DEADLY SINS REVISITED: A REVIEW OF THE EXHIBIT LABEL LITERATURE

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INTRODUCTION

Label development is an important concern of every visitor facility particularly when interpretation is a major goal. One of the best resources for label development is Bevery Serrell's (1983) manual, *Making Exhibit Labels: A Step by Step Guide*. In addition to providing a step-by-step process for designing effective labels, Serrell (p. 18-19) suggests "eight deadly sins" that are characteristic of unsuccessful labels:

1. too long and wordy;
2. too technical for the intended readers;
3. boring, with inappropriate information;
4. badly edited, with mistakes in grammar, spelling, or syntax;
5. too small – tiny words crammed on a 3 x 5 card;
6. hard to read (the result of poor typography);
7. colored in a way that makes reading difficult or tiresome;
8. badly placed, causing neck, back, or eye strain in the viewer.

Serrell's book was published in 1983 and is still an excellent resource. Since that time, there have been several studies that have addressed many of the parameters of effective label design. The current review attempts to look at the visitor studies that support this list of "sins" and, in some cases, describe in greater detail and/or expand upon it. In the final section, an attempt is made to explain visitors' reaction to labels in terms of the empirical factors reviewed.

EMPIRICAL FACTORS THAT INFLUENCE LABEL READING

1. Label Length

Serrell's first sin, "too long and wordy," has been verified repeatedly. Several studies have shown that label length correlates negatively with visitor reading (see Table 1). However, it is not clear what the relevant variables are for this factor, since it could be defined in any of the following ways: number of words, number of lines, number of sentences, number of information chunks, etc. From a review of the studies, it seems that the following inferences may be drawn: (1) longer labels result in a lower percentage of visitors who stop; (2) when visitors do read, they read a larger proportion of short labels than they do of long labels; and (3) the same amount of information can draw more attention if it is presented in smaller chunks.

It is difficult to state exactly how many words should be included on labels, since other factors may interact with label length. For example, in one study (Bitgood, et al, 1989) visitors spent longer reading a label on a topic of unusual interest than they spent on shorter labels. Presumably, the interest level in the subject matter may counteract the tendency not to read long labels. Other factors such as "museum fatigue" might also interact with label length. Future research efforts should study such interactions. It does appear that a "safe" number of words per label is somewhere between 30 and 75.

2. Label Placement: Vertical Position

This factor refers to the placement of labels with respect to height from the floor or ground. While Serrell's 8th sin ("badly placed, causing neck, back, or eye strain in the viewer") may apply to this factor, the major problem with labels placed more than a couple of feet above eye level is that visitors don't appear to notice them as easily as labels placed in a lower position (see studies in Table 1, page 8). For whatever reason, visitors are less likely to visually explore their environment by looking up than by looking from side to side or down. The results of these studies suggest that for optimum viewing, labels should be placed below a height of 6 or 7 feet off the floor or ground. However, an important consideration in such placement is where the visitor will stand to read the label. The greater the distance between the label and where the visitor stops, the more likely visitors will read labels placed high off the floor/ground.

3. Label Placement: Relational Position

This factor refers to label placement in relation to other labels, other objects, and architectural features such as circulation pathways, exits, etc. As in the case of vertical placement, Serrell's 8th sin (badly placed so as to cause visitor discomfort) does not fully explain why visitors do not read poorly placed labels. Badly placed labels may not be

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detected by the visitors because the labels never fall within the visitors' line-of-sight. Table 1 (page 9) provides a summary of studies dealing with this factor. Several conclusions are suggested by these studies. First, labels should be placed so that they can be easily read while visitors are stopped and looking at the exhibit. This means that they should be in the immediate area that visitors stop, they should be close to the exhibit objects to which they refer, and they should be visible without visitors having to turn around. Second, it should be immediately obvious to which objects or animals the label refers. Third, the impact of architectural features such as pathways and exits on visitors must be carefuly considered when placing labels. The work of Melton (1935) suggests that an exit draws visitors away from exhibits. If this is so, it can be reasoned that labels close to an exit will receive less attention.

4. Size of Letters and Graphics

Serrell's 4th sin ("too small") has also been empirically verified. In at least two studies, the size of letters and graphics has been shown to influence whether visitors stop to read labels (see Table 1, page 8). Letter size too small to read easily appears to be only one aspect of this factor. Large letters may make the label more noticeable.

5. Density of Labels or Objects

The effects of density of labels (i.e., the number of labels per fixed space) on visitor label reading was not part of Serrell's "eight deadly sins" and has received little attention in empirical studies. It seems reasonable to assume that a high concentration of labels will result in a lower probability of visitor reading. Melton's (1935) work on the density of paintings in an art gallery may be relevant to this factor. As the number of paintings in the gallery increased, both the average number of paintings viewed and the average time per painting decreased. If this effect generalizes to the problem of how visitors attend to exhibit labels, it suggests that a high density of labels will be associated with a low probability of reading. Since there is currently no empirical data on this factor, we can only speculate at the current time.

6. Figure-Ground Contrast

Several authors have argued that figure-ground contrast between lettering/graphics and the label's background influences label reading by visitors (e.g., Borun & Miller, 1980; Serrell, 1983; Weiner, 1963). This factor is Serrell's 7th sin ("colored in a way that makes reading difficult or tiresome"). If there is not sufficient contrast, it is difficult to distinguish letters from their background. Although no one is likely to dispute the importance of this factor, we could find no visitor-related studies that validate its importance.

7. Subject Matter/Content/Grammar

Serrell suggested three "sins" associated with this factor: "too technical for the intended readers;" "boring, with inappropriate information;" and "badly edited, with mistakes in grammar, spelling, or syntax." Suggestions by Serrell (1983) and Rand (1985) on writing copy for labels can serve as valuable guidelines. Adding human interest and using good style should not be ignored. While the label's content is obviously important, there have been few attempts to measure the impact of content on visitor label reading.

Under at least some circumstances, the content of the label may influence label reading. It is unclear at this point what types of content stimulate reading-related behavior. One possible factor is "visual content," defined by Serrell (1981) as "information that directs the visitor's attention to the exhibit by asking questions or makes comparisons using information which can be visually verified." Obviously, the interest level of the subject matter will also affect reading. High interest topics have been shown to result in longer reading times (e.g., Bitgood, Conroy, Pierce, Patterson, & Boyd, 1989).

8. Cueing

Visitor cueing involves the use of stimuli such as verbal or written instructions to look at labels or look for particular content in labels (see Table 1, page 9). For example, a handout with questions that can be answered by reading the labels substantially increased label reading in both a zoo and museum (Bitgood & Patterson, 1987). In another study, a question presented as the label headline increased visitor reading (Farrington, et al, 1989). Questions placed on the exhibit cases near labels that had previously received very little attention resulted in a dramatic increase in label reading (Hirschi & Screven, 1988). Cueing was not mentioned by Serrell in her list of "deadly sins." This is not surprising since Serrell was concerned with developing effective labels rather than improving ineffective ones. Cueing has been used primarily to save labels that suffer from the "deadly sins." However, it could also be used to increase attention to good labels.

9. Movement

Movement attracts attention. Movement can draw visitors to an exhibit and, once at the exhibit, visitors may read. On the other hand, movement could distract visitors from reading if such movement competes with label reading. An animal engaged in movement in a zoo may be more interesting to visitors than label reading. There is no data currently available that tests the effects movement on label reading.

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10. Multi-sensory Inputs (Sound, touch, etc.)

Sensory inputs other than visual stimuli may also draw the attention of visitors. Peart (1984) reported that adding sound to a crow exhibit attracted more visitor attention and resulted in more visitor interaction with the exhibit. In zoos we have frequently observed visitors being attracted to an exhibit containing an animal making noise. Once the visitor is attracted to the exhibit, the chances of label reading may be enhanced. More data is needed to determine under what conditions increased visitor attention may occur with muli-sensory inputs.

11. Manipulative Stimuli

Manipulative stimuli such as flip labels may influence visitor reading. While flip labels have been used for years, there are few carefully controlled studies to substantiate their effect. Farrington, Schreider, Webb & Zemach (1989), in one of the only empirical reports, found no substantial increase in visitor reading with the introduction of a flip label. Chan Screven (personal communication), who has studied flip labels for several years, suggests that such devices must be carefully designed if they are to work effectively.

12. Color

Advertisers claim that color in retail displays attracts consumer attention. If so, then the same principle should apply to exhibit labels. However, empirical support for such an impact has yet to be demonstrated. We could find only one study that addressed this factor. Borun and Miller (1980) found no increase in reading by children when a colored border was placed around label text. Since the sample size for this study was small and since the subjects were children who have a low probability of reading, we should be cautious about drawing any conclusions from this study. More studies are needed.

13. Diagrams, Illustrations, and Photographs

It is often assumed that the presence of diagrams, illustrations, and/or photographs will increase attention to a label. Unfortunately, as of this moment, there is little data to support this contention (See Table 1, page 9). Borun and Miller (1980) found that neither a diagram illustrating a scientific principle or a drawing of "Star Wars" character R2D2, had any effect on label reading in children. Bitgood, Nichols, Pierce, Conroy, and Patterson (1986) found no changes in visitor reading when an illustration was added to a label. While these studies may not have adequately tested the effects of illustrations and photographs, they may suggest that such label supplements do not have a universally enhancing effect on label reading. If these label enhancements do have an effect, it may be in drawing attention to a label that would not otherwise be noticed because of visual competition from other labels and/or objects.

14. Typography

Typography refers to the style, arrangement, or appearance of letter typeset. The reader is referred to Serrell's (1983) excellent discussion of typography for a detailed description of this factor. We could find no empirical studies in aquariums/museums/zoo/science centers that reported on the effects of typographical factors such as: line length, line spacing, justification of lines, and all capitals versus lowercase and capitals. Previous research appears to come from textbook-type applications. Whether or not such findings generalize to exhibit labels remains to be demonstrated.

15. Ambiguous Coding

Roger Miles (1989) has suggested that the label designer and the visitor may use different codes for interpreting information contained on a label. For example, in an arctic fox exhibit at the Birmingham Zoo we observed a parent looking at the habitat sign, "Arctic Tundra," and mistaking it for the name of the animal. Time lines on charts are often misread by readers. Visitors may have difficulty discriminating one symbol from another as is often the case in the use of animal silhouettes in wayfinding systems. Evaluating visitors' understanding of any coding system should be a necessary part of the development of the system.

16. Size of the Label's Background

The size of the label's background may be important because larger signs are more noticeable than smaller ones. Hodges (1978) found an increase in label reading when the total size of the sign was enlarged. However, Bitgood, Nichols, Pierce, Conroy, and Patterson (1986) found no increase in visitor attention to a label when the background was enlarged by four times the original area. While it is too early to make any empirical conclusions, we might speculate that the effects of the background size may be most important when there are many objects visually competing for the visitors' attention. In the study by Bitgood, et al (1986), detecting the labels was easy since there were very few visual distrations in the exhibit gallery.

TOWARD AN EXPLANATION OF VISITOR BEHAVIOR

In order to better predict visitor reactions to exhibit labels, it would be helpful to understand how each of the emprical factors (e.g., label length, placement) influences

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visitors. This section offers some possible explanatory processes that may prove useful in better understanding visitors. The following mechanisms for explaining visitor reading are suggested:

• *Line of sight*: labels are most likely to be noticed if they fall within visitors' visual field as the visitor moves through the exhibit area. Objects placed overhead are often out of a person's line of sight because people are less inclined to look up than to look from side to side.

• *Signal detection*: labels must be salient in order to be noticed or detected by visitors. Visual "noise" such as many stimuli competing for the visitor's attention, make detection more difficult.

• *Legibility*: label text must be easily distinguished from background and letters must be clearly discriminated. If letters are too small or if letters are difficult to distinguish from one another, then legibility decreases.

• *Perceived cost-benefit*: visitors appear to weigh the cost (e.g., effort) and benefits (e.g., interest level) before approaching or reading a label. If the perceived effort is greater than the perceived interest, reading is unlikely to occur.

• *Mental processes*: comprehension level and interpretation coding are assumed to influence visitor reactions to labels. Thus, technical language, abstract concepts, and ambiguous coding is likely to discourage label reading or create misconceptions.

Table 2 summarizes the possible explanatory processes associated with each empirical factor. At this point each of these processes can be described only in a sketchy way. Parameters need to be carefully mapped out. For example, "line of sight" can be described in terms of height, width, and distance. How much does visitor looking decrease with each increase in height of one foot? With respect to the "signal detection" process, what variables contribute to visual "noise" (stimuli that interfere with detecting an exhibit label)?

CONCLUSIONS

Several conclusions seem appropriate from the above literature review. First, although we are beginning to understand some of the variables that influence visitor label reading, we have very little understanding of interactions among these variables. Second, some factors have received very little study. Third, in light of the lack of sufficient empirical guidelines, front-end and formative evaluation should be carried out in the development of labels. Fourth, additional "deadly sins" of labeling can be added to Serrell's list. Finally, explanatory processes need to be derived from the empirical findings.

Interactions among variables

We need to study how factors such as interest level, fatigue, etc. influence visitor reading with varying lengths of labels, varying placements, etc. Carefully controlled research projects are necessary in order to make progress in this area.

Factors in need of study

We need more empirical study of many factors such as label density, typography, visual enhancements (diagrams/illustrations/photographs), manipulative labels.

Need for evaluation

Front-end evaluation is needed to assess what visitors already know about the subject matter, their level of interest, and any misconceptions they may have. In addition, formative evaluation is needed to trial test labels under development. Evaluation can help avoid the "deadly sins" by designing labels for their intended audience and by trial testing the labels before they are finally installed.

Additional "deadly sins"

Based on the above review, at least three new "sins" may be added to Serrell's list:

9. fails to "grab" the attention of the visitor.
10. codes are open to ambiguous interpretation.
11. is lost among the visual "noise" of too many other labels and objects.
12. doesn't address visitor knowledge, interest, and misconceptions.

Explanatory processes

In order to better predict visitor behavior, we need to develop theoretical systems. Several explanatory concepts are suggested in this article. Considerable research is needed before these mechanisms will have high predictive value in the design of labels. For the moment, these mechanisms may serve as general working principles. If designers consider such mechanisms as "line of sight," "perceived cost/benefit," "signal detection," "legibility", and various mental processes (e.g., coding, prior knowledge), the probability of a successful exhibit label should be improved.

[See "Bibliography on Exhibit Labels" on pages 13-14 for complete references to the citations in this article.]

Table 1
Summary of Empirical Studies

STUDY/FACILITY	EXHIBIT & FINDINGS
STUDIES ON LABEL LENGTH	
Bitgood, Nichols, Pierce, Conroy, & Patterson (1986)/ ANNISTON MUSEUM OF NATURAL HISTORY	*Egyptian Mummy* exhibit. Higher percentage of visitors read when the information was divided into 3 labels, each 50 words, rather than presented in one label of 150 words.
Bitgood, Conroy, Pierce, Patterson & Boyd (1989)/ ANNISTON MUSEUM OF NATURAL HISTORY	*Attack and Defense* exhibit. Label reading was negatively correlated with label length. Longer labels received less reading than short ones.
Borun & Miller (1980)/ FRANKLIN INSTITUTE	*Gravity Tower* exhibit. Proportion of visitors reading the complete label decreased as the number of topics increased.
Farrington, Schreider, Webb, & Zemach (1989)/ DENVER MUSEUM OF NATURAL HISTORY	*Tyrannosaurus Rex* exhibit. Eliminating the donor panel of a multi-framed label increased the readers.
Hodges (1978)/ MILL MOUNTAIN CHILDREN'S ZOO	All exhibits. Decreasing the number of words/increasing size of the background increased visitor reading.
Robinson (1931)/ BUFFALO MUSEUM OF SCIENCE	Not specified. Decreasing number of words and simplifying the technical language increased visitor reading.
Serrell (1981)/ BROOKFIELD ZOO	Various exhibits. Labels with fewer words and "visual content" were read by more visitors.
Thompson & Bitgood (1988)/ BIRMINGHAM ZOO	*Predator House.* Labels with fewer words were read more often than those with more words.
STUDIES ON VERTICAL PLACEMENT	
Bitgood, Conroy, Pierce, Patterson, & Boyd (1989)/ ANNISTON MUSEUM OF NATURAL HISTORY	*Attack and Defense* exhibit. Labels placed above 8 feet off the floor were read less often than labels placed between three and six feet.
Bitgood, Benefield, & Patterson (1989)/ NORTH CAROLINA ZOO	Several exhibits. Labels in the "header" position were read less often than in the "rail" or "side" positions.
Bitgood & Patterson (1989)/ BIRMINGHAM ZOO	*Social Animal* building. Labels in the "header" position were read less often. (correlation)
STUDIES ON LETTER SIZE	
Bitgood, Nichols, Pierce, Conroy, & Patterson (1986)/ ANNISTON MUSEUM OF NATURAL HISTORY	*Egyptian Mummy* exhibit. Increasing the letter size resulted in higher percentage of label reading.
Thompson & Bitgood (1988)/ BIRMINGHAM ZOO	*Predator House.* Larger letters produced higher percentage of label reading.

STUDY/FACILITY	EXHIBIT & FINDINGS
STUDIES ON RELATIONAL PLACEMENT	
Bitgood, Nichols, Pierce, Conroy & Patterson (1986)/ ANNISTON MUSEUM OF NATURAL HISTORY	*Egyptian Mummy* exhibit. Labels placed closer to exhibit object were read by more visitors.
Bitgood, Conroy, Pierce, Patterson & Boyd (1989)/ ANNISTON MUSEUM OF NATURAL HISTORY	*Attack and Defense* exhibit. Labels placed in line-of-sight were read more often than those requiring visitors to turn, etc.
Bitgood, Benefield, & Patterson (1989)/ NORTH CAROLINA ZOO	Several exhibits. Labels placed behind viewing area or away from where visitors stop were less likely to be read.
Melton (1935)/ BUFFALO MUSEUM OF SCIENCE PENNSYLVANIA MUSEUM OF ART NY MUSEUM OF SCIENCE & INDUSTRY	Several museum galleries. Visitors tended to leave at the first exit they came to even though they had not viewed all of the exhibits.
Melton (1972)/ NEW YORK MUSEUM OF SCIENCE AND INDUSTRY	*Development of Plow* exhibit. Labels were more likely to be read when placed on racks below the exhibit case than on the wall or on stands on top of the cases.
Thompson & Bitgood (1988)/ BIRMINGHAM ZOO	*Predator House.* Labels placed off the visitors' path were read less often than those on the path.
STUDIES ON CUEING	
Bitgood & Patterson (1987)/ BIRMINGHAM ZOO and ANNISTON MUSEUM OF NATURAL HISTORY	*Predator House/Alabama Cave* exhibit. Questions on handout increased time at exhibit and label reading.
Farrington, Schreider, Webb, & Zemach (1989)/ DENVER MUSEUM OF NATURAL HISTORY	*Tyrannosaurus Rex* exhibit. A question presented as the label headline substantially increased the percentage of label readers.
Hirschi & Screven (1988)/ MILWAUKEE PUBLIC MUSEUM	Five separate exhibits. Questions placed on exhibit cases dramatically increased visitor reading.
STUDIES ON DIAGRAMS, ILLUSTRATIONS AND PHOTOGRAPHS	
Borun & Miller (1980)/ FRANKLIN INSTITUTE	*Gravity Tower.* Addition of a colored border around label and/or a drawing of "Star Wars" R2D2 increased label reading in children.
Bitgood, Nichols, Pierce, Conroy, & Patterson (1986)/ ANNISTON MUSEUM OF NATURAL HISTORY	*Egyptian Mummy exhibit.* No increase in visitor reading when an illustration of hieroglyphics added to label.

Table 2
Possible Explanatory Processes

EMPIRICAL FACTOR/ OBSERVATION	EXPLANATORY PROCESS	DESCRIPTION
LABEL LENGTH/ Observation: short labels are read more than long labels.	Perceived cost/benefit	The perceived effort to read long labels overpowers the perceived benefit of reading unless the visitor is extremely interested in the subject matter.
VERTICAL PLACEMENT/ Observation: labels placed high on vertical plane are read less often.	Line-of-sight	Labels placed overhead are out of the visitors' line-of-sight because of the tendency of people to not to look up.
RELATIONAL PLACEMENT/ Observation: labels placed away from the circulation flow are less likely to be read.	Line-of-sight	Labels placed within circulation flow are more likely to fall within viewer's visual field.
	Perceived cost/benefit	The perceived effort to approach the label placed away from the exhibit object may be stronger than the perceived benefits; architectural features such as exits may draw attention away from labels.
SIZE OF LETTERS/ Observation: labels with large letters are more likely to be read than labels with small letters.	Legibility	Letters must be large enough to be clearly read.
	Signal detection	Even when labels are in the visitor's line-of-sight, the problem of detecting a label from visual "noise" remains; large letters are more salient and can be detected easier than labels with small letters.
DENSITY OF LABELS/ Observation: it is speculated that a high density of labels results in a lower probability of reading.	Signal detection	A high concentration of labels make detection of individual labels difficult.
	Perceived cost/benefit	Effort to read high density of labels may be more than perceived benefits.
FIGURE-GROUND CONTRAST/ Observation: it is assumed that better contrast results in increased reading.	Legibility	There must be sufficient contrast between letters and their background in order to distinguish letters.
	Signal detection	If labels and letters blend into the background, they are dificult to detect.
SUBJECT MATTER-CONTENT/ Observation: content of the label influences visitor reading.	Perceived cost/benefit	Topics of interest are more likely to be read since perceived benefit (satisfaction) is greater than the perceived effort.
	Comprehension level	Visitors will stop reading what they do not

EMPIRICAL FACTOR/ OBSERVATION	EXPLANATORY PROCESS	DESCRIPTION
CUEING/ Observation: labels are more likely to be read if visitors are cued to read.	Signal detection Perceived cost/benefit	Cueing may draw attention to labels that were not initially noticed. Cueing may increase interest in topic.
MOVEMENT/ Observation: moving objects may attract visitors to exhibit label.	Signal detection	Moving objects are more visually salient and consequently draw attention.
MULTI-SENSORY INPUTS/ Observation: sound attracts visitors to exhibit area and may increase reading.	Signal detection Perceived cost-benefit	Sound draws visitor attention resulting in visually searching for the source. Multi-sensory stimuli may be more intrinsically interesting.
MANIPULATIVE STIMULI/ Observation: labels with interactive elements may receive more attention.	Perceived cost/benefit	Touching and manipulating objects appears to be intrinsically rewarding.
COLOR/ Observation: labels with color may attract more attention than black and white labels.	Signal detection Perceived cost/benefit	It may be assumed that color is more salient than black-and-white and thus more easily detected. Color may be intrinsically more interesting than black-and-white.
DIAGRAMS, ILLUSTRATIONS, & PHOTOGRAPHS/ Observation: illustrations and photographs may increase visitor attention.	Signal detection	Diagrams, illustrations, and photographs may increase the salience of the label.
TYPOGRAPHY/ Observation: it is assumed that typography influences whether or how much visitors read.	Legibility	Typographical appearance influences whether or not the letters can be easily read.
AMBIGUOUS CODING/ Observation: visitors may use a different interpretive code than was intended by the label designer.	Cognitive processes	Cognitive codes are not always understood by visitors.
SIZE OF LABEL BACKGROUND/ Observation: larger backgrounds may attract more attention than smaller ones.	Signal detection	Under conditions of high "visual noise," larger label backgrounds may be more salient and thus more easily noticed.