failed to get the information they desired. Such statistics are important in evaluating the effectiveness of a computer system. A second important source of information is post-usage interviews to ascertain whether the users succeeded in retrieving desired information and to determine their subjective satisfaction with the search process. Observations in the third museum had a great effectiveness on improving the user interface and the structure of the database but were still insufficient to analyze search strategies. The authors cannot judge whether two or six minutes with the system is a successful use; only subjective comments can indicate attitudes. However, there now exists a baseline of usage data against which to judge future installations.

For User Interface Designers

The museum environment is very tough to design for since the users are so diverse and even 15 seconds of training may be unrealistic. The initial steps to take should be obvious to the patrons so that they become engaged and experience success. Then the user should be presented with concise information about the database contents, the metaphors for usage, and the syntax for action. The touch-

screen appears to be a convenient and reliable device and the take-off strategy is effective if care is taken to provide a comfortable physical installation, visible feedback about the current touch position, and reasonably sized targets. Instructions should be specific and results should be achieved with a small number of steps. The database structure does make a dramatic difference, and overviews in the form of a table of contents are necessary to complement a lengthy index. In spite of the best efforts in design, testing with real users is still necessary. However, testing need not be lengthy or burdensome. Four to six hours should be enough to give an indication of the problems and successes that patrons have as well as provide ample suggestions for improvement.

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