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ENVIRONMENTAL PSYCHOLOGY IN MUSEUMS, ZOOS, AND OTHER EXHIBITION CENTERS

Stephen Bitgood
Jacksonville State University

INTRODUCTION

The definition of a "museum"

The word "museum" conjures varying images to different people. Some might think of the natural history museum with dusty mounted animals that they visited occasionally as a child. Others might think of the architecture of museums as a defining characteristics – the palatial steps leading into a huge columned entrance designed to create a feeling of awe and reverence in the visitor. Still others might reminisce about family visits to a science center with hands-on science exhibits and an Omnimax movie. Still others might recall a local history museum crammed with Native American artifacts or old farming tools. Those who have more aesthetic tastes might think of an art museum filled with art works, some of which are comprehensible, while others seem to stretch the definition of art.

A museum can, of course, be all of the above things. However, for purposes of this chapter, the focus will be on a museum as an exhibition center whose primary mission is education. This includes (but is not limited to) art museums, history museums, botanical gardens, science centers, nature centers, and zoos. The concept that connects these facilities is "educational exhibition." While theme parks such as Sea World and EPCOT have educational exhibitions, their major goal is profit rather than education. Theme parks may also be distinguished from museums in terms of willingness to share data collected about their visitors, collections, and programs thus minimizing their scientific contributions to environmental design research.

Formal versus informal education

Museums are informal learning institutions. As educational institutions, museums share several characteristics with formal education (regular classrooms). For example, both usually formulate objectives or teaching points. Both employ common media (e.g., lecture, film, slides, computers, demonstrations) although the frequency of use may differ between formal and informal practice. In addition, both tend to organize the subject matter into academic chapter headings. Both rely on text materials to deliver their messages to a greater or lesser degree.

Despite the above similarities, informal educational environments differ markedly from formal institutions (e.g., Bitgood, 1988; Brown, 1979; Screven, 1986). These differences include but are not restricted to:

- Instructional stimuli. In formal education, the instructional stimuli are usually verbal, whereas in informal setting they are more likely to be visual. Formal education emphasizes sustained exposure to the education material (usually called studying), while informal education is characterized by a brief exposure to the material as the visitor passes by.
- The physical environment. A classroom in formal education usually attempts to minimize distractions (e.g., bare walls, lack of competing sounds). The focus of attention is usually on the instructor and/or audio-visual presentations. In informal education, the environment is flooded with competing stimuli, many of them distracting the learner from focusing on a single educational message.

- Overt behaviors. Formal education is usually teacher-paced and responses are explicitly prescribed (study the text, take a test, etc.). In informal education, behavior is less explicitly prescribed or under the influence of external factors. The visitor is generally considered to make choices (Do I go here or there? Should I read this label?).
- Social contacts. In formal settings, social contact is highly controlled and socialization among group members is discouraged. In informal learning settings, on the other hand, social contacts are sometimes the most important part of the experience (or at least a very important aspect).
- Learning consequences. In formal education, consequences of behavior are coercive. Powerful rewards and punishers (earning good grades, failing, social ridicule) are the usual consequences of academic performance. In informal education, the consequences are minimal. You are not admonished if you fail to read an exhibit label or understand the exhibit's message. In museums the less coercive consequences include the delight in discovering new knowledge or reminiscing about old artifacts, and the pleasure of social interaction with family and/or friends.

The emerging field of visitor studies

While there may still be debate over whether or not there is a distinct discipline (Loomis, 1988), "visitor studies" has become the name of the field for those who study the visitor perspective to environmental design issues in museums. Those who practice visitor studies come from a variety of fields and only a few would consider themselves environmental psychologists. Some come from an educational background, some from museum studies programs, some from content area disciplines (history, science, etc.). There is no higher education degree in visitor studies at this time, although there has been increasing interest in establishing such a program (e.g., Friedman, (1995).

The field now has an association (Visitor Studies Association, established in 1991), an annual conference (which began in 1988), a newsletter *(Visitor Behavior* from 1986 to 1997 and *Visitor Studies Today* from 1998 to present), and has a Standing Professional Committee within the American Association of Museums. A journal *(International Laboratory for Visitor Studies Review),* devoted exclusively to visitor studies, was published from 1988 to 1992. Other journals *(Curator, The Journal of Interpretive Research, Environment and Behavior, Museum Management and Curatorship)* also publish articles on visitor studies.

There are other organizations with overlapping interests in exhibition centers, but visitor studies is the only group strongly concerned with applying psychological and educational research methods to environmental problems within the museum setting.

THE METHODOLOGY OF VISITOR STUDIES

Target audiences

Research and evaluation in museums have included three general audiences: leisure (unscheduled visitors), school groups, and nonvisitors.

Leisure visitors. The bulk of visitor studies have focused on unscheduled, onsite (leisure) visitors. This, of course, makes sense since leisure visitors (groups of families and friends) comprise the largest museum audience. Leisure visitors tend to be very heterogeneous groups, often comprised of multi-generational members.

School groups. In addition to the individuals and groups that show up at the door, a large segment of museum audiences include school groups which differ substantially from the leisure visitor (e.g., Bitgood, 1991c). School groups are usually guided by

teachers, parents, and/or docents and generally focus on specific content areas (usually associated with its relevance to the school curriculum). Unlike the usual visitor, school group also have supplementary educational material sometimes presented in the formal classroom or workbook-type of tasks to complete within the museum.

Nonvisitors. There are also times when non-visitors are selected (e.g., Hood, 1983). Non-visitors are studied to attempt to understand why many people do not visit or to identify differences in leisure values or demographics between visitors and nonvisitors.

Quantitative versus qualitative methodology

There is some debate within the field on the appropriateness of qualitative and quantitative methodologies. Some have argued that the nature of the informal learning environment dictates a qualitative approach (e.g., Wolf, 1979); others argue that both types of methodology may be fruitful, each contributing some valuable information (Bitgood, Serrell, & Thompson, 1994).

Observational methods

Observational methods typically include tracking visitors through an entire exhibition or exhibit area, conducting a time sampling at specific areas, or intensive or focused observations of a single exhibit or small exhibit area.

Tracking studies, This method is used to study an entire exhibition when it is important to identify how people move through the exhibition, where the "hot" and "cold" spots are, etc. A selected visitor and/or group is observed throughout the exhibition noting where, how long, and what visitors do when stopping. This method allows comparisons among exhibit elements. It assesses the circulation patterns, and gives a "big picture" analysis of how visitors distribute their attention in an exhibition.

Time sampling. This method records visitor behaviors at selected times in each of the specific areas of the exhibition. Similar to tracking studies, all areas are generally sampled, but the focus here is on all visitor activity in each area rather than a record of an individual visitor's behavior. This is another way to assess how visitors distribute their attention without having to examine every exhibit element for every visitor.

Focused observations, When only one exhibit (or a small number) is being studied, focused observations can provide a cost-effective way to collect observational data. If a problem exhibit display has been identified, intensive assessment of the impact of this exhibit on visitors can be conducted.

Self-report methods

Self-report methods include both surveys and focus groups. Surveys are used to measure a variety of things including attitudes, free recall and/or recognition of information, and the visitor's ability to apply or generalize what he/she has learned. Here are a few typical examples of museum surveys:

- A museum exit survey designed to measure overall visitor satisfaction for the entire museum experience.
- A survey to obtain visitor reactions to a specific exhibit or exhibition.
- A front-end survey during the planning stage of an exhibition designed to assess the potential audiences preknowledge, attitudes, and preferences for media, topics, etc.
- A survey to identify possible visitor orientation problems.

Focus groups have also become a popular way to collect information about visitors, especially when marketing is involved. Groups may be asked to respond to questions about the museum's image, about their experiences at the museum, or about exhibits or programs still in the planning stage.

Critique of measurement in museums

The most accepted form of evaluating an exhibition combines observational and self-report data recognizing that observational data has more validity for assessing what visitors actually do and self-report data are necessary to assess thoughts, feelings, and attitudes associated with the visitor experience.

There are currently several major problems with data collected in museums. First, many evaluators and consumers of the data lack the knowledge and skills to collect and use the information in a reliable and valid manner. Second, there has been very few studies reporting reliability and validity of the instruments used to collect the data. A third problem is that the museum stakeholders (e.g., directors and boards) lack the knowledge to judge the reliability and validity of the data collected. These problems should be reduced as professionals and consumers become more knowledgeable in evaluation.

THE HISTORY OF ENVIRONMENTAL PSYCHOLOGY IN MUSEUMS

Visitor studies in informal learning settings has a short history and will be given a very brief treatment here. Interested readers are referred to Shettel (1989), Shiele (1992) and Bitgood and Loomis (1993) for more detailed descriptions of this history.

The 1920s and 1930s: Focus on environmental design. While a few isolated studies of visitors were conducted prior to the 1920s, the first systematic research was conducted by Edward Robinson and Arthur Melton at Yale University (e.g., Melton, 1933; 1935; 1972; Robinson, 1928; 1930; 1931). Robinson and Melton were primarily interested in studying how the physical design of the museum environment influences visitor behavior. Among their major contributions were a systematic study of factors that influence visitor attention and patterns of visitor circulation through exhibit galleries. While environmental design may have been the primary focus of Robinson and Melton, they were not oblivious to the fact that the museum is a learning environment. Melton, Feldman, and Mason (1936) reported a series of studies examining the effects of instructional design variables (e.g., previsit activities) on the learning of school children in museums.

The l960s and early l970s: The application of behavioral learning approaches. During the two decades following the work of Robinson and Melton, only a few scattered studies were conducted. In the 1960s, however, a renaissance of visitor studies activity began in museums. The most prominent leaders were Harris Shettel (e.g., Shettel, 1967; Shettel, 1976; Shettel, Butcher, Cotton, Northrup, & Slough, 1968; Shcttel & Schumacher, 1969) and Chan Screven (e.g., 1969; 1974; 1975). Screven and Shettel's backgrounds in behavioral learning and programmed instruction were readily applied to the assessment of cognitive and affective learning that results from exposure to exhibits.

The late 1970s and 1980s. Until the late 1970s, visitor studies were conducted primarily by outside professionals (Melton, Robinson, Screven, and Shettel were not museum employees). The locus of evaluation projects began to change in the 1970s when visitor evaluation started to become an internal process. The British Museum of Natural History (London) under the leadership of Roger Miles, Mick Alt, and Steve Griggs became the first museum to adapt an internal, systematic approach to visitor evaluation during the l970s (e.g., Alt, 1980; Griggs, 1981; Miles & Alt, 1979; Miles & Tout. 1978).

Also during this time period, the Lawrence Hall of Science at Berkeley began a series of studies on exhibit effectiveness (e.g., Eason & Friedman, 1975; Eason & Linn, 1976; Friedman, Eason, & Sneider, 1979; Sneider, Eason, & Friedman, 1979). Minda Borun at

the Franklin Institute of Science (Philadelphia) was another key early investigator in visitor learning during this period (e.g., Borun, 1977; Borun & Miller, 1980; Borun, Flexer, Casey, & Baum, 1983).

In the late 1970s, Robert Wolf and his associates (e.g., Wolf & Tymitz, 1978; Wolf, 1980) developed an approach called "naturalistic evaluation' which used qualitative methods of data collection and attempted an holistic approach to the museum experience. Much of their work was completed at the museums of the Smithsonian Institution.

The Exploratorium, in San Francisco, under the direction of Frank Oppenheimer developed the science center concept most prevalent today. This concept involves almost exclusive use of hands-on, interactive exhibit devices (e.g., Duensing, 1987; Oppenheimer, 1968; 1975*;* 1986). The importance of the Exploratorium model is evident by the fact that so many science exhibits mimic those developed at the Exploratorium. Oppenheimer's philosophy (people will learn what they want and when they want and what visitors learn is less important than the fact that they learn something) has become a major view of informal science education.

John and Mary Lou Koran at the University of Florida, applying a cognitive approach, began their museum work during this period (e.g., Koran, Lehman, Shafer, & Koran, 1983). John Falk and his colleagues (e.g., Falk, Martin, & Balling, 1978; Falk & Balling, 1980; 1982) were also active during this period; they reported a series of studies on factors influencing field trip learning by school groups.

Another methodological approach was introduced to visitor studies in the late 1970s and early 1980s. A group of researchers using an ethological approach (e.g., Diamond, 1980; 1982; 1986; Gottfried, 1979; Rosenfeld, 1979; Rosenfeld & Turkel, 1982; Taylor, 1986) provided a series of dissertations at the University of California-Berkeley. Their studies conducted at the Lawrence Hall of Science offer excellent examples of the value of descriptive research in visitor learning.

The current period; The era of eclecticism. In the late 1980s a large number of new investigators joined the visitor studies movement and the amount of research has increased dramatically. A number of different approaches (cognitive developmental, information processing, behavioral, ethological, etc.) are applied and melded into mu1ti-method evaluation systems. Piaget's cognitive developmental theory has been adopted by several educators (e.g., Boram, 1991). Norman's (1988) information processing approach has been applied to the design of interactive exhibits (e.g., Bitgood, 199la; Kennedy, 1990). The contributions of the behavioral, cognitive, and ethological approaches have all been integrated into the arsenal of visitor studies methodology. Although philosophical arguments are still common (e.g., St. John, 1990; Shettel, 1990), there are probably more similarities than differences in the application of methodology.

The interested reader can find an increasing number of sources for the visitor literature. Publications include: *Curator, Visitor Studies Today, Current Trends in Audience Research* (an annual publication by the American Association of Museums' Committee on Audience Research and Evaluation), *Journal of Museum Education, International Journal of Museum Management and Curatorship, ILVS Review, Visitor Behavior, Visitor Studies: Theory, Research and Practice* (the annual collected papers from the Visitor Studies Conferences). There have also been two related special issues of a Sage publication, *Environment and Behavior* — one on visitor studies in zoos and the other on museums. Conference presentations on visitor studies can be found at the annual meetings of the American Association of Museums, the Association of Zoos & Aquariums, the Association of Science-Technology Centers, Visitor Studies Association,

at many regional conferences, and at a surprising number of one-time conferences on special topics.

THE SCOPE OF THE FIELD

Several areas of visitor studies can be identified, although it is important to emphasize that they must all work together to make a successful museum environment. For a more detailed discussion, see Bitgood and Loomis (1993) and Bitgood and Shettel (1996).

Audience research

One approach to visitor studies has been called "audience research" (e.g., Hood, 1983). This area is concerned with: why people visit or why they stay away, people's impressions of the museum, how leisure values relate to visitation patterns and satisfaction. This area is most clearly associated with marketing and publicity and professionals who conduct these types of studies are often marketing firms or marketing departments within a museum.

Exhibit and program evaluation/development

The bulk of activity in visitor studies has focused on exhibition development and assessment. Fewer visitor studies have been conducted on program development, although it is not uncommon particularly for school group programs to be evaluated.

Exhibition evaluation can be implemented during all three major stages of development (planning, preparation, and installation). Visitor input during the planning stage is called front-end evaluation; during the preparation stage it is called formative evaluation; and after installation, it is called either remedial or summative evaluation (Bitgood & Loomis, 1993; Screven, 1990).

Orientation and circulation

"Conceptual orientation" refers to information and delivery devices that give visitors advance organizers about the museum and the exhibitions within. Some information such as architectural style may communicate visually. "Wayfinding" (sometimes called physical or geographical orientation) is what it sounds like — the ability to navigate through the museum. "Circulation" is related to patterns of movement through museum settings. A number of variables have been identified that influence this movement or these pedestrian traffic patterns (e.g., Bitgood & Lankford, 1995).

Visitor services

Another area of concern is related to the "front-line" staff. "Customer relations" is recognized as a critical area in museums, theme parks, hotels, and retail stores (e.g., Hayward, 1996; Hill, 1996; Hood, 1993; Simmons, 1996; Stokes, 1996).

SETTING FACTORS

One way to describe environmental design in museums is to focus on the major settings found within a museum — the entrance/lobby, the exhibitions, areas with amenities (rest rooms, gift shop, and food service), and, finally, the macro-architecture of the museum. These settings will he discussed individually.

ENTRANCE AND LOBBY

The design of the facility's entrance and lobby is of critical importance especially for infrequent visitors or first-time visitors who are unfamiliar with the museum (e.g., Bitgood & Tisdal, 1996). The museum must ensure that the "hard architecture" and orientation systems meet the needs of visitors. "Hard architecture" includes the physical environment (placement within the space of doors, windows, ticket booths/windows,

information desks, etc.). Foremost of the visitors' needs are: (1) conceptual orientation (knowledge about what to see and do and how to plan the visit), and (2) wayfinding (knowing how to find the rest rooms, exhibit galleries, gift shop, cafeteria). Based on lobby information (entrance fee, information about exhibitions, etc.), visitors sometimes make the decision not to pay the entrance fee and leave the museum. In addition to visitor needs, the museum must communicate to the visitor the rules of behavior, choices, special programs, etc. Unfortunately, very little research has focused on this area, although museums tend to spend considerable energy dealing with these problems.

One of the difficulties in designing the entrance/lobby is political — a number of different museum stakeholders want some control. For example, in science centers, the lobby usually contains an information desk, a membership desk, ticket windows for Omnimax or Imax movies and the planetarium shows, local tourist information, etc. Each of these entities competes for the ideal location for their particular function. Thus, the resulting lobby configuration may be more political than practical.

Conceptual orientation. Information about what to do, alternative choices, where to go, etc is often provided in a visitor guide, on orientation signage, or by museum staff. Several generalizations can be abstracted from the literature:

- On-site staff to provide orientation information is inadequate since visitors rarely ask staff for orientation information (visitors are more likely to ask for content). (Cohen, Winkel, & Olsen, 1977).
- You-are-here maps are generally not used for wayfinding purposes, but for conceptual orientation or to provide information about which exhibits were located in the museum (Cohen, et al, 1977).
- When a combination of visitor guide and orientation slide show are available in the lobby, visitor questions to staff may substantially decrease suggesting improved visitor orientation (Birney, 1991).
- If possible, visitors should have visual access to rest rooms, gift shops, and entrance to exhibition galleries when they are orientating themselves in the lobby.
- Location of functions in the lobby should meet visitor expectations (e.g., rest rooms, phones, coat rooms are expected to be adjacent to each other).

Wayfinding. Wayfinding information is also critical at the beginning of the visit. Hand-held maps (usually in the form of a visitor guide), fixed you-are-here maps, directions signs, museum staff are all used to decrease the confusion.

- A visitor guide may increase the total time visitors spend in the museum and/or exhibitions viewed and result in overall increased satisfaction with the visit (Bitgood & Richardson, 1987; Bitgood & Tisdal, 1997).
- Redundant wayfinding cues (hand-held maps, direction signs, and you-are-here maps, etc.) are helpful to visitors because such cues provide a feeling of security, give the visitors a choice of options, and are more likely to be noticed.
- Maps should be simple, but give enough information so that visitors can locate where they are at any moment (Talbot, Kaplan, Kuo, & Kaplan, 1993; Levine, 1982).
- You-are-here maps should follow the Levine's principles of forward-up equivalence, a you-are-here symbol, and some landmark that is visible in the environment and present on the map. (Levine, 1982).
- Wayfinding information should be placed at the point it is needed (e.g., choice points).
- Visitors prefer hand-held maps over other wayfinding devices (e.g., Bitgood & Richardson, 1987).

EXHIBITIONS

It has been about 70 years since the ground-breaking studies of Robinson (1928) and Melton (1935). After reporting a series of studies in museums, Melton suggested the following:

> "The obvious recommendation which flows from these studies is that there should be a branch of museum research which is wholly concerned with the psychological problems of museum architecture." (p. 267).

Melton's reference to "museum architecture" is what is more commonly called "exhibit design." There has been much effort in the last 30 years or so toward realizing Melton's recommendation. However, there are few theoretical formulations to tie together the growing body of empirical observations.

Bitgood (in press) has suggested that three interrelated principles of attention explain and help organize what we know about visitors' reactions to exhibitions:

Principle #1: Attention to exhibits is selective, visitors attend to one thing at a time and what gets attention is determined by distinctiveness or salience of the element/object and by whether or not the visitor's pathway is close to the element/object.

Principle #2: Visitors must be motivated in order to focus their attention on exhibits. Motivation is a function of cognitive-emotional arousal (e.g., interest level), the amount of perceived work, and the number and intensity of distractions.

Principle #3: The resources for attending to exhibitions have a limited capacity and are depleted by mental and physical effort. The rate of depletion and renewal is dependent upon the total amount of effort expended, the amount of cognitive-emotional arousal, and the amount of time.

Selectivity

Attention is selective in the sense that some things capture our attention while others do not, and in the sense that we can attend (generally) to only one thing at a time. If visitors can attend to only one exhibit element at a time, what will it be? Capturing visitor attention is the first step in the process of communicating the educational message. Visitors must first pay attention to a label before it has any chance of delivering any kind of message.

Two obvious factors in capturing attention are the salience or distinctiveness of the exhibit element and the traffic flow patterns in the environment. The more salient the element, the more likely it will be noticed. Traffic flow also influences whether an exhibit element will be detected: objects in locations along the pathway taken by visitors have a reasonable chance of being seen while those outside the pathway have almost no chance of receiving attention.

Stimulus salience (distinctiveness). Below are some of the major factors that influence visitor attention in terms of detecting exhibit elements:

- Isolation. An object isolated from other objects is likely to get the undivided attention of visitors (e.g., Melton, 1935; 1972). The greater the number of stimuli surrounding an element, the less likely it will be noticed, especially if it lacks other salient factors.
- Size. Larger objects receive more attention than smaller ones (e.g., Bitgood & Patterson, 1993).
- Contrast with setting background. Objects that blend into the background may be ignored because they lack attention-getting power. In the parlance of signal detection theory, background "noise" makes it more difficult to detect a stimulus.

- Multi-sensory characteristics. Adding sound, smell, or touch to an exhibit attracts more attention (sometimes at the cost of less attention to surrounding objects (e.g., Melton, 1972).
- Lighting. The overall level of lighting is, of course, important in determining whether or not an object will be noticed. In addition, the contrast in lighting between the object and its surrounding produced by spot lighting is another way to make it more detectable.
- Line-of-sight placement. An object that falls easily within a viewer's line of sight is easier to detect. One consideration is the distance from the floor. Objects placed more than six or seven feet above the floor often go unnoticed because people tend not to look up (Bitgood, Benefield, & Patterson, 1989; Bitgood, Conroy, Pierce, Patterson, & Boyd, 1989). Another consideration is where visitor attention usually is focused, that is, on the object. If a label is not close to the object it describes (e.g., on the railing in front of the object), the label is less likely to be noticed and read (Bitgood, Hines, Hamberger, & Ford, 1990).

Circulation/traffic flow. Many exhibit objects are ignored because of the traffic flow. If visitors do not pass by an object, it will not attract attention. Consequently, it is critical to understand the factors that influence traffic flow in exhibit environments. Rarely do visitors pass by all objects in a gallery (Bitgood, Hines, Hamberger, & Ford, 1991; Melton, 1935).

- Attraction of a salient object. A large object (such as an exhibit display) will influence the traffic flow by creating a tendency for visitors to move toward or approach after entering the environment (Bitgood, et al, 1991). Landmark objects influence pathway which in turn influences whether or not other objects receive attention. For example, visitors are likely to bypass and consequently ignore a less salient object in order to approach and view a more salient one.
- Attraction (or distraction) of an open door.. Melton (1935) reported that there was a strong tendency for visitors to enter a gallery move along the right-hand wall and exit by the first open door. When the door was closed so that visitors had to exit by the same door as they entered, visitors circulated more completely through the gallery giving attention to more objects on exhibit.
- Arrangement of objects/displays. The arrangement of objects within the environment determine how people will move through the environment (e.g., Bitgood, Hines, Hamberger, & Ford, 1991). In every exhibit space, there are "hot" and "cold" spots of visitor attention which are at least partially influenced by the circulation patterns of visitors. A myriad of exhibit islands creates a chaotic traffic flow in which some displays receive a high level of attention and others receive a low level. When the flow is chaotic, visitors are more likely to miss a display unintentionally. If there is a clear pathway or order of viewing displays, each object is more likely to get attention.
- Inertia. Visitors tend to continue along a straight-line path unless some force (e.g., landmark exhibit object) pulls them away. Melton's (1935) proposed "exit gradient" is a special case. Melton defined "exit gradient" as the tendency to take the shortest distance between the entrance and exit when moving through a gallery.
- Right-turn bias. In the absence of other forces (see above), visitors have a tendency to turn right when entering an interpretive space (e.g., Melton, 1935).

Motivating focused (sustained) attention

The second principle of attention in exhibitions is that focused attention requires motivation. Motivating visitors to focus on labels and objects is the most challenging task in exhibition design. Rand (1990) has suggested some intriguing ideas on how to "hook" readers with the use of language. Screven (1992) has identified many of the variables that seem to increase visitors' motivation to read labels. Motivating interest results in focused visitor attention on the exhibits.

There appears to be three general factors involved in motivating visitors to focus their attention on exhibits: (1) minimize the perceived effort to obtain information; (2) increase cognitive-emotional arousal (provoke interest in the subject matter if it is not already there); and (3) minimize distracting factors.

Minimize perceived effort. In terms of the processes of attention, mental effort may do two things: (1) it decreases motivation to attend; and (2) it depletes the resources of attention. The first of these will be discussed here, and the latter (depletion of the resources of attention) later. By reducing mental effort, more cognitive resources for attending to exhibits are available and presumably, this increases motivation to focus. Since most of the effort is mental and involves making sense of interpretive labels, the following principles deal primarily with label design.

- Number of words per label chunk. Bitgood and Patterson (1993) demonstrated that breaking down a long label into three smaller ones (chunks), resulted in increased reading.
- Proximity of label to object. The least amount of effort in label reading occurs when a visitor can look at the exhibit object and read a label at the same time. Thus, placing a label on a railing in front of the object viewed is more effective than on the side of the exhibit or away from the exhibit (e.g., Bitgood, Benefield, & Patterson, 1989). Placement closer to the exhibit object is apparently important in a recessed exhibit display as well (Bitgood, Campbell, Desmidt, Gunnip, Hawerott, & Johanessen, 1992).

There is a common approach to interpretation (especially in natural history museum and naturalistic zoo exhibits) that places interpretive labels away from the naturalistic exhibits. The assumption is that the immersion experience will be compromised by the presence of text which is unnatural to the setting. Instead, interpretative labels are often placed in a central area away from the exhibit. Evaluations of such exhibits suggest that this is a mistake if one wants to motivate visitors to read labels.

- Ease of cognitive processing. Visitor are more likely to read if information is arranged in a manner that minimizes effort. One way to accomplish this is to bullet a list of items rather than embedding it in a paragraph format. Another way to decrease cognitive processing is to provide small chunks of text close to a visual image on a diagram/illustration/graphic.
- Figure-ground contrast. Not only is it easier to attract attention with figure-ground contrast, but it is easier to read text when the letters and the background have high contrast (Bitgood, 1990b).
- Sensory overload (density of labels/objects). The greater the number of labels in an area, the less attention any one label is likely to receive. While this relates to attention, it may also relate to perceived effort. That is, an overabundance of text in any form (number of words per label or number of labels) may be perceived as too much work.

Increase cognitive-emotional arousal (by provoking interest, thought, etc.). One of the more difficult tasks that exhibits attempt is to provoke interest and/or thought in

the visitor. Once stimulated, visitors usually become more "mindful" and are more willing to read and think about the exhibit content. Thus, increasing cognitive-emotional arousal motivates mental focusing on interpretive objects. Provoking interest may also be a way to renew the resources of attention (see principle #3, capacity of attention).

Below are brief descriptions of, and the evidence for. many of the variables that seem to stimulate cognitive-emotional arousal.

- Asking questions. Among others, Rand (1985) has suggested that labels should ask questions rather than just tell the facts (e.g., "Which jaws could crush a crab?"). Several studies suggest that labels that ask questions can be effective at provoking label reading (Hirshi & Screven, 1988; Litwak, 1996). The content of the question is likely to be critical. If the question raises issues/information that are not interesting to visitors, it is not likely to be motivating.
- Confront and correct misconceptions. Once a misconception about a subject has been identified by a visitor study during the planning stage (front-end survey), directly confronting this misconception may provoke greater interest. Rand (1985) provides an example:

  "They may look empty, but mudflats crawl with life."

At present there does not appear to be any studies that have examined the effectivenss of addressing misconceptions explicitly, although Borun and her colleagues (Borun, Massey, & Lutter, 1993) have documented the difficulty in overcoming misconceptions about gravity in a series of exhibits at the Franklin Institute of Science.

> "Not all fishes need a buoyancy regulator; when a wolf-eel or sculpin swims, it doesn't go too far from the bottom. But what do you suppose happens when a wolf-eel stops swimming?" (Rand, 1985)

There is a danger in taking this approach. If the question is too difficult, the reader may lose interest and is unlikely to try additional challenges. It is also important to provide the correct answer once visitors' interest has been stimulated.

- Writing style. Rand (1985) has listed a number of label objectives that translate to good writing style. These include:
  - Draw analogies ("Flatfishes are quick-change artists.")
  - Use a reader-relevant approach to explain things ("Orca clans take care of their own.")
  - Communicate in a conversational tone that is approachable, familiar, often humorous, but not flippant or formal ("See the rock with ruffles? That's the hornmouth, one of the more ornamental snails").
  - Address the reader directly ("The tentacles you see are sensitive to touch and help locate dirfting algae.")
- Identify high interest content. A survey during the planning stage can often identify information that is of interest to visitors (and it's not always what the museum staff thinks visitors are interested in).
- Mental imagery. Mental imagery can help create a feeling of immersion by encouraging the visitor to put themselves in a particular time and place. Screven (1992) described this as "encouraging visitors to fantasize or project themselves into an exhibit situation."
- Handouts. Robinson (1928) used a handout giving more detailed descriptions of selected paintings than found on wall labels. Those who used this handout showed decreased "museum fatigue" (i.e., increased total amount of time in museum and attention to art work). Others have found similar findings (Bitgood & Davis, 1991).

- Presence of 3-D objects. Two-dimensional labels by themselves attract less attention than labels associated with three dimensional objects (e.g., Peart, 1984).
- Format of label. Labels can be designed using several formats (graphic panel with blocks of text, flip labels that can be raised to reveal an answer to a question or additional information, auditory labels either self-activated or visitor activated, etc.).
- Instructions on what to look for or what to do. Assuming visitors are at all curious about the objects they are seeing, they generally welcome information that tells them what they should look for or do.
- Hands-on flips. Arndt, Screven, Benusa, and Bishop (1993), in a zoo study at a lion exhibit, found that flip labels increased the percentage of visitors who stopped, viewing time, and learning. Flip labels, when carefully designed, are capable of sparking considerable curiosity.
  - Clarifying the message. Written text can help to clarify the message. Bitgood, Cleghorn, Cota, Crawford, Patterson, and Danemeyer (1996) found a dramatic increase in attention and total time in the gallery when text was placed on life-size photos. The text clarified both what was being said and who said it in recorded voices conducted over speakers.
  - Social interaction. Interpretive experiences are primarily social in nature. Design should consider how to motivate visitors to share information and ideas. Parents often read labels to children, and it is not uncommon for one adult to read to other adults in a group. Labels are likely to encourage social interaction if they are interesting, challenging, prompt parents to ask questions of their children, etc.

Minimize distractions. Sensory distractions such as sounds from outside the interpretive area can take attention away from labels. In one of the first studies of label reading at a zoo, my colleagues and I observed that each time the zoo train blew its whistle as it passed, visitors would stop reading labels. Once interrupted, visitors did not go back to complete reading of a label. They moved on to the next exhibit. This phenomenon was observed for almost every visitor!

- Sounds. Sounds of all types can distract visitors from reading. Sound bleed from other exhibits is a common distracter in museums, zoos, and science centers.
- Competition from other exhibit elements. Frequently, two elements of the same exhibit compete with one another for attention. An object may compete with a label, a label with another label, etc.
- Novelty of the surroundings. The work of John Falk and his colleagues (e.g., Balling & Falk, 1982; Falk & Balling, 1980; 1982) suggests that, at least for school groups, a novel setting distracts students from the programmed interpretation. To some extent, this may also apply to all visitors in interpretation settings. Visitors may be concerned with where to go next, etc. Good orientation (visitor guides, direction signs, etc.) will minimize the distractions.

Limited capacity of attention

The third principle of attention states that the resources of attention have a limited capacity in the sense that there appears to be only so much available and they appear to deplete with physical and mental effort.. The reserves are renewed slowly over time and, to some extent, by cognitive-emotional arousal. Consequently, three factors are of critical importance to this principle of attention: the size of the reserve, the rate of depletion, and the rate of renewal.

Evidence for this depletion effect is provided by several studies of "museum fatigue" (Falk, Koran, Dierking, & Dreblow, 1985; Melton, 1935; Robinson, 1928). Robinson (1928) compared decreases in attention across time during visits to four museums that differed in size as well as other characteristics. He found similar decrements in attention (as measured by average viewing time per painting) at all museums. He found an even greater decrement in attention across viewing in a laboratory study in which subjects were asked to view 100 prints of paintings. Subjects were allowed to view each print as long as they wanted. Dividing the prints into tenths, Robinson found that there was a systematic decrement from the first to the last tenth of the prints. Melton (1935) found a similar decrement in attention (as measured by average viewing time per painting) when the number of paintings in a gallery was systematically increased from 6 to 36 in increments of six.

Falk et al (1985*)* reported evidence for a decrement in attention across time in a study at the Florida State Museum of Natural History. They monitored visitors' attention to exhibits, to the setting, to self, and to other people throughout the visit. They found that visitors' attention to exhibits dropped rapidly after 30-45 minutes in the museum. "The primary change in visitor behavior during the observations was a change form moving slowly from exhibit to exhibit and reading labels to 'cruising' through the halls, stopping occasionally and only very selectively" (p. 254).

Serrell (1998) reported viewing time measures and overall usage in exhibitions at a number of museums conducted by a number of different investigators. Visitors spent less than 20 minutes in 82% of the 110 total exhibitions included in the study. Many of these exhibitions were large which didn't seem to make a lot of difference. The median stops in these exhibitions was 33.9% of the total possible exhibit elements. These findings can be easily interpreted as support for the limited capacity of attention.

Size of reserve. The total capacity of the attention reserve is assumed to be limited, based on the physical energy available to the individual, condition of health, mental attitude, and so forth. Obviously, the capacity would vary for different individuals and for each individual from one time to another.

Rate of depletion and renewal. How quickly the reserves of attention are depleted is assumed to be influenced by the amount of mental effort, by the number and strength of distractions (both setting and social), information overload, by cognitive-emotional arousal, by physical fatigue, by time pressures, and by rate of pacing through the exhibition (e.g., rest periods allow renewal).

Several design factors may reduce this attention decrement:

- Design heterogeneous exhibits rather than monotonous displays with similar objects all in a row. Displays of similar objects or animals all in a row create a rapid decrement in attention. By varying the displays in terms of content and appearance, greater interest is maintained.
- Minimize mental effort every way possible. As noted above, there are many ways to decrease the amount of mental effort required by visitors.
- Increase interest level with methods described above under "Provocation." Provoking interest by the methods described above should also help to hold off object satiation.

Renewal rate refers to how fast the reserves of attention are replenished. It is assumed that a recovery period will renew these resources. Thus, taking a break to have a snack or eat lunch will rejuvenate the resources of attention. Increasing cognitive-emotional

arousal (stimulating interest) also acts to renew the reserves. Thus, entering a new museum gallery on a new topic (especially one that is interesting) generally results in increased attention to exhibits.

Interpretive labels can come in many forms and, in the form of hand-held guides, may be used to slow down the rate of depletion of attention. Robinson (1928) reported a study (study #4) in which pamphlets were used as a visitor guide to art work in a small museum. Those who used the guide spent more time in the museum (28 versus 17 minutes); viewed a larger number of art works (46 versus 30), and viewed a larger percentage of the art works *(25* versus 17). Those who did not use the guide showed the usual decrement in viewing time across their visitation. Thus, the hand-held guide appeared to counteract the "fatigue" effect usually observed.

Some implications and related concepts

Re-distribution of attention. Any change to the interpretive setting creates a change in the pattern of visitor attention to the whole milieu. According to the attention framework, this redistribution is the result of a combination of moment-to-moment selectivity, motivated focusing, and depletion of the reserves of attention. In an interpretive environment dense with stimulation, the capacity of attention is likely to be depleted before all elements have received an adequate level of attention. Also, in a densely stimulating environment, only the most distinctive elements are likely to receive attention because of the selectivity principle.

The limitations of attention require that designers plan the interpretive experiences carefully so that visitors distribute their attention to focus on important messages and objects. This is a difficult task. In addition to considering the moment-by-moment distribution of attention, the designer must, throughout the interpretive area, attempt to minimize mental demands that sap visitors of their resources for attending.

Re-distribution of attention was demonstrated in a study by Melton (1935; 1972) in which the number of art works in a museum gallery were systematically varied. When the number of artworks were increased, the attention to each one was decreased. While this study did not examine interpretive labels, it seems a safe guess that the finding would generalize to text.

A more detailed analysis of the distribution of attention can be found in a study by Bitgood and Patterson (1993). Their study, conducted over a two-year period, systematically varied label characteristics and locations. The study was conducted in a small Egyptian mummy gallery at the Anniston Museum of Natural History. Labels were systematically changed and a bronze bust added to the gallery during the course of the study. Each change in the gallery resulted in a re-distribution of visitor attention to all objects in the gallery. For example, when more labels were added, the percentages of stops at labels increased, but the total reading time decreased. In addition, when the percentage of label readers increased by label changes, average total time in the gallery for label readers declined suggesting that the new label readers produced by making the labels more attractive didn't influence the overall time in the gallery of these new readers. However, when a three-dimensional object (bronze bust of a mummy) was added to the gallery, the total gallery time as well as time viewing other objects in the gallery increased.

The complementary role of Interpretive labels. The structural limits of attention prevent visitors from simultaneously attending to both label and objects. When given a choice, visitors look at objects rather than read labels. Since the focus of visitor attention

is primarily on three-dimensional visual experiences, this is where interpretation should start. Rarely do visitors start their viewing experience by reading text. In study after study, two-dimensional graphic panels not associated with some three-dimensional objects receive very little attention. (This is one reason why it is difficult to get visitors to read introductory labels). Label reading cannot compete with the visual experience. It follows that labels are most effective when they complement the objects. They complement by focusing attention on important characteristics or explaining phenomenon, or serving some other such function. Visitors generally want to know what they should look for, how to focus their attention, etc. How do you design for this supplementary role for labels? Here are a few suggestions to provide visual reference to the label.

- Focus attention on important ideas or relevant features associated with the object.
- Create a symbolic dialogue between the label and the object.
- Answer the visitors' questions first, then tell them what you think they should know.
- Ask what is most notable or important about the object(s).

Since interpretive labels are less attention-getting than objects, it is predicted that there will be a greater decrement in attention to label reading than to object viewing as the resources for attention deplete. I don't know of any data that relates to this prediction.

Communicating educational messages. Focused attention is necessary, but not sufficient for the interpretive messages to be communicated. Once visitors attend to the label and are motivated to read, the final task is to ensure that the interpretive message in communicated. The critical factor here is difficulty of comprehension. Anything that makes comprehension more difficult is going to increase mental effort, deplete the resources of attention, and consequently decrease the chances of delivering interpretive messages. It seems that many of the variables associated with interpretive labels seem to influence both motivation and communication. Text that is difficult to understand impedes visitor motivation to read.

Here are a few principles from the literature that, when followed, facilitate the delivery of the interpretive message:

- Syntactic complexity. Screven (1992) described a group of variables he termed "syntactic complexity." They include sentence length and number of sentences with phrases that lack any new information (e.g., in summary). As Rand (1985*)* points out: "every word counts." It is easier to understand if short, simple sentences are used.
- Semantic complexity. According to Screven, semantic complexity includes: "number and level of propositions, causal structures, vague, abstract language, concept density (ratio of concrete to abstract concepts."
- Vocabulary. Difficult-to-understand vocabulary has been frequently been noted as a problem in communicating interpretive messages (Bitgood, 1989; Screven, 1992; Serrell, 1983; 1996). The best advice is to keep it simple and test any questionable words/phrases on the target audience.
- Writing style. Clarity, conciseness, and simplicity will usually facilitate understanding of the interpretive message. In addition, Rand suggests using an active voice, vivid language, and addressing the reader directly.
- Presence of labels. It may seem obvious to most, but objects rarely (if ever) speak for themselves. Without interpretation at the critical location where it will be used, visitors are likely to get the wrong message, a trivial message, or none at all.

- Literary techniques. Rand (1985) has suggested drawing analogies and using a conversational tone to "hook" readers. Serrell (1996) suggests that labels tell stories. Both of these techniques, when used intelligently, are likely to increase label effectiveness.
- Conflicting messages. At times what visitors see and what they read are in conflict. If a sign at a zoo exhibit implores visitors not to feed the bears, it is inconsistent for a keeper to throw an apple to the bear when the bear begs.

Visitors can more readily attend to the educational messages if the labels are designed to minimize mental effort, increase interest level, and help visitors focus their attention on easy-to-understand information.

Response facilitation. In the case of "hands-on" (interactive) exhibits, the device must be designed such that it facilitates an appropriate response (one that is consistent with or aids in the understanding of the objectives of the exhibit). Norman's (1988) principles of design provide a useful guide for such interactive exhibits (Bitgood, 1991; see also, Kennedy, 1990):

- Visibility: it should be obvious what to do by looking at the device..
- Feedback.: all responses should receive immediate and continuous feedback.
- Conceptual model: the visitor conceptual model of how something works must match the designer's model.
- Natural mapping: when appropriate, controls should be mapped out in the same pattern as what they are controlling. For example, in the Pacific Science Center there is an exhibit in which visitors attempt to identify the smell from bottles. The smells are identified by flip labels that are laid out in the same pattern as the bottles. It is clear which flip goes with which bottle simply by seeing the natural mapping.
- Navigation: it should be easy to navigate through instructions (or software programs).
- Instructions: instructions must be simple and placed close to the things they are describing.

When interactive exhibits are designed, visitor testing is crucial. We have not reached the point where we can predict with any certainty how all of the design variables are going to work together.

AMENITIES

Rest rooms. In surveys of visitor satisfaction, one of the consistently important factors is cleanliness and availability of rest rooms.

Food service. It seems logical that if a visit is of sufficient length, providing food is likely to keep visitors in the museum longer. However, there is apparently no data to support this assumption. Nor does there appear to be any studies on the impact of quality of food as an incentive to visit or remain in the museum. The tendency to provide fast food chain restaurants in museums may reflect the preference of children.

Gift shop. Many visitors (especially families) expect to purchase a souvenir of their visit. It is unclear how this effects visitor satisfaction or motivation to visit.

MACRO-ARCHITECTURE

The architectural style of the building may also convey meaning to visitors (e.g., Bitgood, 2000, Thompson, 1993). The architectural difference between art museums and children's museums illustrates this point. Art museums tend to be designed as temples with large columns, palatial stairs to the entrance, and large atriums, all designed to create a feeling of awe and reverence. Both written and unwritten messages command the visitor not to touch. It is ironic that the outside entrance to the Philadelphia Museum of Art is used quite differently than originally intended. Skateboarders fly down the stairs

while would-be Rocky imitators run up the stairs and jump up and down as Rocky did in the movie.

A children's museum is designed quite the opposite. The message here is come in and enjoy, play, touch, have fun. Bright colors, attractive objects, and easy-to-do activities are the norm.

VISITOR VARIABLES

The environmental factors described above (lobby, exhibitions, amenities, macro-architecture) are only part of the museum formula. Visitor variables also play an important role. In addition, environmental and visitor variables invariably interact.

Demographics and leisure values

As one might suspect, age, gender, educational level are important variables in understanding the museum environment. In addition, Hood (1983) has provided evidence that leisure values are strongly correlated with visitation patterns.

Social influence

The overwhelming percentage of visitors come in groups — usually with families or friends unless they are part of a school group. Consequently, museum visitation is, to a large extent, a social experience. Groups typically approach an exhibit together and discuss the exhibit, point to exhibit elements, and try as a group to make sense of the display. Provocative exhibits tend to stimulate group discussion and pointing.

Exhibit design often interacts with visitor variables. For example, some exhibits allow only one individual access, while others encourage group participation.

Preknowledge and attitudes

Visitors enter the museum with knowledge and attitudes that influence their interests and how they cognitively process their museum experience. Some type of misconceptions for any subject matter can be found in visitor studies. These preconceptions are important to identify at an early stage of exhibition development so that the exhibition can be designed to correct them. For example, Borun (1988) found that visitors he]d several misconceptions about the concept of "gravity." She then designed and tested exhibits to correct these misconceptions.

FINAL THOUGHTS

Environmental design in museums is still in its infancy and suffers from a lack of competent researchers. However, practitioners do not suffer from a lack of enthusiasm and it is expected that improved education and training will continue to develop. Despite the limitations, there are a number of empirical principles that seem to have generality across museums, and visitors. It is difficult to predict the degree to which these principles will be able to guide museum design. At worst, they provide a set of heuristics which, combined with front-end, formative, and remedial evaluation can greatly improve the chances of success.

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