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IMPLEMENTATION FORMATIVE EVALUATION OF *EARTH OVER TIME* VIDEODISC EXHIBIT

Report for

Interactive Video Science Consortium

by
Barbara N. Flagg, Ed.D.

with the assistance of
Karen Hoelscher
Ilona Holland
Debra Slechta

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SUMMARY OF IMPLEMENTATION FORMATIVE EVALUATION OF *EARTH OVER TIME* VIDEODISC

Information was collected from museum visitors during the implementation of *Earth Over Time* in two consortium museums. The general goals of the research were (1) to understand who uses the disc, how it is used, and what is gained from its use; (2) to identify design changes necessary to improve appeal, accessibility, and comprehensibility of the videodisc; and (3) to generalize lessons learned to decision-making for future IVSC videodiscs.

METHOD

Earth Over Time was evaluated in the Boston Museum of Science and the Academy of Natural Science in Philadelphia on a weekday and two weekend days. The exhibit was set up temporarily in the Dinosaur Hall in both museums. Chairs were available to Philadelphia users. Visitors were automatically video and audiotaped while using or watching someone use the videodisc. After using the disc, a sample of visitors were interviewed briefly. Older respondents answered a short questionnaire about comprehensibility and appeal before being interviewed about user friendliness. Younger visitors were interviewed on these same issues.

SUMMARY RESULTS

Overall, visitors found the activities appealing, informative and easy to use.

Demographics. Adults were the largest user group, and 9-12 years olds were the next largest user category. Families comprised almost half of the total sample. Males and females both used the exhibit equally in the older age groups, but males significantly outnumbered females in youngsters under 12.

Infrequent Touchers. About half of the visitors either did not touch the screen at all while viewing the exhibit or touched it infrequently. Boston had significantly more people than Philadelphia who viewed without ever touching the exhibit. Parents in this group tended to watch over their children's use rather than interact with the exhibit themselves, whereas the youngest children were prevented physically by older siblings from frequently touching the screen.

Frequent Touchers. Family groups, who made frequent use of the touch screen, typically showed one child member taking control of the screen initially and then passing control to a parent or sibling. Most of those who had control over the exhibit throughout their experience were adults alone or in couples. One-fifth of the total user sample demonstrated an interesting pattern of touching the screen as they walked away from the exhibit, almost as if resetting the program or getting in a "last word."

Duration. The length of time users stayed at the exhibit ranged up to 30 minutes at both Boston and Philadelphia, but the distribution of durations at the two museums differed significantly. On average, Boston visitors used the disc for 3.4 minutes; in contrast, Philadelphia users, who could sit down, averaged 9.2 minutes at the exhibit. Half of the visitors in Boston stayed at the exhibit one minute or less, whereas half of the Philadelphia users stayed six minutes or less. Mothers with children under 9 maintained interest longest, and females of all ages tended to stay longer than their male counterparts. The interest of the target audience of 9-12 year olds was especially short when visiting in class groups. Preteens in family groups in Philadelphia maintained interest, but in Boston, their durations were shorter than average.

Durations within Activities. Visitors stayed within the six individual exhibit activities from less than 1 minute up to 13 minutes. Users maintained interest longest in the two complex activities of Save the Beach and Journey to the Sea Floor, averaging 3 minutes each.

Appeal of Activities. The favorite topic overall was Journey to the Sea Floor, particularly favored by adults. Although Continental Puzzle was not initially chosen by many users, those who experienced it enjoyed it. The Puzzle was the second favorite activity overall, and the favorite of teenagers and the 9-12 year old group. This was the least favorite activity for adults. Time Slider, Volcanoes & Earthquakes, and Hawaii were equally appealing to the interviewed visitors. Hawaii was the favorite topic for youngsters under nine. Save the Beach was the least appealing topic overall, and those most interested were adults.

Appealing Features. The youngest children, under nine, liked the ability to manipulate things on the screen and liked the activities because the information was understandable and related to previous interests. The target age group of 9-12 year olds gave similar reasons for liking the exhibit activities. The teenagers also mentioned manipulation of the continents and learning new information, particularly about volcanoes. Ranging in age from 20 to 72 years old, the adult visitors liked the presentations because they were understandable, informative, novel, timely, and built on previous interests. The manipulative aspect of the puzzle did not spark the interest of the adults as much as it did the children; however, the adults did appreciate activities that allowed control of one's choices and showed consequences of one's actions.

Learning. Children as young as 5 years old learned from this exhibit. The youngsters and young adults primarily focused on descriptive elements -- how things looked, how big they were, how high, how hot, and so forth. Both young children and adults abstracted the major objective of the exhibit, that the earth is always changing: "Learned that a lot of things have changed and pieces of earth have slided;" "The changes of land masses over time was new to me. Seeing continents move really brought it home."

Results on appeal, accessibility, and comprehensibility specific to the six individual activities are discussed in the body of this report.

SUMMARY RECOMMENDATIONS

Continental Puzzle

- Add audio directions after the first touch on the puzzle describing how to move the pieces successfully. Specific wording should be tested but a statement like the following might suffice: "Touch the center of the piece and drag it into position."

- If possible, reprogram so that Eurasia tends to slide up and over North America when users try to bump it into Africa.

- Address the issue of users accidentally touching the Time Slider button. Perhaps program to ignore a touch sequence from South America to Time Slider or move the time slider icon to the center of the bottom screen.

- Check on the problem of two simultaneous hits that cause a jump in the position of a continent. Perhaps the program could sense a continent that is extremely out of place and initiate a "start over." It is unclear how much of a problem this is in practice.

Shakes, Quakes, & Hot Spots

- The freezing of the picture at the end of a video was confusing to viewers. It is advisable to cycle back automatically to the submenu so that another choice can be made.

Save the Beach

- Users can touch telephone numbers in sequence (as if dialing a phone) without a resident's video appearing. The program should respond immediately to the first number touched so that "telephone play" is limited.

- Being able to repeat the phrase "dial his or her speed number" is an accidental discovery by users, but a circumstance that should be looked into.

- Increasing the attract loop time-out limit so that users have time to discuss choices during the simulation format before the attract loop cycles is low priority because it was a problem only once. On the other hand, an adjustment should be considered if economically feasible.

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INTRODUCTION

This formative evaluation collected information from museum visitors during the implementation of *Earth Over Time* in two consortium museums. Implementation formative evaluation can help developers to: (a) fine tune the program for the museum setting, and (b) feed forward into design criteria for future projects.

The general goals of this research project were to

- Gain an understanding of who uses the disc, how it is used, and what is gained from its use;
- Identify design changes necessary to improve appeal, accessibility, and comprehensibility of the videodisc; and
- Generalize lessons learned to decision-making for future IVSC videodiscs.

This report first presents usage, appeal, and learning results for the exhibit as a whole. Then the issues of appeal, accessibility, and comprehensibility are explored for each of the six topics: Continental Puzzle, Time Slider, Volcanoes & Earthquakes Around the World, Explore Hawaiian Volcanoes, Journey to the Sea Floor, and Save the Beach. Design recommendations, where appropriate, are associated with each topic; and general design lessons are discussed in the last section of the report.

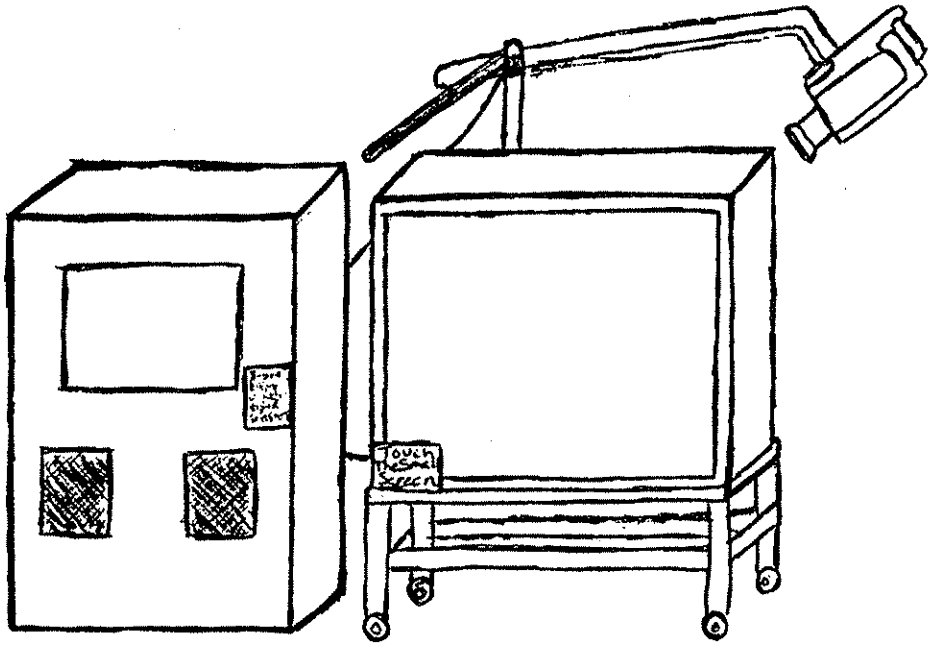
Vignettes from the data videotapes are presented in indented paragraphs, with direct quotations in italics.

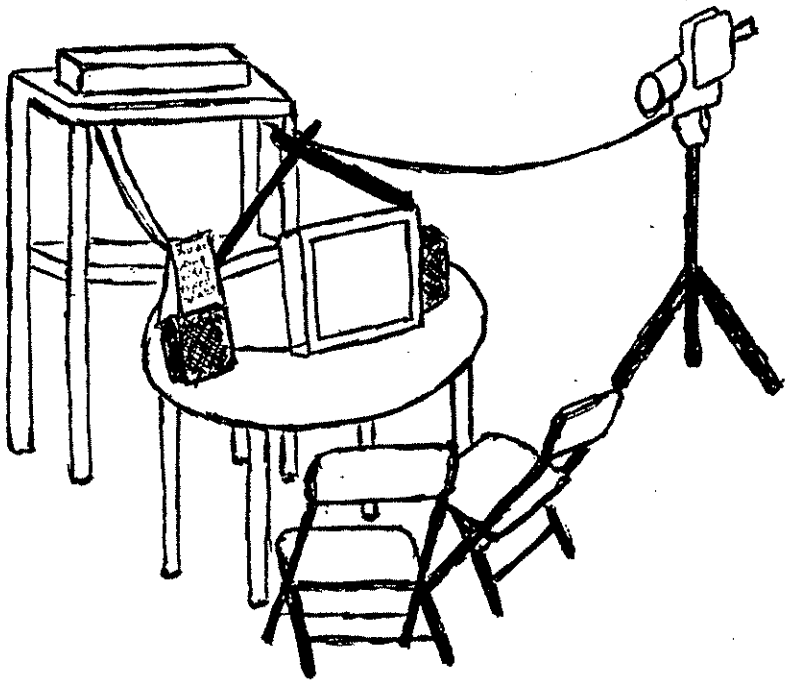
METHOD

Evaluation Sites

Earth Over Time was evaluated in two IVSC museums: Boston Museum of Science and Academy of Natural Sciences in Philadelphia. The Boston museum drew approximately 1.7 to over 2 million visitors per year over the past two years, whereas the attendance at Philadelphia is 400,000 per annum. Philadelphia is physically a much smaller museum with a smaller percentage of interactive exhibits. In neither museum was the videodisc set up in its final exhibit configuration or location. The program was placed temporarily in a corner of the dinosaur hall in both museums.

The equipment in Boston (see figure at right) was placed in a kiosk, with the center of a 13" color touch screen about 44" from the floor. Two audio speakers sat below the touch screen. A 25" repeater color screen was placed in a rack to the right of the touch screen with a sign and arrow saying "touch the small screen." A video camera and microphone were placed above and to the right of the repeater screen, angled so as to capture the verbal comments and facial expressions of the visitors at the two screens.





In Philadelphia (see figure at left), the 13" color touch screen with audio speakers at each side was set at the front of a round table, available to users who could sit down in two folding chairs. The remaining videodisc equipment was placed in full view on racks close to the table. A boom mike, positioned above the touch screen, recorded verbal comments. A videocamera on a tripod to the right of the equipment table recorded viewers' nonverbal responses.

In both museums, signs informed visitors that they were being videotaped so that the museum could improve the exhibit design. Responses to the videodisc of those who noticed the signs were not different qualitatively from those visitors who did not focus on the recording equipment.

Procedure

One female researcher worked at each museum in December, 1989 from 11 AM to 3 PM on a Weekday, a Saturday and a Sunday, according to the following schedule: Boston -- December 8, 9, 10; Philadelphia -- December 10, 11, 16. (A blizzard in Philadelphia forced a change of schedule there.)

Observation and self-report data were collected through three methods:

- Visitors were automatically video and audiotaped while using or watching someone use the videodisc.
- The computer automatically logged time and location of users' touches.
- After using the disc, a sample of users were interviewed briefly. Older users answered a short questionnaire about comprehensibility and appeal before being interviewed about user friendliness. Younger visitors did not respond to a questionnaire but were interviewed on the same issues.

Interviewed Sample

As users left the videodisc system, the researchers introduced themselves and asked for an interview. Few visitors refused to be interviewed. When researchers completed an interview, they waited for the current users to finish and then interviewed them. Thus, the sample was a non-systematically chosen volunteer group, intended to maximize the number of interviews. The demographic profile of the interviewed sample matches the videotaped user sample fairly well.

Interviews and questionnaires were analyzed for all three days for each site, for 62 visitors in Boston and 52 in Philadelphia. Males made up 54% of the interviewed sample, and minorities, 10%. At both sites, over half of the interviewed visitors were adults, one-third were pre-teens and younger, and one-tenth were teenagers.

Videotaped Sample

Videotapes were analyzed for one weekday and one weekend day (16 hours).

Of the 122 users on the weekday, about one-third were 9-12 year old class groups and one-third were families -- parents with children under nine years old. About one-fifth of the sample were teens in Boston in same-aged groups and pairs. Adult singles or couples made up 13% of the weekday's user sample.

Of the 135 users on the weekend day, two-thirds were families -- parents with children under twelve years old. About two-fifths of the sample were teens in Boston in same-aged groups and pairs. Single and paired adults accounted for 16% of the Sunday sample.

Videotaped Sample (continued)

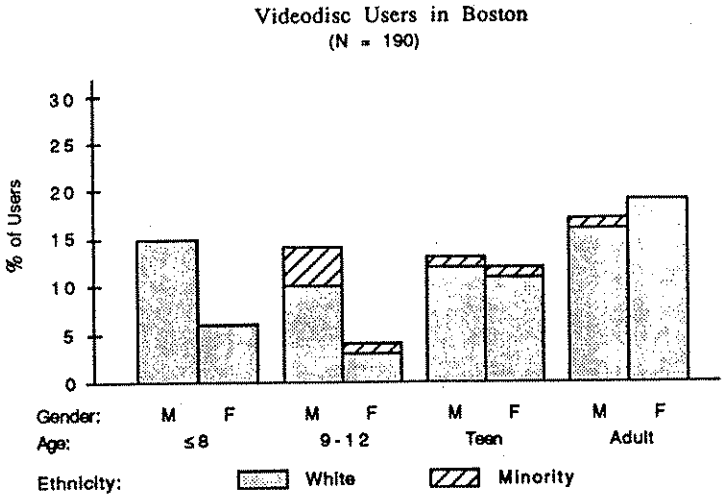
Number. Videotape analysis yielded 190 users in Boston (90, Friday; 100, Sunday) and 67 users in Philadelphia (32 Monday; 35, Sunday).

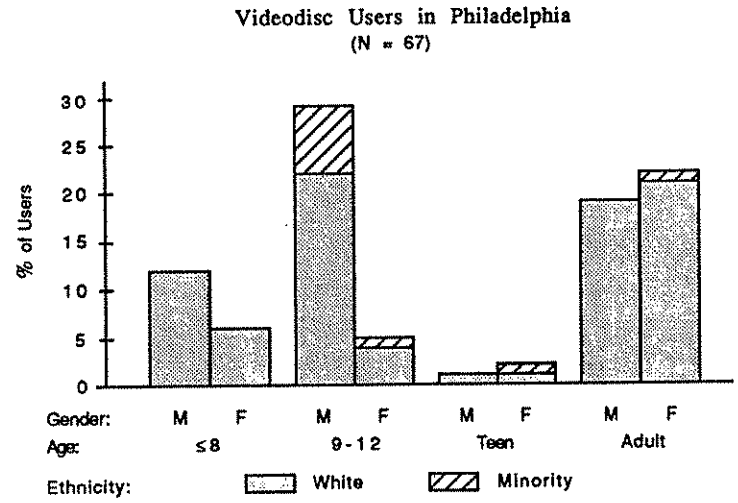
Age. Users ranged across all age groups, although teens comprised only 3% of the Philadelphia users, reflecting the lack of teenage visitors to the museum as a whole.

Adults were the major users in both museums (36% in Boston; 41% in Philadelphia). The next largest user group was teens in Boston (25%) and pre-teens in Philadelphia (34%). Pre-teens in Boston accounted for 18% of the users. The youngest visitors, 8 and under, made up about 20% of users at both museums.

Gender. Of the total sample, 59% were males. Females were users as often as males in the adult and teen categories. However, males dominated about 3 to 1 in the pre-teen group and 2 to 1 in the youngest group.

Ethnicity. Minority visitors (Black, Hispanic, Asian) comprised 9% of the Boston sample and 12% of the Philadelphia sample.





Analysis

Interview and questionnaire data were analyzed for all three days for each site, for a total of 114 visitors. The videotapes and computer touch logs for one weekday and one Sunday were coded for each museum; that is, sixteen hours of observation for a total of 257 users. The weekday and weekend data were combined for analysis and interpretation.

Participants' nonverbal behavior, verbal discussion, interview and questionnaire responses were examined to address the issues of

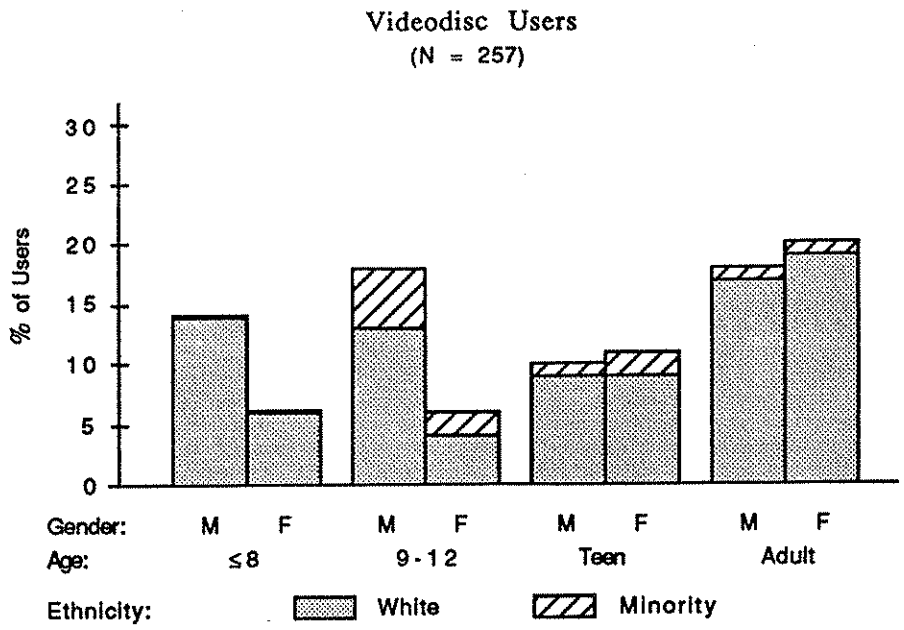
Usage	Who chooses to use the disc? What kinds of groups use the program? What types of touch patterns occur, by whom?
Appeal	How long is interest maintained? How often are topics and subsections of topics chosen? Who explores what topics in further detail? What activities and features of activities do users like and why?
Accessibility	Do visitors know how to start the program, how to operate it, and how to get around it? What activities are easy or difficult to use?
Comprehensibility	Which content is confusing? What do people say they learn from the experience?

OVERALL USAGE RESULTS

Who Chooses to Use *Earth Over Time*?

Users were defined as visitors who touched the screen, or if they did not touch, they watched the screen and other users for at least one minute.

The target audience specified by the design team was 9 to 12 year old children accompanied by classmates or their parents. These two groups were seen most often in the videotapes as users of the disc.



Adults were 37% of the whole user group, divided about equally between males and females.

The next largest user category (24%) was the 9-12 year olds, two-thirds of whom came in class groups. This category included 3 times as many males as females.

Teens counted for about one-fifth of the total user sample, with gender distributed equally.

Youngsters under nine made up the final one-fifth of the sample, and there were twice as many males as females in the youngest group.

What Type of Groups Use *Earth Over Time*?

Two-thirds of the videotaped user sample fit the target audience definition of family or class groups.

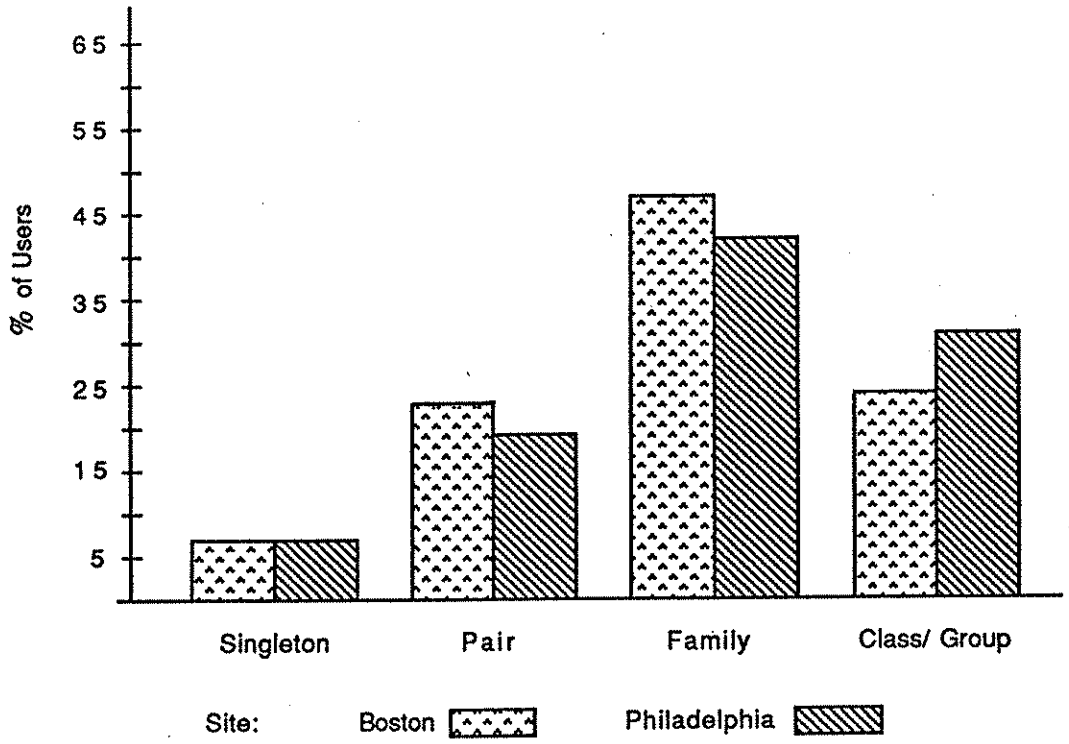
Families, defined as parent(s) and child(ren) at the exhibit, were the largest user category at both museums, comprising almost half of the total sample.

Classes of children and non-family groups made up the second largest category of users, accounting for one-quarter of the sample. The classes were exclusively 9-12 year olds with their teachers, and the non-family groups were teenagers at Boston.

Pairs were one-fifth of the sample, and teen pairs were half of this category.

The remaining 7% of the videotaped sample were single adult users.

Type of Group with which Users Visited
Boston (N = 190) and Philadelphia (N = 67) Museums



What Types of Touch Patterns Occur, By Whom?

Visitors were categorized as to their interaction with the program, depending upon how often and when they touched the exhibit:

- Did Not Touch: Users viewed for 1 minute or more but did not touch.
- Touched Infrequently, <5: Users touched less than 5 times, or users remained for a length of time, touching more than 5 times but much less frequently than those with them.
- Touch Control Early, then Relinquished: Users touched frequently then gave control to another, continuing to watch and occasionally touch.
- Coviewed First, then Acquired Touch Control: Visitors watched another use exhibit first, then touched frequently.
- Touch Control Throughout Experience: Users touched frequently and almost exclusively throughout their stay at the exhibit.

Non-touchers and Infrequent Touchers

In the top graph on the next page, consider the first two categories: Did Not Touch and Touched Infrequently, <5. About half of all visitors either did not touch the screen at all while viewing or touched it infrequently (20% and 29%). Boston had significantly more people than Philadelphia who watched without ever touching the exhibit. Family and class groups together comprised 75% and 81% of these two touch patterns, respectively. Some members of the family or class did not want to or were not allowed to touch the screen much.

In the bottom graph on the next page, the age breakdown of Did Not Touch and Touched Infrequently helps clarify the usage patterns revealed in the top graph and in the videotapes.

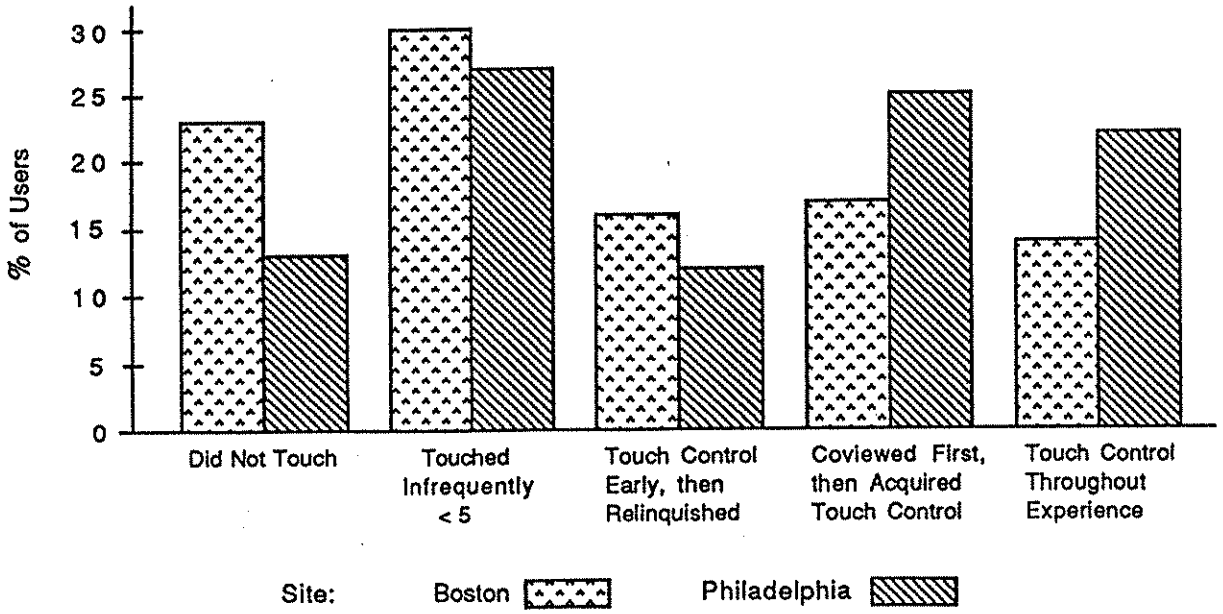
Parents tended to watch over their children's use, touching the screen few times, if any.

The 9-12 year olds in these categories, particularly class groups and particularly boys, tended to touch a few times and then move on to another exhibit. This age group rarely watched without touching.

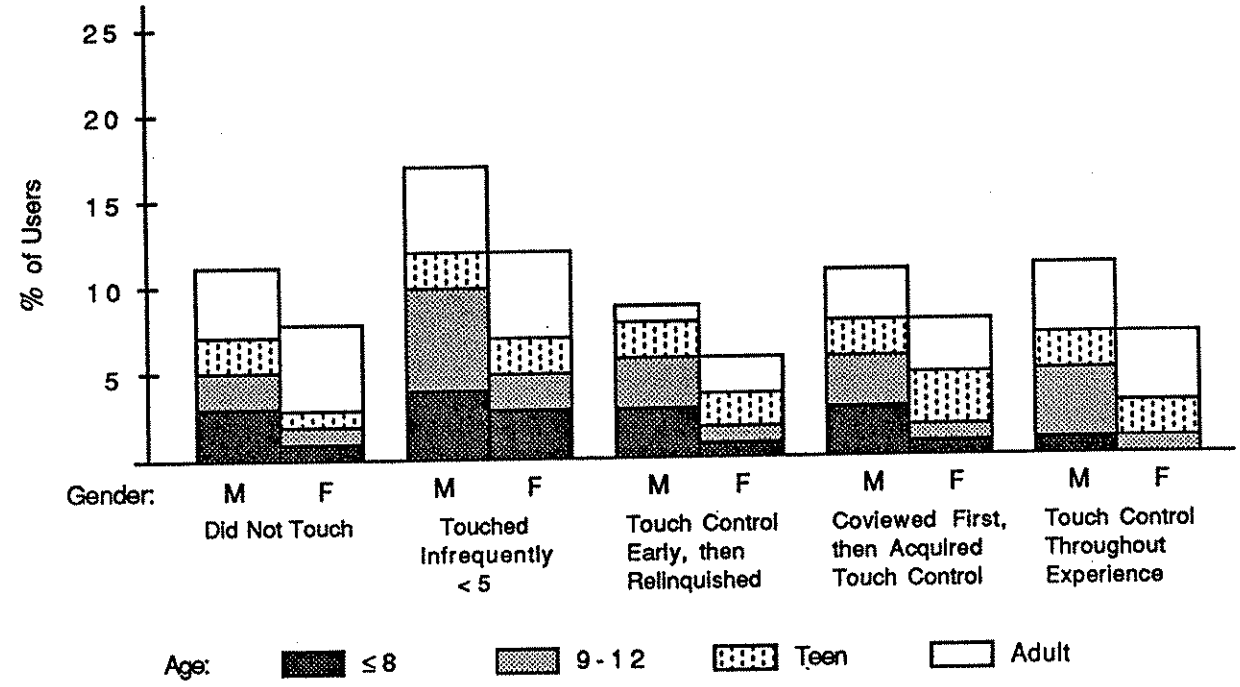
Some children in the 8 and under group were distracted after their initial touches, but many were prevented from touching often or at all by older siblings and occasionally parents. Users would hold other viewers' arms and hands or position their body and hands to cover the active touch areas.

> Younger sister touches Other Topics, while older sister is trying to see Sea Floor: *Oh, Becca! Now we have to start all over again. Next when they show you this big thing again, push the one on this side, not this side.* Older sister covers touch spots with hands. Dad: *Why are you covering it up like that?* Older sister: *Because I don't want her to push it.*

Type of Touch Pattern for Boston (N = 190)
and Philadelphia (N = 67) Users



Type of Touch Pattern by Gender and Age
(N = 257)



Frequent Touchers

Half of the total user sample fell into frequent-toucher user groups (see three righthand categories in top two graphs on next page).

The top graph on the next page shows that frequent touchers in Philadelphia were more likely to have control throughout their experience or to watch others first and then interact with the exhibit. In Boston, frequent touchers were split equally as to whether they held control at the beginning, end, or throughout their experience with the exhibit.

The middle graph on the next page describes the demographic distribution of frequent touchers. Of those who had touch control early, then relinquished control, 61% were children and adults in family groups who gave control to another family member. Another 26% were teens in pairs or groups, mainly in Boston, who turned control over to their partner.

About one-fifth of the total sample coviewed first, then acquired touch control. Over half of this category were children and parents who received control from family members. Parents tended to coview first rather than to take control first. Preteens in classes and teens in pairs and groups also gained control after a period of coviewing.

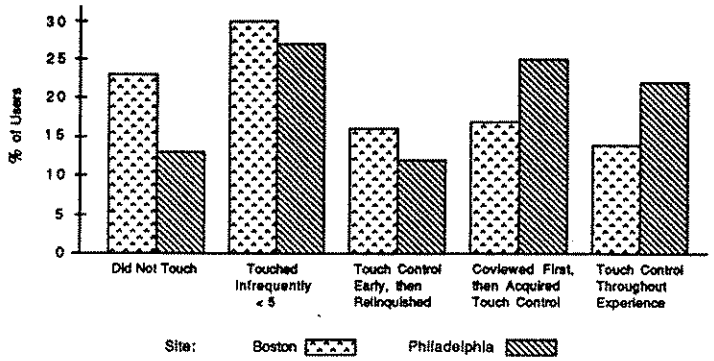
Of those who touched the exhibit initially and retained touch control throughout their experience, one-third were adults alone or in couples. Preteens in complete control in family and class groups accounted for one-quarter of this category, whereas another 16% were teens who controlled the screen while in a couple or group situation. Only 3 of the 50 children under 9 years old controlled the exhibit throughout their experience.

Touching Upon Leaving the Exhibit

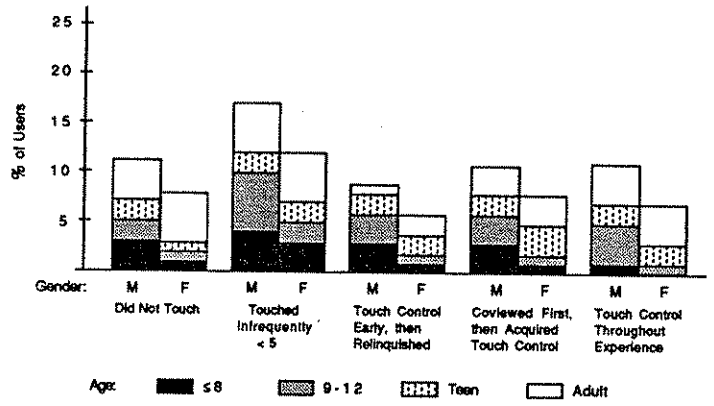
As shown in the bottom graph on the next page, one-fifth of the total user sample demonstrated an interesting pattern of touching the screen as they walked away from the exhibit. In some cases, it looked as if the user was resetting the program so that another could use it; in other cases, it looked as if the user was getting in a "last word." Two-thirds of the users touching the screen upon leaving were male; half were 9-12 year olds; three-quarters were family/class/group members, and one-fifth were minority.

This behavior is apparently not a random activity, because the demographics in the bottom graph differ significantly from the whole sample (compare with graph on p. 6). Those who touched the screen as they left the exhibit were more often male, more 9-12 year olds and fewer adults, more family/class/group members, and more often minority.

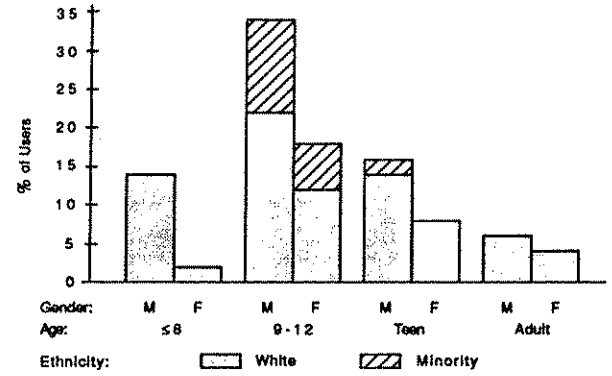
Type of Touch Pattern for Boston (N = 190)
and Philadelphia (N = 67) Users



Type of Touch Pattern by Gender and Age
(N = 257)



Touched Screen Upon Leaving System
(N = 51; 20% of Total Users)



OVERALL APPEAL RESULTS

How Long is Interest Maintained?

Time at the exhibit was recorded if visitors touched it or if they watched someone else for one minute or more, without touching it themselves. Duration of use began when a user approached the exhibit to touch or view it and ended when they walked away from the exhibit; if a visitor returned to use the exhibit again, their duration of use was extended. Thus, in the graphs on the next page, "length of time using videodisc" refers to each visitor's total amount of touching and viewing time.

Distribution of Duration at Sites

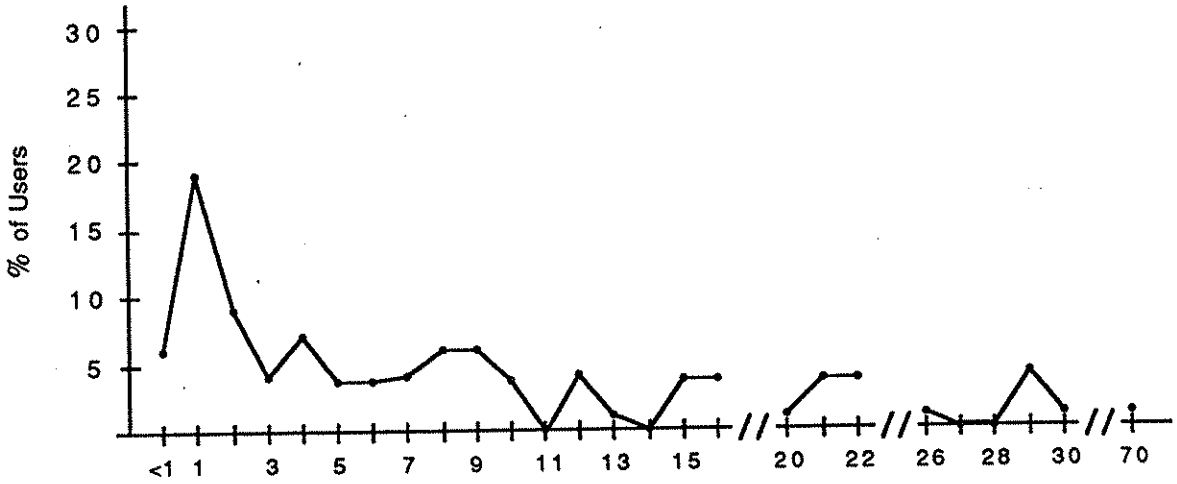
Half of the visitors in Boston stayed at the exhibit one minute or less, whereas half of the Philadelphia users stayed six minutes or less.

Durations at Boston ranged up to 31 minutes (a parent whose children returned several times). Durations at Philadelphia also ranged up to 30 minutes, with an outlier user at 70 minutes. (The latter was a museum volunteer who used the disc whenever the hall was free of visitors.)

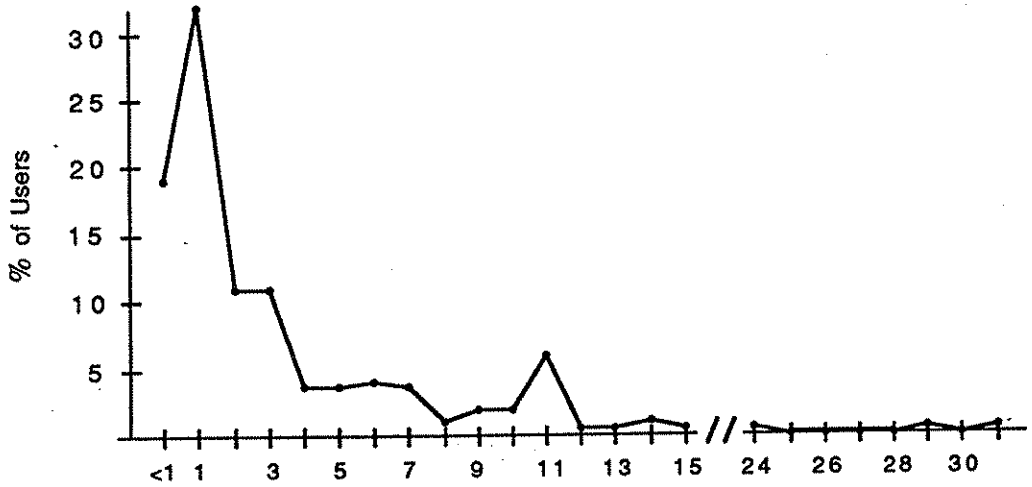
On average, Boston visitors used the disc for 3.4 minutes and Philadelphia visitors, 9.2 minutes. Excluding Philadelphia's outlier from the data yields an average duration of 8.3 minutes.

Having chairs at the exhibit apparently encouraged Philadelphia users to stay longer; although one could argue also that the Philadelphia museum had fewer distractions to attract users away from the exhibit.

Distribution of Length of Time
Using Videodisc in Philadelphia
(N = 67)



Distribution of Length of Time
Using Videodisc in Boston
(N = 190)



Average Durations for Demographic Subgroups

In the Boston graph to the right, the overall average duration with the exhibit was 3.4 minutes. The longest average durations were contributed by "White Female Adults" working with their "≤ 8 Year Old Children." The youngest boys and girls and the adult females interacted longer than average with the exhibit (5.1 and 4.1 minutes; respectively). Minority teens also showed a longer than average duration (6 mins.), but this group only included 5 visitors.

The 9-12 year old target audience stayed the shortest times, below the Boston site average. Boys and girls did not differ in duration, but there were differences in duration between family and class groups. Preteens in family groups averaged 3.2 minutes at the exhibit, whereas preteens in class groups averaged .81 minutes. Boston teachers made little effort to engage their classes' interest in the exhibit.

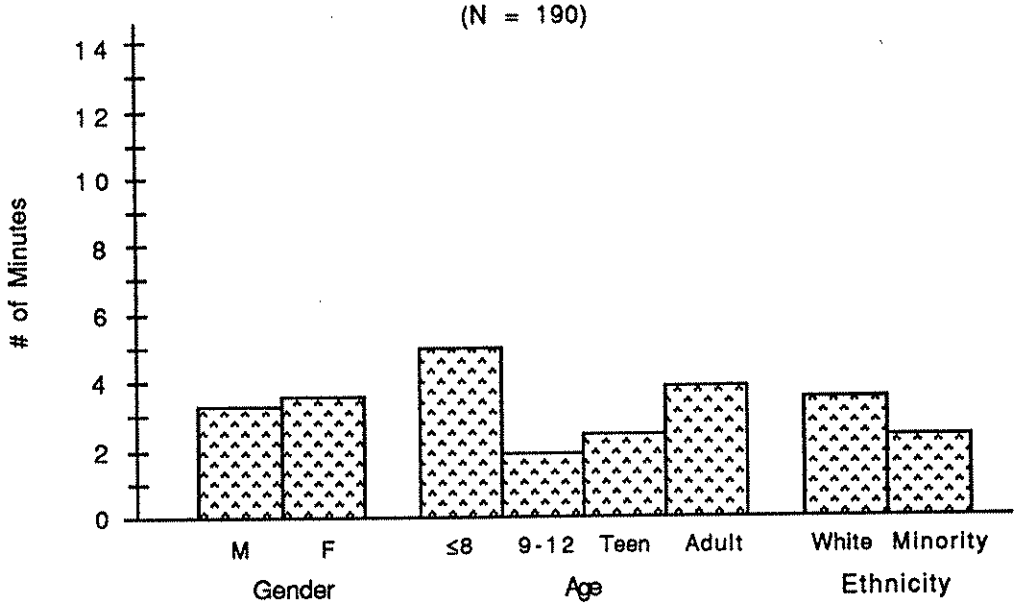
In the Philadelphia graph to the right, the outlier duration of 70 minutes by a museum volunteer was not included in the averages. The overall average duration was 8.3 minutes. Like Boston, the longest average durations in Philadelphia were contributed by "White Female Adults" working with their "≤ 8 Year Old Children." The adult females averaged 9.1 minutes. The youngest children averaged 11.2 minutes, with girls staying twice as long as boys.

Also like Boston, the 9-12 year old target audience in Philadelphia used the disc for short periods, but only the class groups. Preteens in family groups stayed at the exhibit longer than the site average (13.8 mins), whereas preteens in class groups stayed significantly below the average (5.1 mins). Teachers in the Philadelphia museum were more likely to participate with their students at the exhibit.

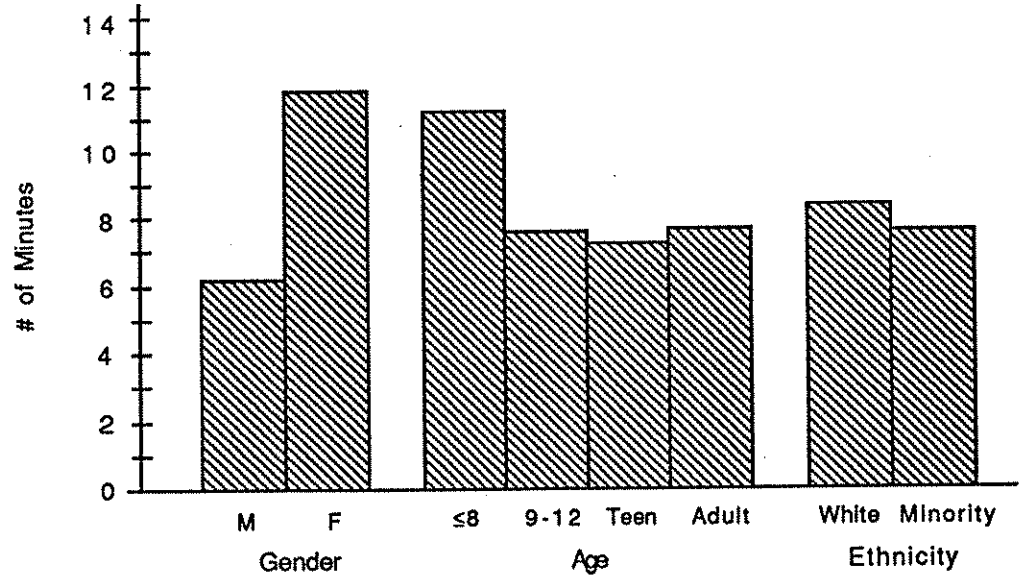
In summary, visitors stayed much longer at the Philadelphia exhibit, but usage patterns were similar at both sites. Mothers with children under 9 maintained interest longest, and females of all ages tended to stay longer than their male counterparts.

The interest of the target audience of 9-12 years old was especially short when visiting in class groups. Preteens in family groups in Philadelphia maintained interest, but in Boston, their durations were shorter than average.

Average Length of Time Users Stayed
With Videodisc in Boston
(N = 190)



Average Length of Time Users Stayed
With Videodisc in Philadelphia
(N = 67)

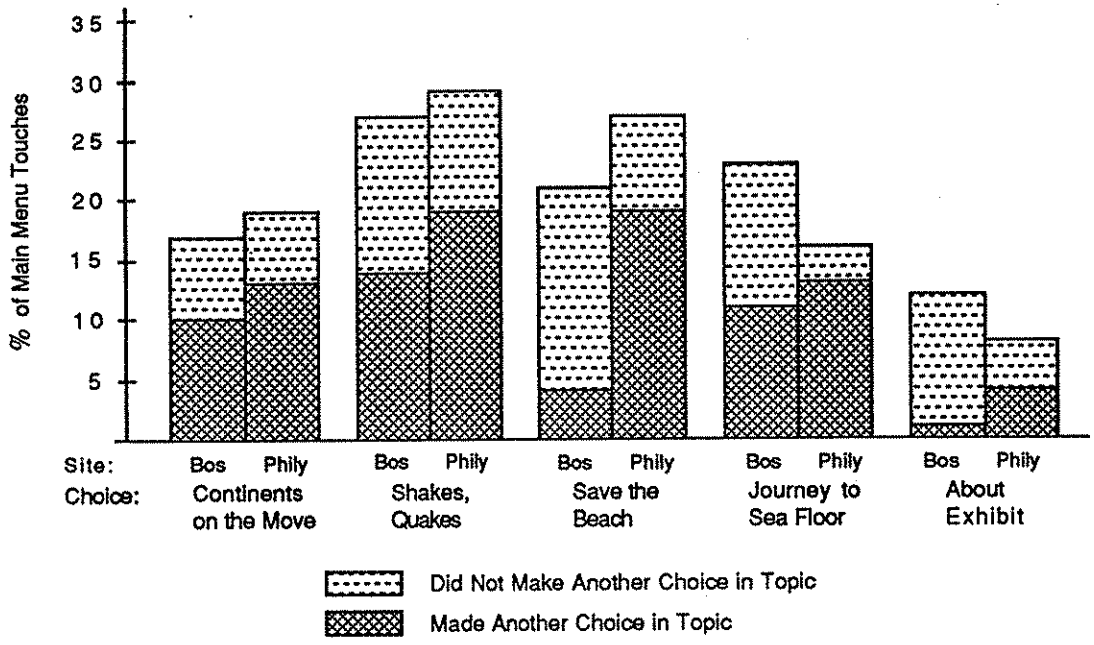


How Often are Main Topics and Subtopics Chosen?

Main topics. Over the analysis period of 16 hours, main menu choices were made 201 times. Most of these touches were intentional choices by a user, but 8% of the touches were made by visitors who interrupted other visitors' activities to choose a new main menu topic. The preference of main menu choices at each site was as follows:

Philadelphia	Boston
Shakes, Quakes, & Hot Spots	Shakes, Quakes, & Hot Spots
Save the Beach	Journey to the Sea Floor
Continents on the Move	Save the Beach
Journey to the Sea Floor	Continents on the Move
About Exhibit	About Exhibit

Distribution of Choices from Main Menu
for Boston and Philadelphia



The position of topics on the touch screen did not affect choice patterns. The most frequently chosen main menu topic at both sites was Shakes, Quakes, & Hot Spots, 28% of the time. This result replicates previous evaluations with paper screens that found that this topic was most appealing to respondents.

For the sites combined, the second most frequently chosen topic was Save the Beach, 24%, the third was Journey to the Sea Floor, 20%, and the fourth was Continents on the Move, 18%.

The topic chosen least often at both sites was About Exhibit, 10% of the time.

Subtopics. Not everyone who chose a main menu topic continued on in the activity by choosing a subtopic. On the average, users chose a subtopic 54% of the time (as indicated in the graph to the left by the crosshatch pattern). Philadelphia visitors continued into deeper levels 70% of the time, whereas Boston visitors went deeper only 44% of the time. Perhaps the inertia imposed by sitting at the exhibit affected Philadelphia viewers.

For first choice main menu topic -- Shakes, Quakes, & Hot Spots, visitors chose to pick from the subtopics 57% of the time. In contrast, the next preferred main menu choice of Save the Beach lost over half of its appeal during the news video introduction or at the time that the Make a Call menu appeared; viewers continued with selections from this menu only 43% of the time. Viewers in Philadelphia pursued this topic significantly more often than viewers in Boston (71% vs 19%), perhaps because Phily viewers could sit down they were more willing to make a time commitment to a simulation.

More than half of the time visitors chose from the submenus of Continents on the Move (61%) and Journey to the Sea Floor (59%). Compared to Boston, Philadelphia visitors were slightly more likely to continue with the first topic and twice as likely to continue with the second topic.

About Exhibit has no submenu. The graph's crosshatched pattern refers to those who looked at the credits before making another main menu choice.

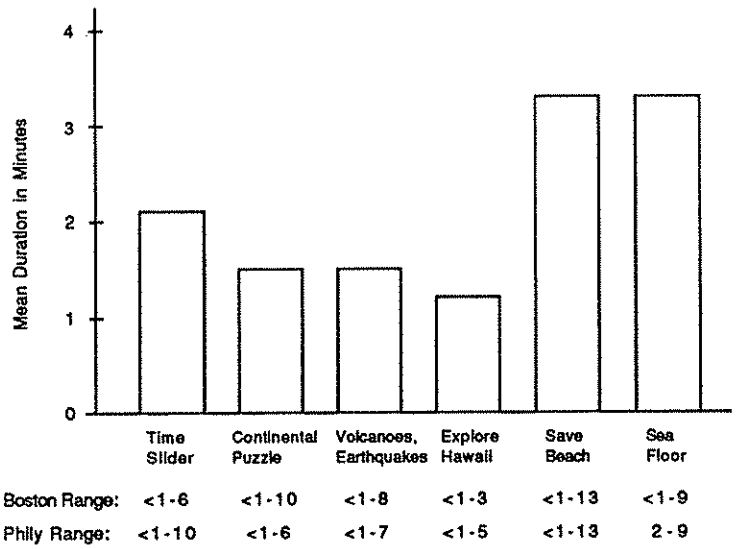
How Long do Subtopics Maintain Interest?

Users stayed longest in two activities. Mean durations were slightly over 3 minutes for Save the Beach and Journey to the Sea Floor. This result might be expected because these activities are the most complex of the videodisc.

Visitors spent slightly over 2 minutes, on average, looking at Time Slider, and an average of 1.5 minutes, playing Continental Puzzle and Volcanoes, Earthquakes. Explore Hawaii elicited short stays of slightly over 1 minute, on average.

The range of durations for the subtopics was similar for the two museums, from less than 1 minute to 13 minutes.

Mean Duration of Use



What Subtopics were Most Appealing?

Visitors were interviewed after using the exhibit (N = 114) and asked which topic that they saw was their favorite. Approximately equal numbers of people used each of the six topics.

The favorite topic overall, chosen by 21% of the interviewed visitors, was Journey to the Sea Floor. In particular, adults favored the Sea Floor.

Although Continental Puzzle was not initially touched by many users, those who experienced it enjoyed it. The Puzzle was the second favorite activity overall, and the favorite of teenagers and the 9-12 year old group. This was the least favorite activity for adults.

Time Slider, Volcanoes & Earthquakes, and Hawaii were equally appealing to the interviewed visitors. Hawaii was the most favorite topic for youngsters under nine.

Save the Beach, although the second most frequently touched topic off the main menu, was the least appealing topic overall with 12% of the interviewed visitors choosing it as their favorite. Those most interested were adults.

Appealing Features

Users were asked what they liked and what they learned. Summaries of their answers and representative quotes are presented in the following pages, according to age groups. Discussion of appeal and comprehensibility specific to the six subtopics appears later in the report under each subtopic heading.

Under nine. The youngest group liked the ability to manipulate parts:

-- *you could move your fingers into the place and the continents moved.*
-- *putting the earth together with my fingers.*

They also liked the activities because the information was understandable and matched and/or elaborated a previous interest:

-- *it told me how the earth was in prehistoric times. I am interested in that time.*

The visuals were also exciting to this age, particularly volcanoes:

-- *I liked the flooding part, the red flooding.*

Preteen. Like the younger group, the target age group of 9 to 12 year olds also liked the activities because they could manipulate parts and because they learned something new or expanded a previous interest:

> *I liked sliding the lever.*
> *I liked to move the pieces to figure out how they fit.*
> *On TV you can't do what you want. I could look at the sea floor closely here.*
> *I like the interaction with people, the creativity and seeing the results of our actions.* [Beach]

> *You could see how continents moved from year to year.*
> *I didn't know about the San Andreas Fault. I never knew gas leaked in San Francisco.*

Teen. The teenagers also mentioned the manipulation of the continents and learning new information about volcanoes, in particular:

It was neat putting the continents together.
I learned that lava is very hot and that when it hits cold water what happens.

Adult. Ranging in age from 20 to 72 years old, the adults liked the presentations because they were understandable, informative, novel, timely and/or built on a previous interest:

Very graphic. Easy to understand. Explained well.
Great idea! Taught social and scientific methods of information gathering. Taught that environmental problems are frequently community issues.
The topic is brand new and up to date. [Sea Floor]
I worked on the pipes for sand dredging in Ocean City. I liked this because it relates to my work. I've wondered if I've been doing the right thing.

"Impressed" was the adjective most used by the adults about the visuals of Volcanoes and Hawaii:

I liked the visuals. I was impressed by the awesomeness of the volcanoes.
I was impressed by the photography . . .

The manipulative aspect of the puzzle did not spark the interest of the adults as much as it did the children; however, the adults did appreciate activities that allowed control of one's choices and showed consequences of one's actions:

I liked the ability to switch from topic to topic to learn what I wanted to know.
I liked that the viewer has choices and gets to move on if dissatisfied.
I liked to re-read and re-think what I'm learning as I do it.
I liked the tools, that you could cut off a piece and dissect the animal.
I liked seeing the consequences of our actions -- could see the best case and worst case scenarios. I liked being able to select my own solutions.

OVERALL LEARNING

Under nine. Children as young as 5 years old learned from this exhibit. The youngsters under nine primarily focused on descriptive elements -- how things looked, how big they were, how high, how hot, and so forth.

I learned about mussels. How big clams could get.
There are giant worms.
Lava can go over land.
Volcanoes are dangerous because lava is really hot.
Learned how high lava could spit out and how far ashes could go.

Some of the young children even abstracted the major objective of the exhibit, that the earth is always changing:

Learned that a lot of things have changed and pieces of earth have slided.
The earth has been changing.
Earthquakes are still going on.
How the city was changing. [Beach]

Preteen. The target age group, 9-12 years, also remarked generally on the changing earth when asked what they learned from their experience:

How earth moves.
The world wasn't always the way it is now.
How volcanoes and earthquakes are formed and change.
How Hawaii was formed and continues to change.
Beaches are getting ruined and we have to do something about it.

Most of the preteens remembered specific factual information (not always accurately):

Heat of lava is about 175 degrees F.
Temperatures could reach 1,500 - 2,000 degrees F.
The lava was 100 something F.
Not all volcanoes run down through everything -they spurt up and go right back.
Learned about plants, chemicals, pressure, and animals. How strange that they could live down there.
Didn't know that we can't catch tube worms cause they go back. Didn't know they were that long and that they had no digestive system.
Learned that some sea animals could live on chemicals.

The focus of their experience for many preteens was on the action or process, learning from play and exploration:

Could move pieces and put continents together.
How Pangea fit together.
Learned about calling and seeing how they were acting.
Pick a number and hear what they say.
Didn't learn anything. Had fun pushing the buttons.
Just playing. Didn't really learn.

Teen. The very few teenagers that were in the interviewed sample also concentrated on specific facts when asked what they learned:

That volcanoes can reach 2000 degrees F and that when they hit water they turn to rock.

Adult. Even the adults came away with a new or reaffirmed concept that earth is constantly changing:

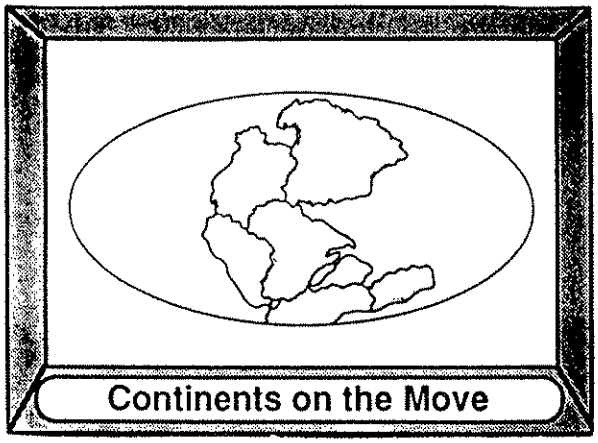
The world's more flexible than I thought. Continents move.
The changes of land masses over time was new to me. Seeing continents move really brought it home. Himalayas, Alps still growing!
I didn't know about active volcano under sea. Earth's floor still being formed.
Volcanic action occurs on edge of continents. Earthquakes and volcanic action are closely related. Mountain ranges continue to grow because of land movement.
Beach still moving.

Adults were less likely to mention specific facts that they learned but more likely to recognize that their previously vague knowledge was clarified or enhanced:

I knew this information but I had never seen the way it fit together.
[Slider]
I got a better idea of when different life forms appeared.
Before doing the puzzle, I didn't have a clue about how they fit.
I've seen some of this before. Learned about tube worms, clams -- didn't know clams got so big.
Some I knew -- but it made the formation of Hawaiian Islands more specific.
I knew much of this but learned the details of what works and what doesn't.
[Beach]

CONTINENTS ON THE MOVE

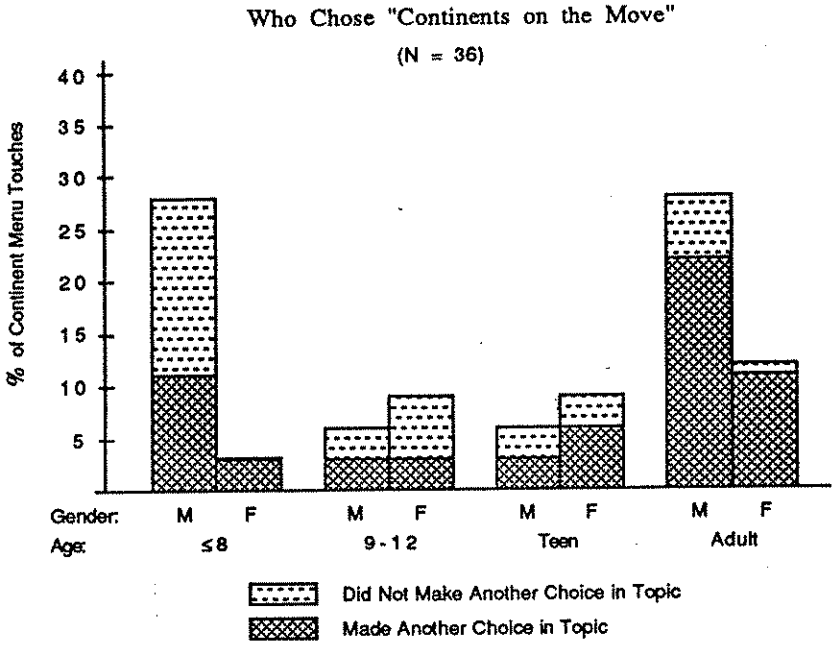
This main menu choice features plate tectonics activities.



Appeal

Of the five main menu choices, Continents on the Move was chosen 18% of the time and ranked fourth in frequency of choice from the main menu.

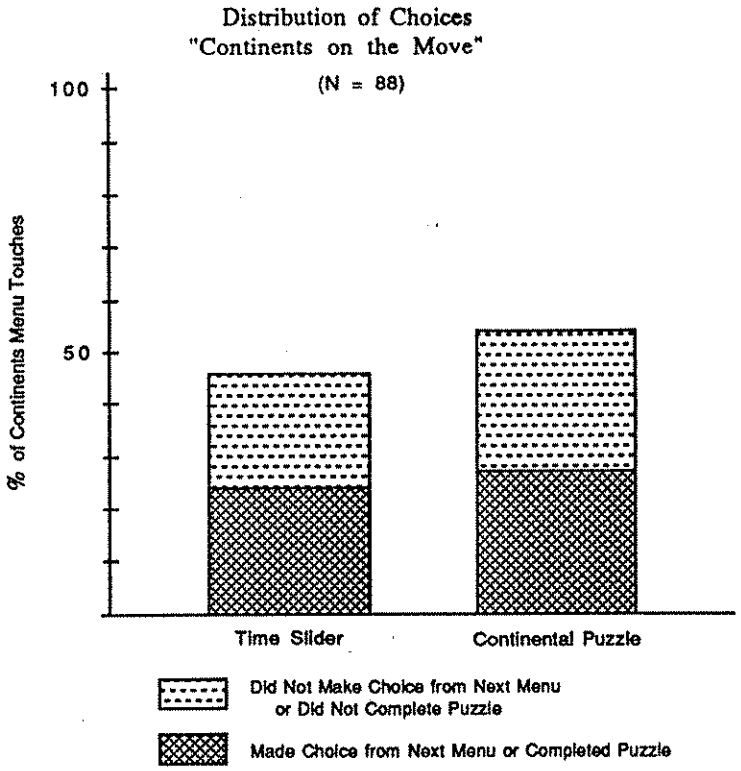
The most frequent choosers of this menu topic were boys under nine years old and male adults. Users were given two activity choices in the submenu for Continents on the Move. The majority of users (61%) went on to choose a subtopic, with females slightly more likely than males to pursue a choice.



Time Slider and Continental Puzzle were chosen via the submenu, or users could chose Slider from the Puzzle screen and vice versa by touching the activity button at the bottom of the screen. From the Continents on the Move submenu, 22 choices were made directly, but an additional 66 switchover choices were made from the activity screens. Users tended to go back and forth within a main category before choosing "Other Topics."

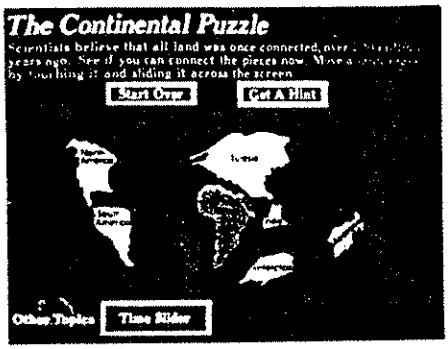
Of the two activities, Continental Puzzle was chosen slightly more often. Over half of the choices were for Continental Puzzle.

Half of the Puzzle and Slider choices were followed by final completion of the Puzzle or a further choice in the Time Slider activity. Otherwise, users made another main activity choice or left the exhibit.



CONTINENTAL PUZZLE

In Continental Puzzle, users are challenged to fit earth's land masses together into one supercontinent as they were 200 million years ago. The "Get A Hint" button provides an outline of the assembled supercontinent, and the "Start Over" button moves the land masses to their beginning positions.



Appeal

> Boy, under 9: *I want to do it again.*
> Mom: *Ok.*
> Boy, moving continents himself, touches one and asks: *Where?*
> Mom: *I don't remember. You did that so easily the first time. Seems like it should be farther down. Maybe on that little hump that you just passed. See that little hump for Antarctica and India to fit together. There you go!*
> Puzzle completed, and son turns to smile very happily at his mom who gives him a hug and kiss.

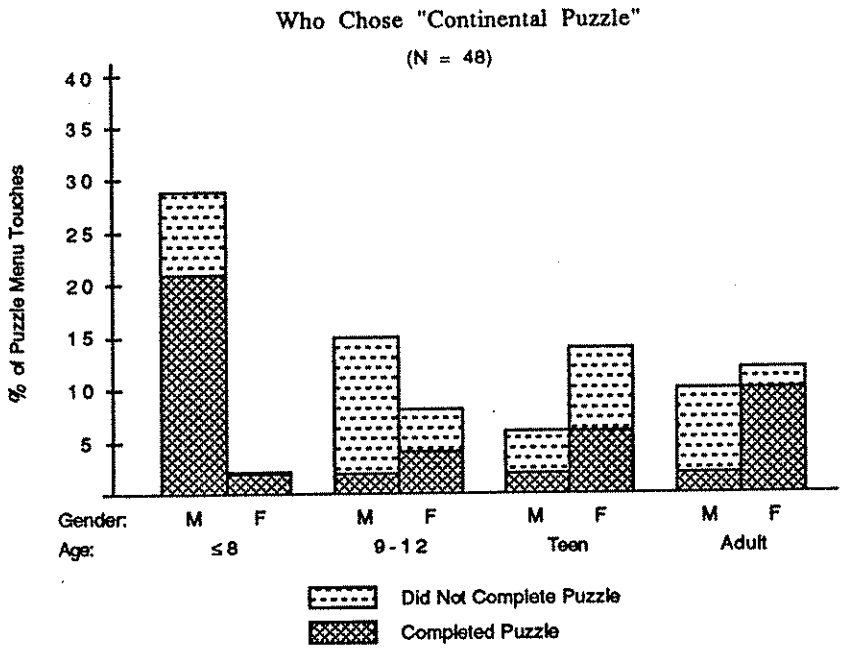
As occurred with the paper mockup puzzles in the previous formative evaluations, groups were pleased to know when they got a piece correctly placed and they seemed quite self-satisfied when the puzzle was complete, congratulating each other.

With an average stay of 1.5 minutes at the Continental Puzzle, visitors' durations within this activity ranged from less than 1 minute up to 10 minutes for users playing several times.

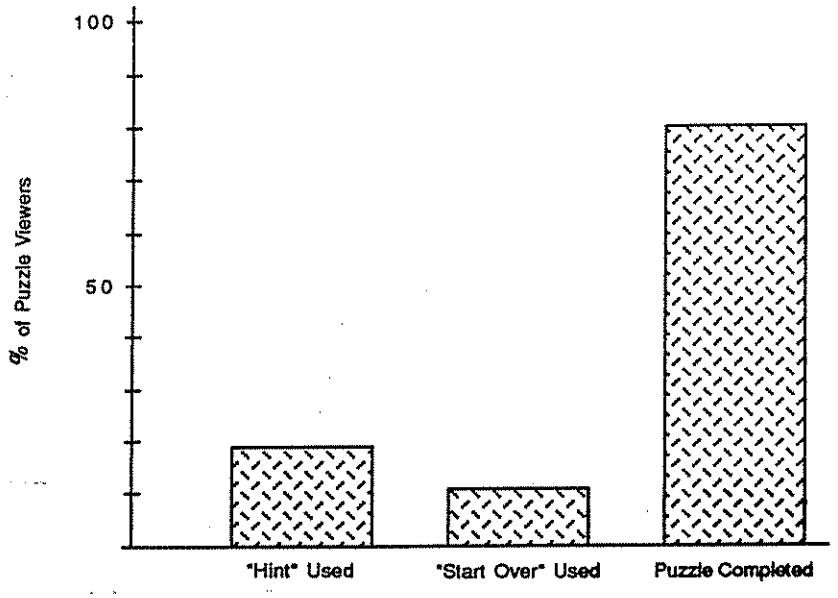
The Puzzle was the second favorite activity according to the interviewed users, and it was the favorite of teenagers and the 9-12 year old group. Adults listed this activity as their least favorite.

The most frequent initial choosers of the Continental Puzzle were boys under twelve years old and teen females. Teen females chose this topic more often than other activities' subtopics. Of the 48 starting touches on the Puzzle, half did not continue to completion for a variety of reasons: switching to another activity, interruption by another user, or drawn away by family.

Only 10% of the users were actually unable to complete the puzzle. Of those who initially chose the activity, boys and girls under nine and adult females (usually Mom and kid) tended to complete the puzzle, whereas older males were much less likely to pursue the activity to its completion.



The initial choosers of the puzzle activity were usually joined in solving it by other family or group members. The solution was a cooperative activity either in touching puzzle pieces and the "hint" button or in verbal coaching.



Of the 87 viewer/users, 80% participated in a completed puzzle.

The "Get A Hint" button was touched by 19% of these viewers from 1 to 11 times in the process of working the puzzle. Boys under 9, teenage females, and adult females used the hint most.

The "Start Over" button was used by 11% of the Puzzle viewers from 1 to 7 times. Typically boys under 9, and preteen and teenage females would start the puzzle over again.

All users liked to manipulate the land mass pieces:

> *Fun to fit the continents together.*
> *I did this five or six times. I thought it was fun and easy.*
> *I liked the ability to move continents yourself.*

Accessibility

Everyone wanted a finger on the puzzle, sometimes creating havoc but sometimes creating a pleasant cooperative family experience:

> Family group:
> Dad: *What's this? OK. You want to try. Let's try to do it.*
> Girl and Boy, about 8 start to move pieces.
> Girl: *That's correct. That's correct.*
> Boy: *Yes, right up there. This little one, right up there.*
> Dad: *Ok. Now take Africa. No, Africa doesn't move. Now you want to move this, right in there. Now move this.*
> Boy: *Right.*
> Dad: *Right in there. Eurasia, down, right, up, up, now down here. Now India. China, there. Antarctica, right in there. Australia, in there. That's it. Now, Australia, right in there.*
> Dad wants to move pieces, but Boy does too.
> Dad: *Oh, maybe it's over here at the top. Good work, over here. That's it!*

Three-quarters of the users were eventually successful in manipulating the pieces correctly. As described in the example below, many started out using an unsuccessful touch technique, but they either adjusted their strategy until the pieces moved or imitated someone else's successful approach. Some users persisted in their unsuccessful strategy and gave up. There was a tendency to touch the screen too lightly and to lift one's finger when the piece did not move as expected.

> Preteen class group with female black teacher, black boy (#1), white boy (#2), and a black girl (#3).
> Teacher: *See if you can connect the pieces now. Try to connect them.*
> Teacher touches screen.
> #2: *Oh.* Girl and boy try to move pieces without response.
> #3: *This ain't working.*
> #2: *Let's try. . .*
> #1: *This one.* #1 successfully moves piece and all work on solution.
> #2: *There, move that. Come on, flip around.*
> #1: *It don't go that way.* Two boys moving pieces.
> Teacher: *Try going around North America*, referring to Eurasia piece.
> #3: *Go up.* Girl tries moving piece along with boys.
> Teacher: *One of you.*
> #1: *Yeah, put that right here.* Doesn't touch screen.
> #3: *Go up.* Girl takes over moving piece.
> #1: *Now bring that over here.* #1 points to spot.
> #3: *See, it don't fit.* #2 moves piece into place.
> #2: *Miss Smith, we did it!* Jumps up and raises arms in victory.

As noted in the vignette above, moving Eurasia, in particular, gave people difficulty because they tried to move it across another continent instead of pushing it up and over North America.

While moving South America, people frequently let their finger slide into the Time Slider button, thus jumping to another topic in the middle of solving the puzzle. Everyone was taken by surprise when this happened, although most found their way back to the puzzle. Hitting Time Slider tended to happen more than once in a session, as shown in the example below:

> Adult Female moves continents: *It won't let you be perverse and stick them in the wrong places.*
> Adult Male pushes South America down and lets finger slide onto the Time Slider button so that Time Slider appears on screen.
> Female: *No. Why'd it do that? That's not nice.* Touches Puzzle button and then Start Over button twice in an apparent effort to make game start. Male slides onto Time Slider button again.
> Female: *Maybe it has to cycle all the way through?*

Finally, there was a problem of two people touching at the same time which apparently resulted in a continent jumping to a different side. Or occasionally children would touch with a thumb and forefinger and the piece would jump between the two touches. The frequency of this occurring could not be determined from the data.

Most of what children said they learned from the Puzzle activity was *what Pangea actually looked like.* The older children and adults brought in the idea of movement and the process of the continents rearranging -- *how continents fit together before they separated from each other.*

Recommendations

- Add audio directions after the first touch on the puzzle describing how to move the pieces successfully. Specific wording should be tested but a statement like the following might suffice: "Touch the center of the piece and drag it into position."

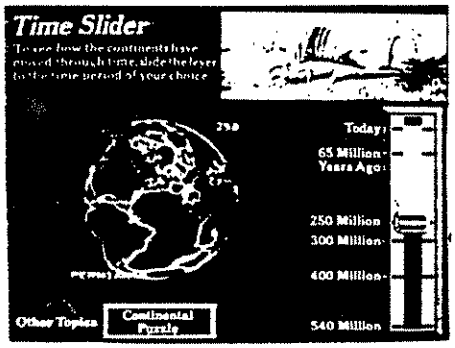
- If possible, reprogram so that Eurasia tends to slide up and over North America when users try to bump it into Africa.

- Address the issue of users accidentally touching the Time Slider button. Perhaps program to ignore a touch sequence from South America to Time Slider or move the time slider icon to the center of the bottom screen.

- Check on the problem of two simultaneous hits that cause a jump in the position of a continent. Perhaps the program could sense a continent that is extremely out of place and initiate a "start over." It is unclear how much of a problem this is in practice.

TIME SLIDER

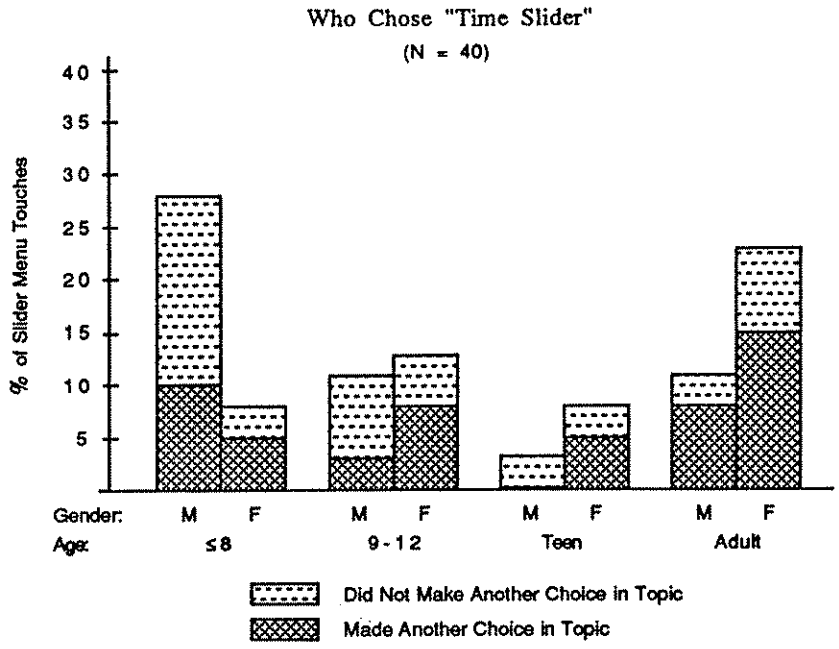
In Time Slider, visitors move a slider icon to one of six different time periods and view a video animation of the movement of earth's land masses. After the video freezes on a view of the globe at the time period chosen, audio and changing still visuals are employed to depict earth's flora, fauna, climate, and geological appearance.



Appeal

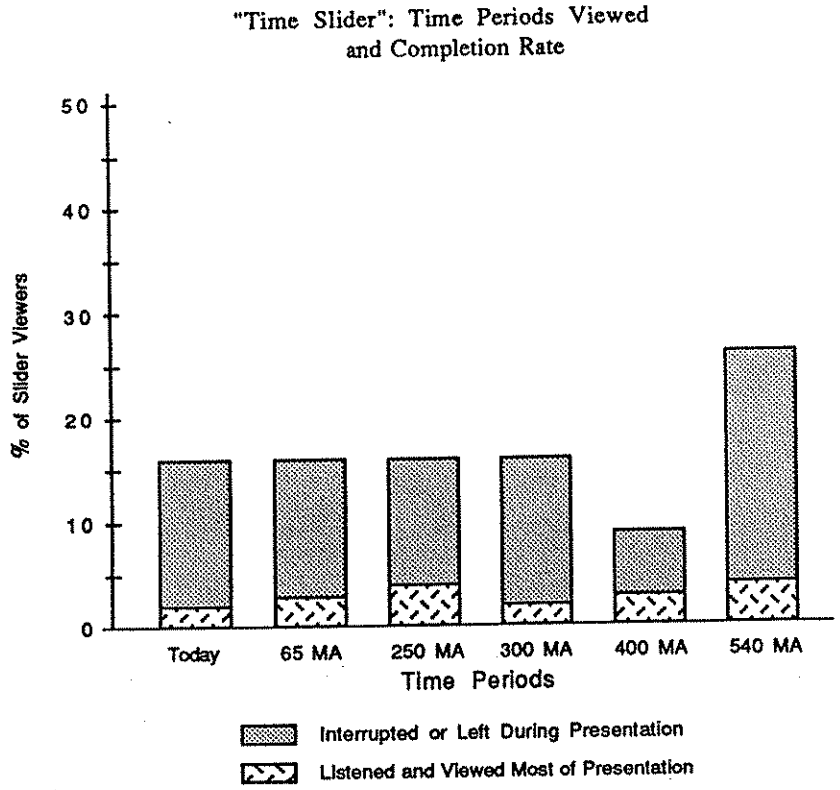
> Dad watches and comments as his under-nine year old son chooses 250 MA: *Look how the earth moves. 250 million years ago - That's what the earth looked like. Look. It's incredible! Look at this. . .* (audio begins) *This is great!*

The most frequent initial choosers of Time Slider were boys under nine years old and adult females. Females, 9-12 years old, chose this topic more often than other activities' subtopics. Of the 40 touches picking Slider, half went on to make a choice. Often the youngest children were interrupted by another user before they could choose. Of those who initially chose the activity, females of all ages were more likely than males to pursue a choice with the slider.



With an average stay of slightly over 2 minutes, visitors' durations within this activity ranged from less than 1 minute to 10 minutes.

The time period of 540 million years ago was chosen significantly more often by viewers of Time Slider. People typically pulled the slider down the whole way initially. This strategy was similar to that used by groups responding tothe paper mockup in the detailed design evaluation (June, 1989). Only 18% of viewers watched or listened to most of the audio-video segments. The tendency was to view the dynamic video of the land masses moving and then to move the slider to another period and watch the video again. If the audio actually began, it was listened to for a short period and then interrupted.



Adult females and boys under nine were most likely to listen to most of the presentation.

Accessibility

The tendency, as with the Continental Puzzle, was to touch too lightly and quickly so that contact was lost while sliding the lever; however, most people figured out how to use the slider successfully. Occasionally visitors would touch the cross bars instead of sliding the lever.

Comprehensibility

> Adult woman calls to her partner who joins her in front of Time Slider.
> Woman: *This is pretty neat, Bill. This is pretty neat. Touch the screen to slide, to move things around.*
> Woman adjusts slider to 450 MA which begins.
> Man: *Oh, Okay.*
> Woman, watching: *OK, now we've got the separation of Laurasia and Gondwanaland.*
> Man, interrupts audio: *Let's put it . . . No, let's start at the beginning.*
> They watch video and cut off audio to move slider again to top.
> Man: *Let's see them all go through the motion.*
> Woman: *This is interesting cuz I really thought that you had the one continent at the beginning rather than the multiple. . .*
> Man: *They moved around.*
> Woman: *. . rather than a number of different subcontinents at the beginning that moved all together at one time.*
> Man: *They whirl around through quite a song and dance.*
> They interrupt audio to move slider full length again.
> Woman: *It doesn't show you Asia crashing into India and a lot of interesting stuff is happening on the other side. . . .*

In the evaluation of the detailed design paper and videotape version of Time Slider (June, 1989), it was predicted that the audio sequences would not hold one-third of the museum audience. As it turned out in this evaluation, the audio did not attract and hold the attention of more than 80% of the viewers, so that learning was limited to the dynamic video of the continents rather than expanded by the rich audio script. The novelty of the slider interactivity and the whirling continents apparently entranced visitors, so that learning more about earth's past from the narration became secondary to feedback resulting from user activity.

Those who concentrated on the video remembered the changing face of the earth over time: *Continents were close together and they moved away and then back. How Pangea looked while being formed.*

Those who caught a little audio narration remembered mostly general descriptions, rather than specific facts, which was more common in recall of other subtopics: *Different time periods had different forms of life and climates. Learned about animals. All kinds of animals lived in different ages.*

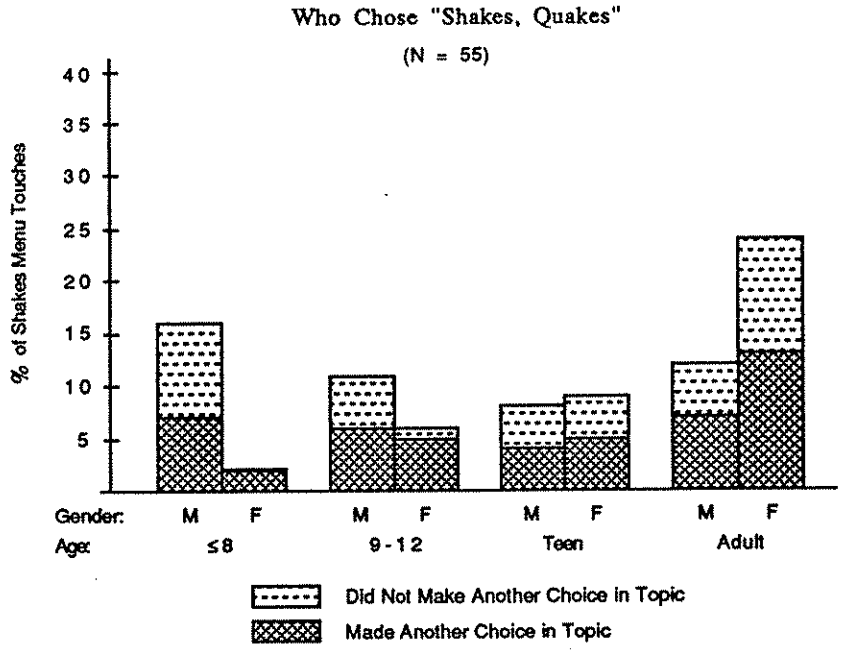
SHAKES, QUAKES, & HOT SPOTS

This choice features videos of volcanoes and earthquakes, which can be controlled by VCR type buttons on screen.

Appeal

Of the five main menu choices, Shakes, Quakes, & Hot Spots was chosen most frequently (28% of the time) from the main menu. This high level of interest is similar to that found in earlier evaluations.

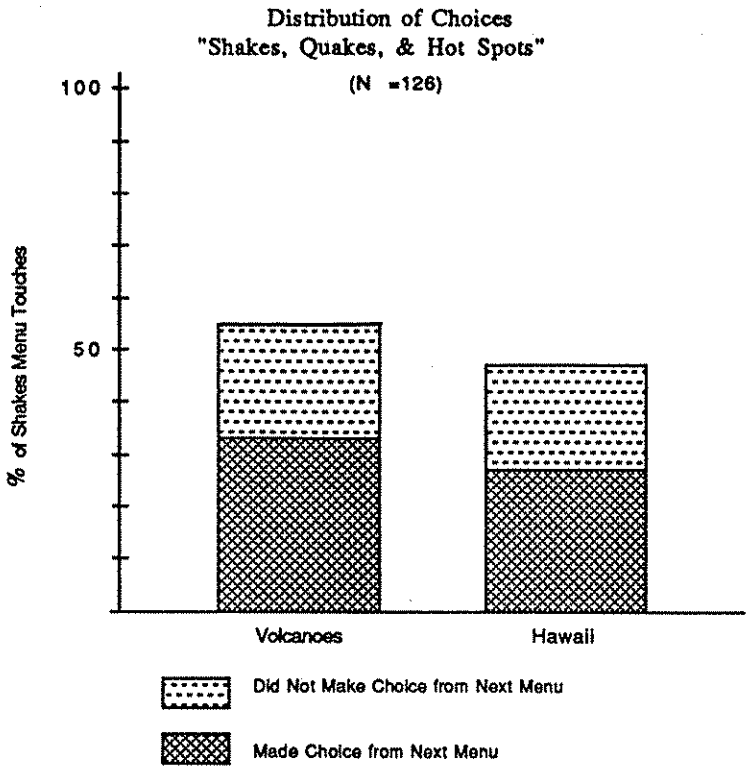
The most frequent choosers of this menu topic were boys under twelve years old and female adults. Users were given two activity choices in the submenu for Shakes, Quakes, & Hot Spots. Half of the users went on to choose a subtopic, with females slightly more likely to continue in this activity.



Volcanoes and Earthquakes Around the World and Explore Hawaiian Volcanoes were chosen via the submenu, or users could chose Volcanoes from the Hawaii screen and vice versa by touching the activity button at the bottom of the screen. From the Shakes, Quakes, & Hot Spots submenu, 32 choices were made directly, but an additional 94 switchover choices were made from the activity screens. Users switched easily and often between subtopics here.

Volcanoes was chosen as often as Hawaii.

More than half of the Volcanoes and Hawaii choices were followed by further choices from the menus of videos. Otherwise, users made another main activity choice or left the exhibit.

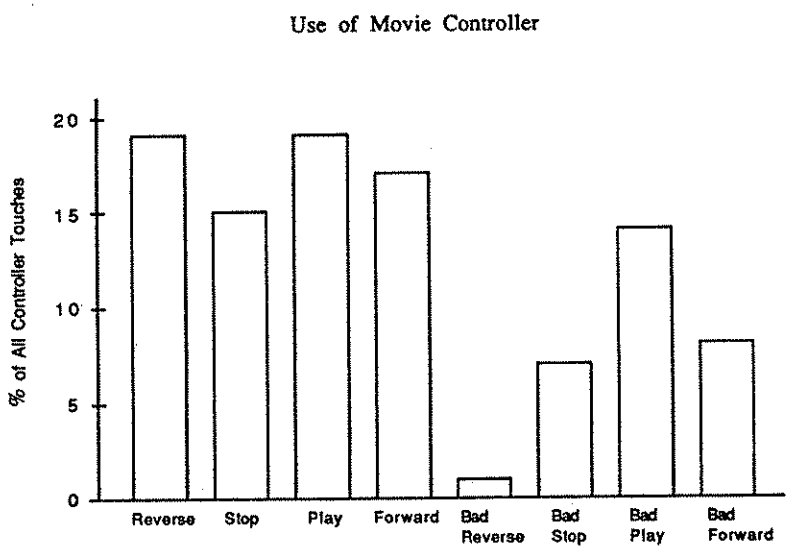


Movie Controller Accessibility

> *Watch this, Dad. I can "still" it. Now, if I want to fast forward it and show you what I just saw. . . or rewind it . . . and then that makes it go.*
>
> -- 9-12 year old boy demonstrating movie controller.
>
> *Wow!*
>
> -- Dad's response.

The movie controller was popular and relatively straight forward to use while the video was playing. All ages used the buttons, but the major users were adults and boys under nine. The adults often used the buttons to demonstrate a point to their family or class, whereas the younger children would touch the buttons for the visual effect.

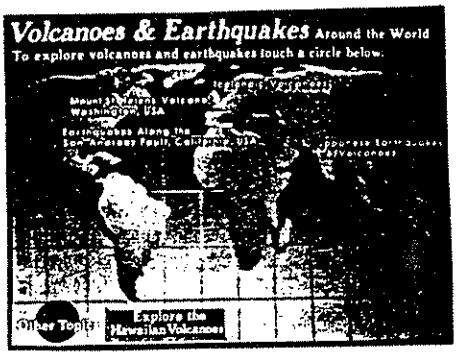
The movie controls were a problem only when the frame froze at the end of the video. Users assumed that they had to press play or forward to see some more video (see bad play, bad forward in graph).



Recommendations

- The freezing of the picture at the end of a video was confusing to viewers. It is advisable to cycle back automatically to the submenu so that another choice can be made.

VOLCANOES AND EARTHQUAKES AROUND THE WORLD



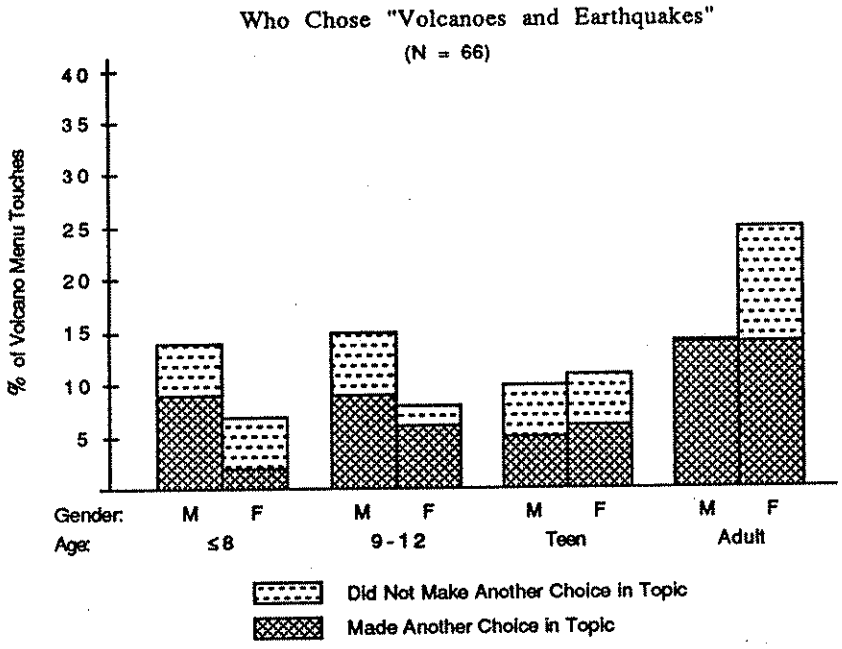
Volcanoes and Earthquakes Around the World allows participants to select movies of earthquake and volcanic activity in Japan, Iceland, Mount St. Helens, and the San Andreas Fault in the USA. Users can control the speed and direction of all the movies by touching VCR type controls on the screen.

Appeal

Wow! I just think this is so amazing. I thought that film was great.
-- a female teenager after seeing Iceland

Look at it! Look at it!. . . That is awesome.
-- mother commenting on Mt. St. Helens to son

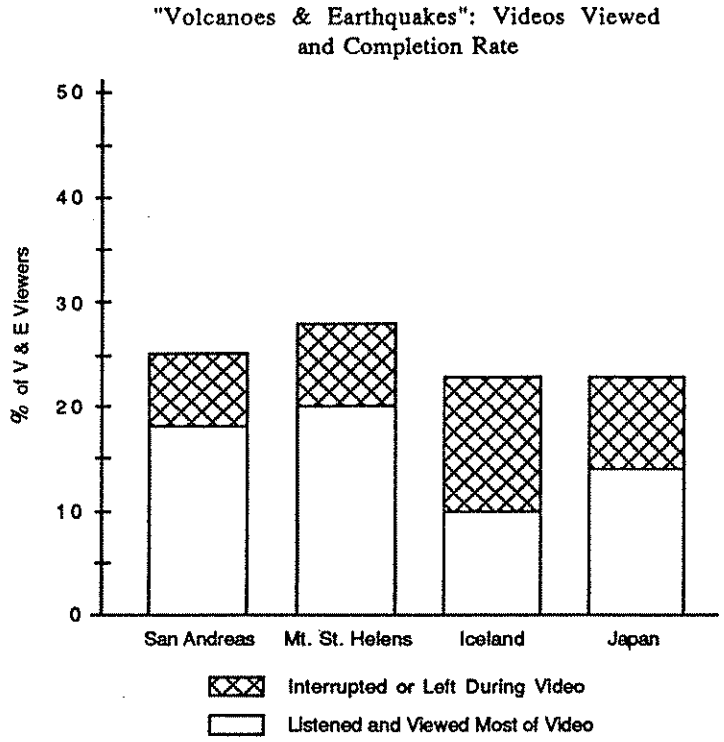
The most frequent initial choosers of Volcanoes and Earthquakes were boys under twelve years old and adult females. Adult females chose this topic most often, along with Sea Floor. Of the 66 touches picking Volcanoes, 64% went onto make a choice, indicating a high degree of interest in comparison to the other videodisc activities. Of those who initially chose the activity, males were more likely than females to make a further video choice; this is in contrast to what was observed in other activities where the females were more persistent in pursuing the topics to deeper levels.



With an average stay of 1.5 minutes, visitors' durations within this activity ranged from less than 1 minute up to 8 minutes.

San Andreas and Mt. St. Helens were videos chosen most often. These topics were probably favored because they were in the United States, since positioning was not a choice factor in other activities and ethnocentrism was apparent in the previous evaluations of this activity.

The segments were watched or listened to completely by 62% of the viewers. Preteen boys and teenagers interrupted the videos most often.

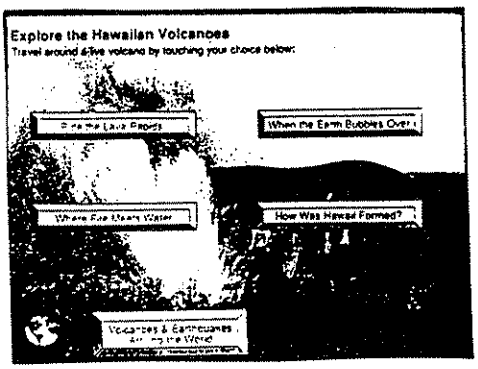


Comprehensibility

> Father and son under nine watch Mt. St. Helens.
> Dad: *Mt. St. Helens. . . Watch this. It blew off the mountain. Watch. See how the mountain looks. Let's go back. I want to show you something.*
> Dad rewinds and stops: *This is what the mountain looks like before the eruption. Mt. St. Helens, right?*
> Dad plays video: *Watch this. Look it's blowing up.*
> Dad stops video: *That's not snow. That's ash.* Dad plays video again.

The volcano and earthquake videos were clearly enjoyed and understood by all visitors. Some visitors remembered specific facts about heat or the formation of volcanoes -- *how long the San Andreas fault is; the destruction in San Francisco came also from the lack of water lines* -- but most were simply impressed by the dynamic visuals.

EXPLORE THE HAWAIIAN VOLCANOES

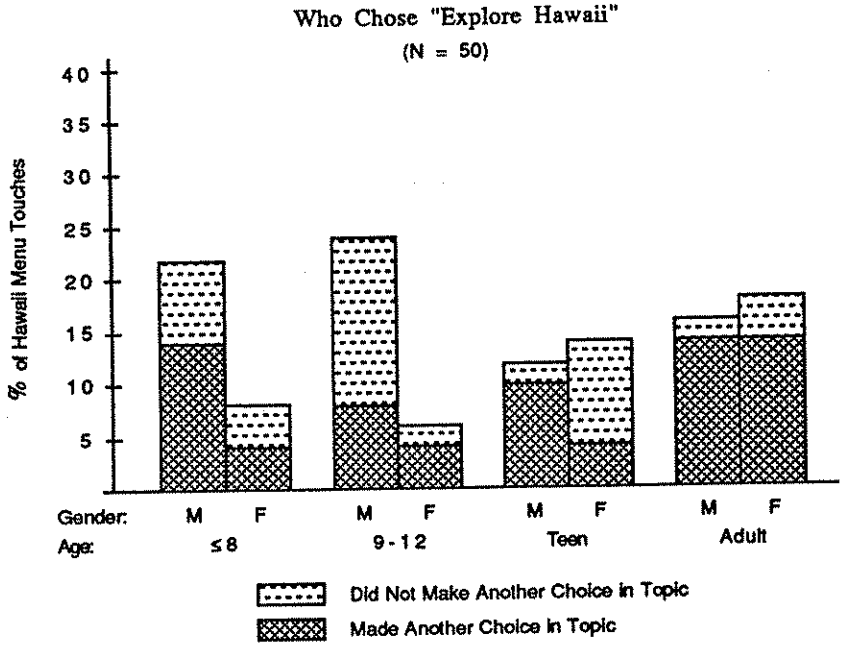


Explore the Hawaiian Volcanoes presents four movie choices showing lava flows, lava hitting the ocean, Hawaiian volcanic eruption activity, and how Hawaii was formed. Users can control the speed and direction of all the movies by touching VCR type controls on the screen.

Appeal

> *Ooh! Isn't it disgusting, Dad?* -- girl about Where Fire Meets Water.
> *Would you like to sleep on that pillow?!* -- Dad, in response.

The most frequent initial choosers of Hawaii were boys under twelve years old. However, this topic was favored by most of the males; preteen, teen, and adult males picked this topic initially more often than other subtopics. Of the 50 touches picking Hawaii, 72% went on to make a video choice. This is the highest followup percentage of any of the topics. Of those who initially chose the activity, males were slightly more likely than females to make a further video choice.

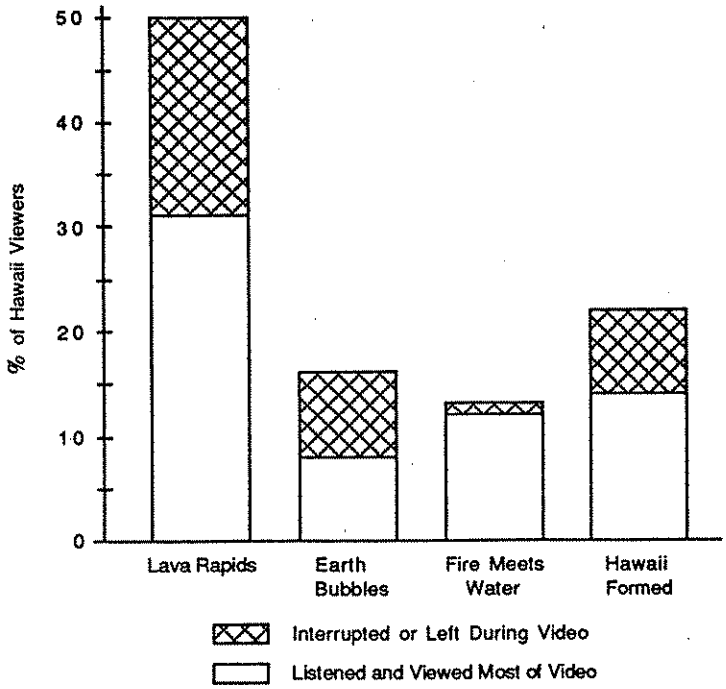


With an average stay of slightly over 1 minute, visitors' durations within this activity ranged from less than 1 minute up to 5 minutes.

Lava Rapids was far and away the favored choice of the videos, although Fire Meets Water was interrupted least often. Lava Rapids was also the favorite video in the detailed design evaluation (July, 1989).

The segments were watched or listened to completely by 62% of the viewers. This is the second highest percentage of followup compared to other topics (Sea Floor fared better).

"Explore the Hawaiian Volcanoes":
Videos Viewed and Completion Rate



Comprehensibility

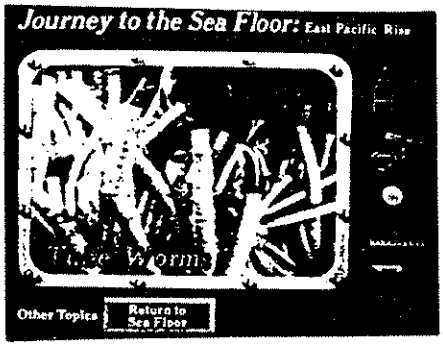
It talked a lot about volcanoes and I could understand it. -- younger than 9 years

Learned more about how volcanoes work -- 9 year old

The scripts were easily understood, but people remembered the visuals more than specific information about volcanoes.

JOURNEY TO THE SEA FLOOR

After a short video introduction, users select any of five sea floor features to learn about: mussels, smokers, clams, lava and tube worms. Users see a brief movie overview about the feature and choose from two to five tools to examine the item further. The tool set includes: scalpel, robot arm, chemistry test, binoculars, hand lens, ruler, thermometer, and microscope.

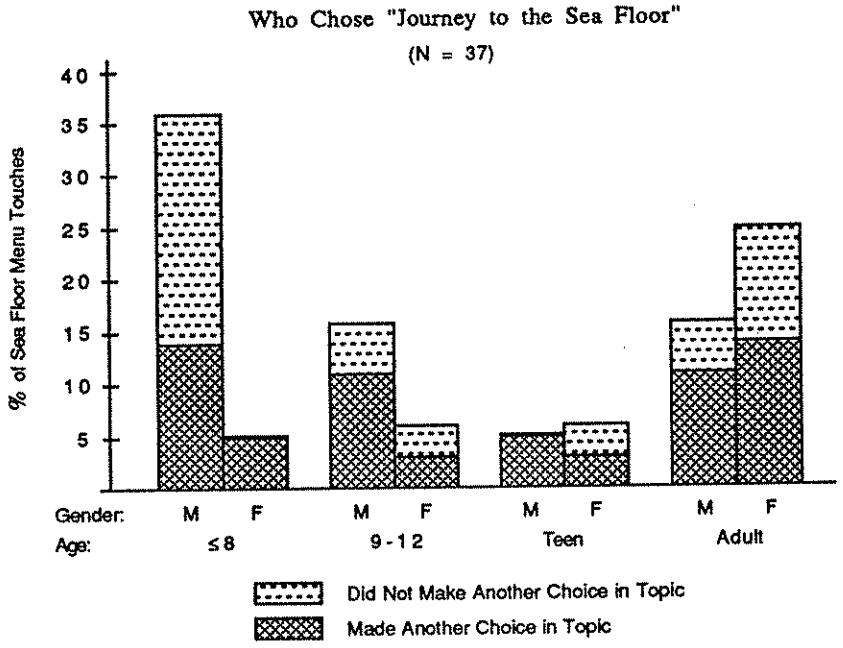


Appeal

> *Esther, this is marvelous!* -- elderly woman calls her friend over to view tube worms' screen. *I'm going to choose the ruler. . . Wow! That I didn't know.*

Of the five main menu choices, Journey to the Sea Floor was chosen 20% of the time and ranked third in frequency of choice from the main menu. Slightly over 3 minutes were spent, on average, within this activity. Duration times ranged from less than 1 minute up to 9 minutes.

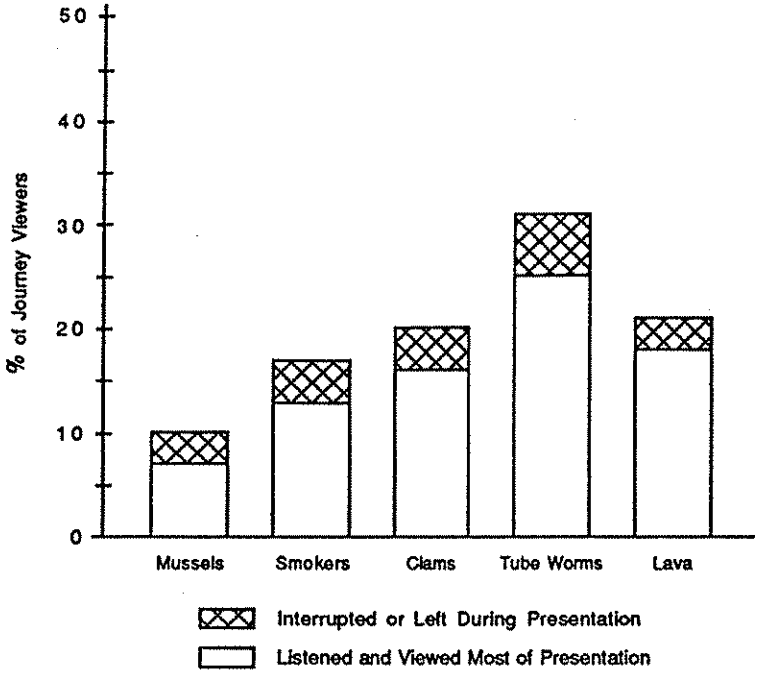
The most frequent choosers of this menu topic were boys under twelve years old and female adults. Boys under nine favored this topic more often than the other subtopics. After a short video introduction, users were given 5 activity choices in the submenu for Journey to the Sea Floor. Two-thirds of the users went on to choose a subtopic, a high percentage compared to other topics. Females were slightly more likely to continue in this activity.



Of the five subtopics, users chose Tubeworms one-third of the time, significantly more often than the others, as seen in the graph on the next page.

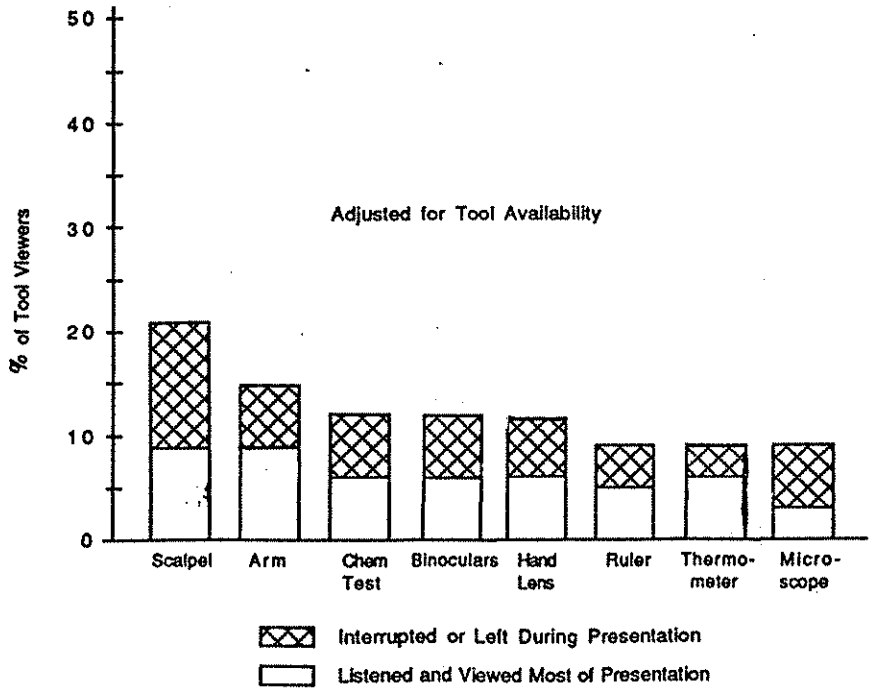
About 80% of the viewers listened to the videos and followed by choosing from the tool list. This is the highest percentage of followup compared to the other main topics.

"Journey to the Sea Floor": Videos Viewed and Completion Rate



"Journey to the Sea Floor": Tools Used and Completion Rate

Of the eight tools available, the Robot Arm and Scalpel were the most popular, whereas the Microscope, Thermometer and Ruler were least popular. There was a tendency not to listen to all of the audio-video of the tool choice but to choose another tool. Many young visitors would touch an icon, watch just long enough to see what the icon represented, then touch another tool.



Comprehensibility

Two middle-aged women (#1, #2) looking at Mussels:
#1: *I didn't realize that they were down there.* Chooses Binoculars.
#2: *Same thing.*
#1: *Uh, huh.*
#2, referring to the narrative mention of bacteria: *Well, something had to convert the hydrogen sulfide to something they could use, and what's in the gills that converts it?.* Chooses Hand lens as narration suggests.
#2 chooses Ruler and then Scalpel.

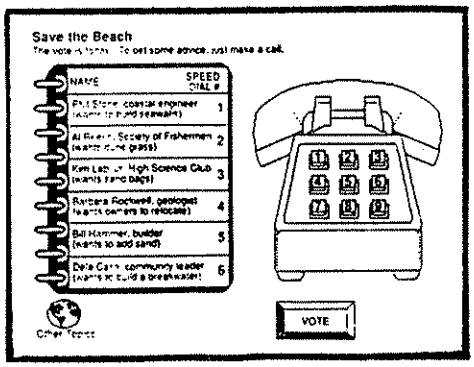
Dad and son, under nine, explore the Smokers.
Dad: *Pick the vents.*
Son: *No.*
Dad: *Pick vents.* Dad touches Smokers.
As son starts to touch a tool, Dad: *Not yet.*
Son: *But I know what I want to do with it.* Dad touches Binoculars.
Son: *No!*
Dad: *Do temperature. Find out how hot it is.*
Son touches Robot Arm. Son touches Chemistry Test.
Dad touches Thermometer. Dad: *600 degrees. The hottest temperature you ever get is 100 degrees. 600 degrees is hotter than ..?..* Son whistles.

The information is this activity was new to visitors and they could access it in a novel way through the touch tools, so a large number of facts were recalled by users. The tube worms and the smokers, in particular, were memorable -- how big, how they looked, how hot, and so forth. The adults went beyond simple facts to an understanding of the relationships --*the way bacteria within gills convert what's in the sea water to carbohydrates. The bacteria on the outside is also food for other sea animals.*

SAVE THE BEACH

In this simulation, users see a brief News video that describes shoreline erosion and how a community vote is scheduled to determine what solutions to take to preserve the beach.

Participants can call any of six community residents who favor different solutions. They can also vote for one of six solutions at any time. After a vote is cast, a News video presents how the strategy fared after a period of time. Users may call residents and vote again.

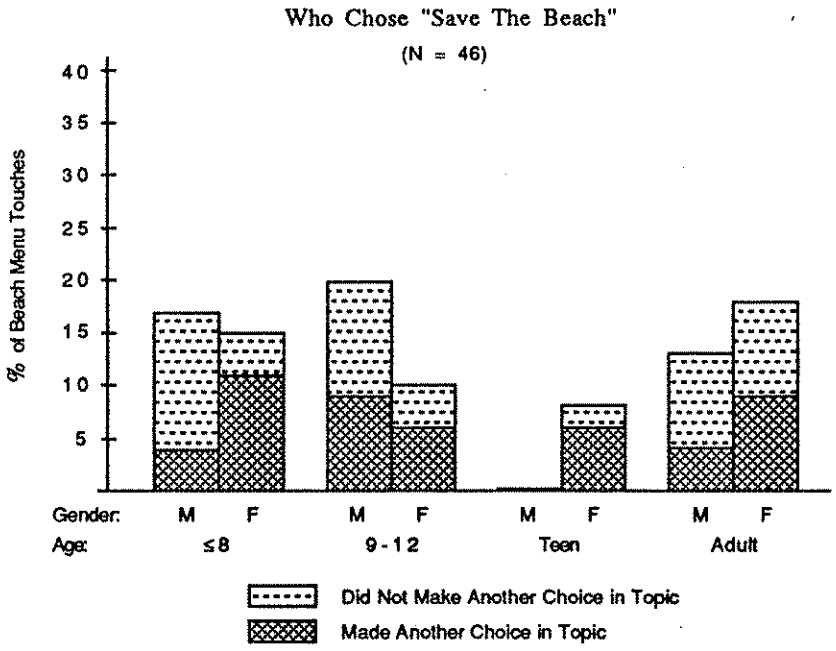


Appeal

Mommy. I called the Mayor!
-- a girl under 9, smiling after hearing phone # 8

Of the five main menu choices, Save the Beach was chosen 24% of the time and ranked second in frequency of choice from the main menu. On the average, visitors spent slightly over 3 minutes within this simulation. Users stayed less than 1 minute and up to 13 minutes.

The most frequent choosers of this menu topic were boys under twelve years old and female adults, although females under nine were more active choosers of this topic than the other subtopics. After a short video introduction, users were given 6 choices in the Make a Call submenu. Only 43% of the Save the Beach touches were followed by a choice from the Make a Call screen, with females half again as likely to continue with the topic as males.



The data in the next set of graphs describing Make A Call choices exclude telephone numbers touched by children who were using the screen phone as a toy. Dialing one's telephone number was a common activity for the under twelve crowd and an occasional teenager. The videodisc program responds to the last number dialed, so users could obtain many beeps as feedback to their telephone play.

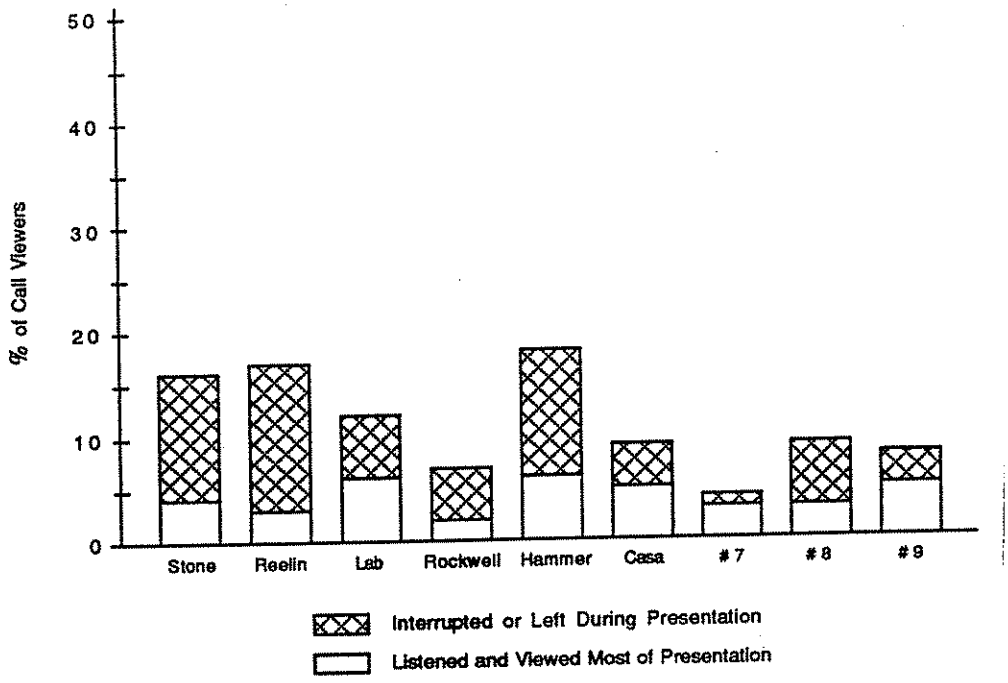
I dialed my phone number and someone said 'hi.' It sounded like my sister. - -- preteen male to his teacher

In another play approach, two young girls and an older woman independently discovered how to make the audio say the word "dial" repeatedly, by touching the screen after the words "dial his or her."

Of the six residents in the Make a Call submenu, users chose three the most: Bill Hammer, add sand; Al Reelin, dune grass; Phil Stone, seawalls.

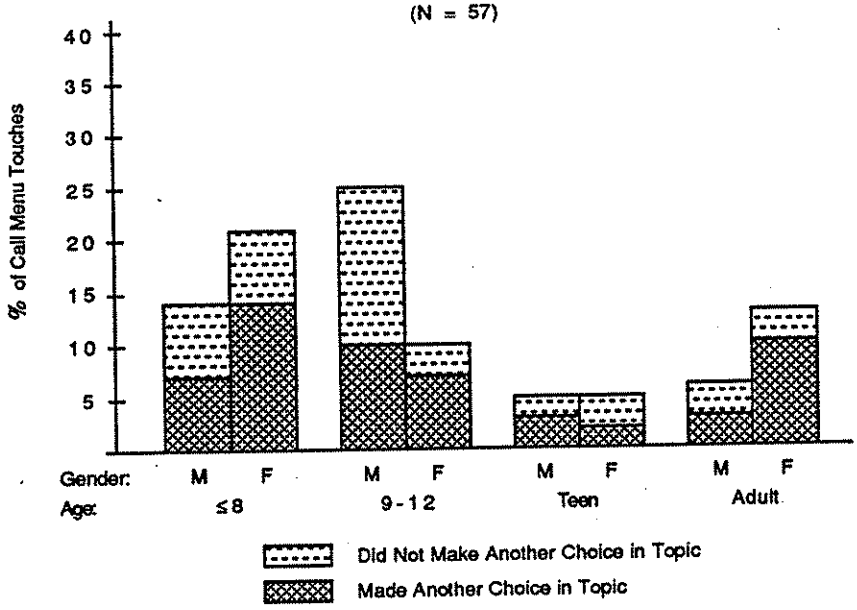
Only 37% of the viewers did not interrupt the residents' opinion presentations. This is a low percentage of interest compared to the other subtopics. Those most likely to be interrupted were Al Reelin, dune grass and Phil Stone, seawalls. Least likely to be interrupted were Kim Lab, sand bags and Dela Casa, breakwater. The unnamed telephone numbers, #7, #8, and # 9 were also popular.

"Save the Beach: Make a Call"
Videos Viewed and Completion Rate



Boys under twelve and girls under nine were the most active call makers. About half of the touches were followed up by another call or a vote, with females slightly more likely to make another call or vote.

Who Chose "Make a Call"
(N = 57)

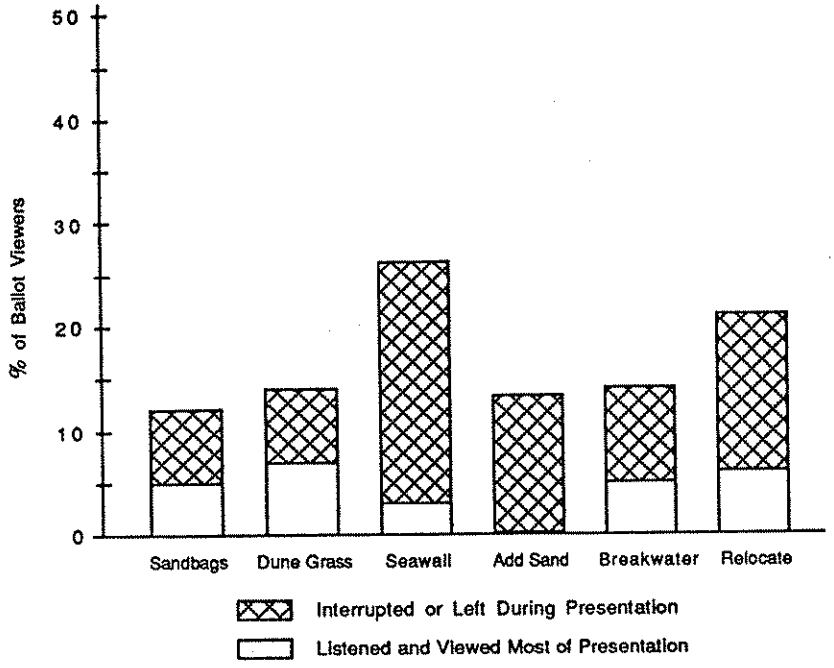


Of the six solutions in the Beach Ballot submenu, users chose two the most:

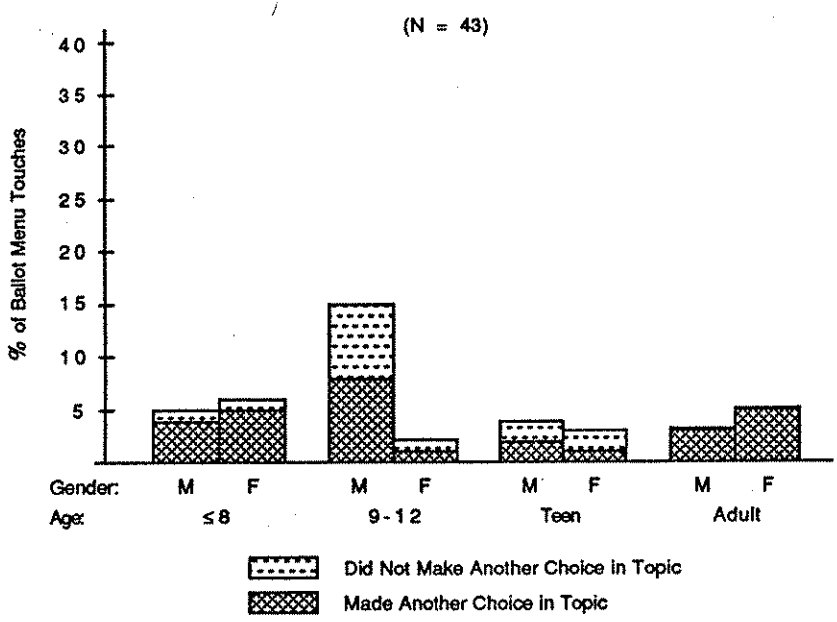
Seawall;
Relocate.

Only 26% of the viewers did not interrupt the news presentations. The tendency was to listen until the bad news was presented and then hunt for another solution. This pattern is similar to that found in earlier evaluation work (July, 1989), in which students would lose interest when it was clear that their solution was not the "right" one. Those solutions most likely to be interrupted were Add Sand and Seawall. Least likely to be interrupted were Dune Grass and Sandbags.

"Save the Beach: Beach Ballot"
Videos Viewed and Completion Rate



Who Chose "Beach Ballot"
(N = 43)



Boys, aged 9-12, were the most active touchers of the ballot screen but they would follow up with another choice about half of the time. The adults followed up all of their votes with another choice in the activity.

Accessibility

Few visitors had difficulty using either menu, except as mentioned previously, many young children dialed a long telephone number. The "Skip Ahead" Button was touched infrequently, mostly by the 9-12 year old group.

The simulation was designed so that visitors would discuss among themselves the choices. Many groups did so, but one group argued long enough so that the program cycled to the Attract loop while the visitors were still trying to make a choice. The group was surprised, and the two older siblings looked accusingly at the younger sibling, blaming him for the change in the program status. Different formats may require different time-out limits.

Comprehensibility

> A preteen boy skips ahead in the News video introduction, briefly checks out the Make a Call menu and Beach Ballot menu, then returns to Make a Call. He spends 4 minutes calling: Hammer, Stone, Casa, Lab, Reelin. The boys' father comes up behind him during Reelin video.
>
> Boy: *I'm trying to decide.*
> Dad: *You're trying to decide?*
> Boy: *Yes.* Boy chooses Beach Ballot.
> Dad: *Decided to vote?*
> Boy: *Yes.* Boy chooses Add Sand.
> Dad: *You know there's no right or wrong.*
> Boy: *I know.* Boy interrupts video when bad news begins and chooses Dune Grass. He interrupts again when bad news begins.
> Boy: *I'm trying to find one.*
> Dad: *You're not going to find one that's right.*
> Boy chooses Sea Wall.
> Dad: *Every one of these is going to tell you what's wrong. That's the way it's going to work. That's what it's doing is showing you that there is no right answer. The only thing you can do. . .*
> Dad touches Make a Call, touches Vote, touches Relocate.
> Dad: *The only thing you can try that might make any sense is relocate.*
> They watch Relocate.
> Dad: *See there's no one answer.*
> Boy touches Other Topics.

The younger children interacted with the phone without attending to the real meaning of this activity -- *they called and asked people that needed help.* As predicted by the paper mockup evaluation (July, 1989), the older users had an understanding of the issues in the simulation and were interested in learning the opinions and the facts, and trying out their own ideas -- *didn't know what walls were for. Now I do. Don't understand how sand bags are supposed to help.* Only the adults, as expected, were not frustrated by the absence of a "right" solution.

Recommendations

- Users can touch telephone numbers in sequence (as if dialing a phone) without a resident's video appearing. The program should respond immediately to the first number touched so that "telephone play" is limited.

- Being able to repeat the phrase "dial his or her speed number" is an accidental discovery by users, but a circumstance that should be looked into.

- Increasing the attract loop time-out limit so that users have time to discuss choices during the simulation format before the attract loop cycles is low priority because it was a problem only once. On the other hand, an adjustment should be considered if economically feasible.

KIOSK DESIGN

Seats

One may infer from the Philadelphia results that sitting down at the exhibit significantly increases the visitor's length of time at the videodisc, increases the tendency to explore deeper into the levels of the topics, and significantly increases the likelihood of participating in a simulation format like Save the Beach.

A potential disadvantage of seats was that they would discourage other users from joining in. Videotapes of the Philadelphia exhibit showed visitors passing by, but many visitors also waited their turn standing behind the seats and some adventuresome children even sat down beside a stranger to take a turn. In Boston, joining a strange group at the screen was as infrequent as it was in Philadelphia, possibly because the small screen made it difficult for more than a few people to actively participate simultaneously. However, in contrast to Philadelphia, Boston users were more likely to move on when they because aware of others waiting to use the exhibit.

Screen Height

In Boston, the center of the 13" touch screen was 44" from the floor with the audio speakers below the screen. Seeing the screen choices and listening to the audio were hampered by the low height. Adults, teenagers, and some older children had to bend over, crouch, or kneel in some cases, to hear and activate the program. Sometimes to view the program better, adults would move back from the monitor and then another visitor would move into the space and interrupt the viewing by touching the screen.

Screen Size

The large repeater screen in Boston attracted visitors to the exhibit from across the hall. This screen was within touching height and was touched frequently despite a posted note explaining to touch the small screen. Most family groups and classes would crowd around the small screen once they realized that it was the controlling monitor. Few people viewed the repeater screen for any length of time, possibly because the audio could not be heard clearly at that monitor.

The small size of the touch monitor, 13", did not appear to bother visitors. The family groups tended to be two to three people, and the small screen limited how many people could access the screen at one time, thus making it more likely that users would complete the viewing of a segment before someone else interrupted.

GENERAL LESSONS LEARNED FOR FUTURE VIDEODISC EXHIBITS

Formats

Three major formats were used in *Earth Over Time*: Game, Simulation, and Movies. The following observations look at the success of the format in the museum setting; however, the particular content in the format may be a confounding factor in these generalizations.

The Game format was the favorite among the preteens and teens but least favorite among adults. The Game format carried the least amount of content but it was successful in conveying its general objective. The Game could be completed by most users, could be completed quickly, and gave visitors the satisfaction of a job well done.

The Simulation format was the least appealing format overall, with adults most interested in it, probably because the Simulation required some higher level thinking. Although the topic title and attract picture was very popular off the main menu, over half of the choosers dropped out during the video introduction or at the first menu. The Simulation required an investment of time that many did not appear to want to make; most of the users were in Philadelphia where they were more committed to the experience, sitting down in front of the kiosk. The Simulation format, however, was effective in achieving its general learning goal.

The Movie format was very popular among all age groups. Appeal differences appeared to be based on content, with younger viewers liking the disaster films of volcanoes and older viewers enjoying videos that provided information new to them. The more control tools that were included in the Movie format, the more users liked it. Although the VCR type video controls were not used frequently, younger visitors used them as a toy, whereas parents used them to teach their children. The combination of short videos and many tools in the

Sea Floor and Save the Beach activities contributed to the greater length of time that visitors stayed in those topics.

Learner Control

The visitors liked being in control of their learning experience, being able to choose what topics they wanted to hear about. There were rare instances where users felt that the computer was controlling them -- the Puzzle, for example, did not always respond as users expected it to.

The short pieces of audio-video held viewers' attention, whereas several pieces chosen sequentially provided them with more coverage of the topic as well as a feeling of being in control of their own experience.

Type of Information

Descriptive facts were the type of information that was typically presented in the videos and typically recalled by visitors. The general concept of the earth changing that was reinforced throughout the program was successfully abstracted by all ages. Other higher level concepts were not salient in visitors' recall, and users did not actively relate the information they were recalling to other events in their lives.

CREDITS

EARTH OVER TIME is sponsored by the Interactive Video Science Consortium, a group of 19 science museums, located mostly in the United States. The disc is produced by Digital Techniques, Inc. in Massachusetts. For more information, contact Dr. Sam Gubins, Academy of Natural Sciences, 215-299-1036.

Site coordinators for data collection for this evaluation were Karen Hoelscher (Boston Museum of Science) and Ilona Holland (Academy of Natural Sciences). Data analyses were performed by Hoelscher, Holland, and Debra Slechta. The evaluation was funded by the National Science Foundation.