A Front-End Evaluation of *Texas Prehistory: How Do We Know?*

Prepared for
The Fort Worth Museum of Science and History

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EXECUTIVE SUMMARY

Only selected highlights of the study are included in this summary. Readers are urged to read the body of the report for a more detailed account of the findings.

INTRODUCTION

This report presents findings from a front-end evaluation of *Texas Prehistory: How Do We Know?,* under development by the Fort Worth Museum of Science and History and supported by a National Science Foundation (NSF) planning grant. This 10,000 square-foot permanent exhibition, with accompanying traveling exhibition and educational programs, focuses on current archaeological and paleontological fieldwork taking place in Texas and explores how scientists are able to piece together the past.

An integral part of the NSF planning grant is the front-end evaluation. Randi Korn & Associates (RK&A) designed this front-end evaluation to identify the background knowledge, conceptions, and observation skills visitors bring with them to an exhibition about prehistory. The specific objectives of the evaluation were to determine:

- How visitors see and understand select specimens
- What steps visitors go through to identify a specimen
- How visitors see and understand a wall of layered rock
- Visitors' conceptions about what scientists do and do not know about prehistory
- Visitors' comfort level using hands-on laboratories to uncover specimens' identities, ages, origins, etc.
- Visitors' ability to draw relationships between today's environment and a habitat that may have existed millions of years ago
- Visitors' ability to distinguish between the work of an archaeologist and a paleontologist.

METHODOLOGY

To understand visitors' conceptions of prehistory and how the work of paleontologists and archaeologists differs, two sets of in-depth interviews were conducted (see Appendix A). In one set 20 visitors were asked questions about a series of specimens, and in the other 20 visitors were asked questions about a painting depicting a dinosaur scene. The data reported in this report are qualitative, meaning that the results are descriptive, following from the conversational nature of the interviews.

The purpose of conducting in-depth interviews is to encourage and motivate interviewees to express their opinions and feelings, recollect memories and associations, and share with the interviewer thoughtful responses to complex questions. Open-ended interviews produce data rich in information because interviewees talk about their experiences from a very personal

perspective. Thus, both interview guides were intentionally open-ended to allow interviewees the freedom to discuss what they felt was meaningful.

I. INTERVIEWS ABOUT SPECIMENS: PRINCIPAL FINDINGS

Responses to Specimens

Interviewees were asked to look closely at seven specimens and for each one to describe what they saw.

Specimen 1: Lava Rock

- About three-fifths of interviewees identified the first specimen as lava based on their preconceptions of lava's physical characteristics or on comparisons made between specimens.

Specimen 2: Limestone with Fossil Crinoids

- All but one of the interviewees identified the second specimen as a fossil. Most spoke little about what they actually saw but rather drew conclusions about the specimen's identity, age, origin, and formation.

Specimen 3: Dinosaur Vertebra

- One-half of interviewees made comparisons between the dinosaur vertebra and the cow vertebra. By making comparisons, some interviewees were able to conclude that the dinosaur vertebra is fossilized bone.
- The other one-half of interviewees did not make comparisons between specimens but instead used the specimen's physical characteristics to conclude that it is bone.

Specimen 4: Cow Vertebra

- All of the interviewees identified the fourth specimen as bone. Three-quarters made the identification by comparing the cow vertebra with other specimens.

Specimen 5: Cow Rib

- All of the interviewees identified the fifth specimen as bone; three-quarters used the specimen's physical characteristics or their prior experience with bones to aid their identification.
- One-quarter made comparisons between the fossilized and recent bones and offered not only a plausible identification for the fifth specimen but also an idea of its relative age.

Specimen 6: Dinosaur Rib

- In contrast with the other fossil and bone specimens, none of the interviewees compared the sixth specimen with any of the others. Instead, all of the interviewees discussed the physical characteristics of the specimen as they attempted to identify it as bone, fossilized wood, rock, or a tool.

Specimen 7: Pigeon Skeleton

- Two-fifths of interviewees referred to the specimen's identification label as they described the skeleton.
- About one-quarter of interviewees made comparisons between the pigeon skeleton and other specimens as well as to dinosaurs and other prehistoric animals.

Relationships among Specimens

After discussing all of the specimens, interviewees were asked, "As a group, all of the specimens together, what, if anything, do they have in common? Does one give clues about another?"

- While most interviewees thought the specimens had something in common, many did not think that looking at one specimen could give clues about another.
- About two-fifths of interviewees suggested that all the specimens were concerned with living organisms; furthermore, most thought their commonality was that they are all bones.

Ways to Identify Specimens

Interviewees were asked, "If you were given the task of having to identify any of the specimens, what might you do?"

- About three-quarters of the interviewees said they would use the library, books, the Internet, knowledgeable people, museum exhibits and staff, or a combination of these if trying to identify the specimens.
- Only three interviewees said they would try to identify the specimens by working with the specimens themselves.

Responses to Rock Wall

Interviewees were asked to look closely at a simulated rock wall in the *Dino Dig* area and to describe what they saw.

- About two-thirds of interviewees said the wall was composed of layers of different kinds of rock. Some simply described the layers, while others talked about them in relation to erosion.

Thoughts on a Dinosaur Bone and Arrowhead Being Found Together

The following situation and question were posed to interviewees: "Let's say you were digging here, and next to a dinosaur bone you found an arrow head. What would you think about that?"

- Eleven individuals, slightly over one-half of interviewees, stated that humans and dinosaurs did not coexist. Some of these participants offered explanations for how

the dinosaur bone and arrowhead could have been found together, while others did not know how to explain the find.

- Eight interviewees stated that humans and dinosaurs lived at the same time and, of these, only one stated religious reasons for this belief.
- One individual was uncertain as to whether people and dinosaurs coexisted.

Laboratory Stations

Interviewees were shown conceptual drawings of the new dinosaur exhibition (see Appendix B) and were told about the possibility of including laboratory stations. They were then asked, "How comfortable would you be doing activities like these in an exhibition about dinosaurs?"

Comfort Using Laboratory Stations

- Most interviewees said they would feel comfortable using an exhibition with laboratory stations.
- About one-quarter of interviewees were concerned that an exhibition with laboratory stations might not be age appropriate for their very young children.

Interviewee Suggestions for Encouraging Use of Laboratory Stations

Interviewees were asked what else should be included in the exhibition to encourage and help families use the lab stations.

- Most suggestions were idiosyncratic, but a few themes emerged: have staff in the exhibition to assist visitors; include a walk-through, simulated prehistoric environment; provide activities for different ages and knowledge levels; give tips on how to look at specimens; and include touchable items.

Other Interviewee Comments

- Two individuals made additional comments relevant to development of a dinosaur exhibition: one interviewee said her husband did not think dinosaurs were real before their son became interested in them, and another interviewee said both evolution and creationism should be given equal weight in an exhibition.

II. INTERVIEWS ABOUT THE DINOSAUR PAINTING: PRINCIPAL FINDINGS

Responses to Dinosaur Painting

Visitors were asked to look closely at a Karen Carr dinosaur painting (see Appendix C) and were then asked to describe what they noticed about the environment depicted in the painting.

- All of the interviewees talked about the dinosaur. In addition to describing the dinosaur, some interviewees inferred the dinosaur's behavior from its appearance, made comments about the presence of the mammal, and discussed the plants.

How Do Scientists Know What the Environment Was Like?

After describing the environment depicted in the Carr painting, interviewees were asked a series of four questions related to how scientists are able to determine what prehistoric life was like.

How Are Scientists Able to Piece Together the Past?

The first question asked interviewees, in light of what they had seen in the Carr painting, "How do you think scientists are able to figure all of this stuff out?"

- Interviewees' views on scientists follow a continuum, with many interviewees stating that scientists make "guesses" or "assumptions" about dinosaurs.
- Most interviewees stated that scientists depend upon physical evidence such as dinosaur fossils and tracks to learn about the past.
- Two interviewees thought that legends and paintings could serve as sources of information about dinosaurs.

How Do Scientists Know about Prehistoric Plants?

Interviewees were then asked, "How do scientists know what kinds of trees existed?"

- Three-quarters of interviewees said that scientists use fossils. Several interviewees simply stated that plants fossilize, while others discussed the significance of finding fossilized plants and dinosaurs together.

How Do Scientists Know How Dinosaurs Walked?

After talking about prehistoric plants, interviewees were asked, "How might scientists know how dinosaurs walked—on two legs or four?"

- Most interviewees said scientists could determine how a dinosaur walked by looking at its bones; one-half discussed the significance of the relative sizes of bones, while others cited how bones "fit together."

How Do Scientist Know What Kind of Habitat Existed?

The final question about scientists asked, "How might scientists know what kind of habitat existed millions of years ago? What clues do they have in today's environment to indicate what existed millions of years ago?"

- Several interviewees simply restated that scientists get most of their information from fossils, while others suggested that scientists also look at the terrain and strata in which fossils are found and use carbon dating.
- A few interviewees thought scientists could study modern animals or plants to better understand prehistoric ones.

Knowledge of What Archaeologists and Paleontologists Do

At the end of the interview, participants were shown two cards: one with the word "archaeologist" and another with "paleontologist," and were then asked to describe what each ones does.

- Overall, a greater range of responses were elicited by “archaeologist” than by “paleontologist,” as some interviewees were uncertain whether archaeologists concentrate on animals, or humans, or the Earth.
- One-half of interviewees thought archaeologists either excavate or study fossils.
- Interviewees thought paleontologists study animals or plants, with one-quarter stating that paleontologists study dinosaurs.

DISCUSSION AND RECOMMENDATIONS

Although most interviewees did not know a great deal about dinosaurs and were not confident of what they did know, dinosaurs continue to capture the hearts and minds of families and thus provide a unique vehicle for introducing children and adults to the processes of scientific discovery.

INTERVIEWEE RESPONSES TO DIFFERENT INFORMATION SOURCES

Specimens

While interviewees were generally not accustomed to using specimens as sources of information, once they were guided through the process of looking closely at specimens, they made keen observations and perceptive comments. When interviewees were initially asked to look closely at specimens and describe them, most interviewees responded by naming the specimens. They did not seem to distinguish between naming and describing and, upon naming the specimens, were concerned as to whether they had given the "right answer." For many interviewees, the difficulty arose, in part, from not knowing how to look closely at specimens. After these interviewees were given a few suggestions on what to look for (e.g., colors, textures, shapes, etc.), they were better able to make insightful comparisons and conclusions. For others, the issue was not having the vocabulary to describe what they were seeing. They relied on labels such as "fossil," "petrified," and "bone" as descriptors and often used these words interchangeably. This use of imprecise language makes it difficult to determine whether interviewees understood the difference between recent and fossilized bone or what it means for a bone to fossilize.

Interviewees found some specimens easier to describe and compare than others. Specimens with which interviewees were the least familiar encourage closer observations and greater detailed description than those with which they were somewhat familiar. For example, interviewees described more visual elements of the dinosaur rib and vertebra, compared to other specimens, because their identities were somewhat mysterious to interviewees, whereas they insisted on naming the lava rock and cow vertebra because these specimens were familiar. Interviewees' observations were also stifled by identification labels, as in the case of the pigeon skeleton. They did not see the purpose of describing a specimen that was already identified for them.

In terms of making comparisons between specimens, interviewees were more comfortable talking about immediate differences and similarities in specimens' shapes, colors, textures, or weights. For example, by comparing the similar shapes and different weights of the two vertebrae, some interviewees were able to identity them as backbones, with one being recent and the other fossilized.

During the course of the interviews, many interviewees overcame initial difficulties analyzing specimens, but remained uncertain as to the purpose of the activity. Even after interviewees identified important features of the specimens, made comparisons between them, and came to thoughtful conclusions, many did not think that one specimen could give clues about another. Further, when asked what steps they would take if they had to identify one of the specimens, most said they would look to external resources such as books and knowledgeable people. Only three suggested that they would use their own observation skills. None of the visitors

acknowledged a connection between what *they* were doing with specimens and what *scientists* do to reconstruct the past.

Recommendations

- Once visitors are given guidance and encouragement to work with specimens, they are able to make skillful observations and draw insightful conclusions. Thus, basing the exhibition around a mystery that visitors solve by gathering clues should provide the appropriate structure and motivation for visitors to learn about dinosaurs and scientific processes.

- Looking carefully at specimens may be a new activity for many visitors. Because the proposed exhibition's theme depends on observation skills, developers may need to provide strategies for studying specimens, questions to focus observations, and possibly even staff to introduce visitors to the idea of using specimens as sources of information.

- Because visitors have little faith in their own observation skills, exhibition components that provide feedback and progressive challenges may be one way to develop their confidence.

- Clearly defining and explaining words such as "bone," "fossil," and "petrified" in the introductory section and other relevant components may be necessary, as visitors use these words interchangeably.

- The exhibition may need to help visitors make comparisons by including carefully selected and paired specimens that have easily discernible physical characteristics (e.g., unique shape of vertebra) and obvious similarities or differences (e.g., fossil versus recent bones).

- Developers may want to consider concealing answers to questions or specimens' identities under flip panels or using an electronic game card or other device to allow visitors the opportunity to first explore before turning to a trusted information source.

- Developers should make the purpose behind looking closely at specimens explicit to visitors and overtly state the connection between what visitors are doing with specimens and what scientists do to understand the past.

Rock Wall

Interviewees were much more comfortable talking about the rock wall than about the specimens. They spoke with ease about its layers, and some developed ideas about how events in the past are recorded in the rock. Two-thirds of interviewees were able to discern that the wall was composed of layers of different kinds of rock (some going as far as to say that one of the layers was "sedimentary rock"). Many of these interviewees talked about how erosion had shaped the wall, and a few discussed how the rock showed environmental change over time. Interviewees' thoughtful responses may have resulted from the timing of the question (asked later in the interview once interviewees were more comfortable talking with the interviewer) or because looking at landscapes may be a more familiar activity than looking at specimens (some interviewees mentioned visiting areas that reminded them of the rock wall). Regardless of the reason, many interviewees noticed details in the rock wall and were able to draw complex meaning from what they saw.

Recommendations

- Interviewees' high comfort level in talking about the rock wall bolsters the case for including a simulated rock wall in the exhibition. This wall can be used to discuss the complex story of how the environment changes over time and how past habitats can be determined from rock formations.

- Because interviewees drew a number of different conclusions from the existing unlabeled wall, the new wall would be more instructive if it had interpretive text and questions to focus observations.

- Visitors may need additional visual clues in the exhibition's rock wall to help them see the different kinds of rock being depicted. Including layers with more obvious color, texture, and hardness differences (while still reflecting the appearance of the natural rock) or schematic drawings with clearly labeled layers may be helpful. Visitors would also benefit from the inclusion of strategies on how to identify different kinds of rock (e.g., a dichotomous key).

Dinosaur Painting

The painting evoked emotional responses from interviewees as they talked about the dinosaur and other aspects of the environment portrayed. Overall, interviewees were comfortable talking about the painting and, with questions guiding them, were able to extract considerable information from it. Some interviewees questioned aspects of the painting, such as the dinosaur's skin color and preferred habitat, and suggested that these elements were part of the "artist's interpretation." From interviewees' comments, it is unclear if they, on their own, would have dissected the dinosaur painting, questioned whether it was realistic, or thought about the connection between what scientists know about dinosaurs and how images of dinosaurs get produced. Interviewees, instead, seemed to simply enjoy the painting for its stylistic and emotional qualities.

Recommendations

- If dinosaur paintings are to be used in the exhibition, detailing the steps involved in their development and showing the roles that the artist, scientists, and specimens play would be key.

- The exhibition may need to address how scientists develop hypotheses about aspects of dinosaurs' lives that may not be preserved in the fossil record, such as skin color, behavior, and interaction with their environment. One way to address this issue is to show that paleontology is a multidisciplinary field in which fossils are just one kind of evidence used by scientists.

- Including dinosaur paintings in the exhibition will greatly enhance the affective experience of visitors.

General Impressions of Scientists and Scientific Methods

The interviewees who responded to the specimens did not see the connection between what they were doing in the interview and what scientists do. This gap in understanding may stem, in part, from their unfamiliarity with using specimens as sources of information or with the nature of scientific knowledge itself. Interviewees were generally confident in scientists' understanding of and ability to decipher specimens, and, in fact, several said they would seek the expertise of a scientist if they had to identify one of the specimens. Only one interviewee questioned scientists by stating that they interpret the fossil record to support evolution rather than being objective.

The interviewees who discussed the dinosaur painting expressed views about scientists that follow a continuum: one end represented by an individual who stated his complete confidence in and deference to scientists and the other by a few interviewees who questioned scientists' methods (i.e., they thought scientists depend upon inadequate information sources and imprecise dating techniques). Some interviewees, those in the middle of the spectrum, felt confident about certain aspects of scientists' knowledge but question others. For example, they spoke with certainty about methods and physical evidence scientists use to determine a dinosaur's gait, but were less certain about how scientists determine what prehistoric habitats were like. Other interviewees stated that scientists make "guesses" or "assumptions," and it was unclear from their comments whether they doubted scientists' knowledge or were trying to discuss the idea of hypotheses but simply lacked the vocabulary to do so.

<u>Recommendations</u>

- The exhibition's premise—engaging visitors in the same processes used by scientists and having them work with real scientific tools to learn about the past—will help visitors better understand how scientists reconstruct the past and dispel some of their misgivings about scientists' work.

- The exhibition should expose visitors to the wide range of scientific tools that scientists use to study the past. Carbon dating may also need to be addressed, as several interviewees thought that this technique is used to date dinosaur fossils.

- The exhibition should promote visitors' engagement in the scientific process and clearly distinguish hypotheses, theories, and facts from guesses, assumptions, and personal opinions. The process by which a hypothesis becomes a scientifically accepted fact should also be highlighted. Because visitors were confident in how scientists determine a dinosaur's gait, this may be a good scenario with which to describe the scientific process.

- By showing the tools and processes scientists use, the exhibition can also address the notion that scientific knowledge is not static. Interactives should be designed to show visitors that new ideas and theories are not arbitrary but rather reflect new information and techniques.

Paleontologist versus Archaeologist

Overall, interviewees either confused archaeologists with paleontologists or had imprecise ideas about what archaeologists do. One-half stated that archeologists either excavate or study fossils,

while the other half were uncertain if archaeologists study animals, humans, or the Earth. It is also unclear what interviewees meant by "fossils," but from their use of the word earlier in the interviews, it seems as if they were talking about animal remains and not human. The confusion over archaeologists and paleontologists was reiterated in the interviews about specimens, as a few interviewees said they would ask an "archaeologist" if they had questions about dinosaurs.

Recommendations

- Because visitors confuse archaeologists with paleontologists, the work that these scientists do and their disciplines should be presented in separate sections of the exhibition.

- By stating explicitly that archaeologists study ancient humans and their artifacts and paleontologists study ancient animals and plants, the exhibition will clarify the roles of these two scientists.

INTERVIEWEES' VIEWS ON HUMAN-DINOSAUR COEXISTENCE

Although eleven interviewees, slightly more than half, said humans and dinosaurs did not coexist, most were unable to give a possible explanation for the dinosaur bone and arrowhead being found together. This is, in part, because most interviewees lacked an understanding of paleontological methods and were somewhat skeptical about how much scientists can determine about prehistoric life. These interviewees seem to be in a precarious position, and depending on many factors, including the way information is presented in the exhibition, their understanding about prehistory could easily be strengthened or weakened.

Eight interviewees thought dinosaurs and humans lived at the same time. Only one of these interviewees stated religious reasons for this belief. This interviewee, who incidentally was well educated in the sciences and thoughtful in his comments, poses a more delicate issue. He felt so strongly about the creationists' perspective that he suggested creationism and evolution be given equal billing in a dinosaur exhibition. It seems unlikely that visitors with such strong feelings could be persuaded to think differently about evolution or dinosaurs by any exhibition. Therefore, the exhibition being planned is more appropriate for visitors whose ideas are based on misinformation than deeply held beliefs.

Recommendations

- Developers will need to decide how to deal with the difficult issue of creationism. Whatever stance the developers take, the Museum needs to stand behind this decision.
- Because of the strong presence of creationism in Texas, the exhibition may need to take a more middle-of-the-road approach than other museums have (e.g., the evolution exhibition at the American Museum of Natural History strongly states that evolution is fact and dismisses all other alternatives). The new dinosaur exhibition may need to simply emphasize the scientific evidence and processes by which scientists reconstruct the past rather than trying to dismiss or challenge religious beliefs.

- Developers may want to seek the guidance of the National Science Teachers Association or other national and local science education associations that are also dealing with issues

surrounding creationism. The exhibition development team already includes a teacher who may also be able to give insights into this sensitive issue.

- The exhibition needs to state in a very clear manner that dinosaurs lived millions of years before humans existed, and it should explain the scientific evidence that scientists have used to create this timeline.

- Formative evaluation should test the tone and language of the interpretive text.

SPECIAL CONSIDERATIONS FOR FAMILIES

If the exhibition is to encourage family participation, a few additional issues may need to be addressed.

- Although families often come to the Museum with children of diverse ages, the majority of exhibition components should be developed with a particular age group in mind. This is the case despite the fact that parents are generally the primary facilitators, because the needs and abilities of 5-year-olds, for example, are very different from those of 10-year-olds.

- Because the exhibition will most likely be targeted to older children, providing a few sensory-rich areas in the exhibition, such as the existing *Dino Dig*, should meet the needs of families with young children as well as those with mixed ages.

- Because a few parents expressed concern that their children know more than they do about dinosaurs, the developers may need to include brief and directed background information (e.g., on pronouncing dinosaur names, distinguishing between popular dinosaurs) so that parents will feel more confident about using the exhibition with their children.

INTRODUCTION

This report presents findings from a front-end evaluation of *Texas Prehistory: How Do We Know?,* under development by the Fort Worth Museum of Science and History and supported by a National Science Foundation (NSF) planning grant. This 10,000 square-foot permanent exhibition, with accompanying traveling exhibition and educational programs, will feature a constructivist approach to inquiry-based learning focused on current archaeological and paleontological fieldwork taking place in Texas. The exhibitions and complementary activities will explore the questions: (1) what is being learned about the prehistory of Texas? (2) how do scientists interpret their findings? and (3) what do we not know?

An integral part of the NSF planning grant is the front-end evaluation. Front-end evaluation is often conducted to provide exhibit planners with information about their audience during the planning stages of an exhibition. Randi Korn & Associates (RK&A) designed this front-end evaluation to identify the background knowledge, conceptions, and observation skills visitors bring with them to an exhibition about prehistory.

The objectives of the evaluation, derived from the exhibition's educational goals and objectives, were to determine:

1. How visitors see and understand select specimens
    - What do they see when they look at specimens?
    - How fine is their vision and ability to describe what they see in specimens?
    - Do they naturally draw comparisons among specimens?

2. What steps would a visitor go through if he or she had to identify a specimen?

3. How visitors see and understand a wall of layered rock
    - What do they see when they look at the wall?
    - How fine is their vision and ability to describe what they see?

4. Visitors' conceptions about what scientists do and do not know about prehistory

5. Visitors' comfort level using hands-on laboratories to uncover specimens' identities, ages, origins, etc.

6. Visitors' ability to draw relationships between today's environment and a habitat that may have existed millions of years ago

7. Visitors' ability to distinguish between the work of an archaeologist and a paleontologist.

METHODOLOGY

To understand visitors' conceptions of prehistory and how they think the work of paleontologists differs from that of archaeologists, two sets of in-depth interviews were conducted. In one set visitors were asked questions about a series of specimens, and in the other visitors were asked

questions about a painting depicting a dinosaur scene. Questions for both sets of interviews resulted from a two-day meeting between RK&A and Jim Diffily, Director of Collections and Exhibits at the Fort Worth Museum of Science and History (Ft. Worth MSH). Their dialogue centered around the exhibition's goals and how these goals relate to visitors' experiences.

The purpose of conducting in-depth interviews is to encourage and motivate interviewees to express their opinions and feelings, recollect memories and associations, and share with the interviewer thoughtful responses to complex questions. Open-ended interviews produce data rich in information because interviewees talk about their experiences from a very personal perspective. Thus, both interview guides were intentionally open-ended to allow interviewees the freedom to discuss what they felt was meaningful. All interviews were tape-recorded with participants' awareness and transcribed to facilitate analysis.

Interviews about Specimens

RK&A conducted interviews in the *Dino Dig* area (a large outdoor digging area designed for pre-schoolers and early elementary students) at the Ft. Worth MSH. A continuous random sampling procedure was followed to select visitors for participation. According to this procedure, the survey administrator approached the first eligible adult visitor (16 years or older and visiting the museum as part of a family group) to enter the exhibition and asked him or her to answer a few questions (see Appendix A), look at specimens (see Table I.2) and a simulated rock wall, and respond to a conceptual drawing of the dinosaur exhibition being planned (see Appendix B). After the visitor completed the interview, the survey administrator awaited the next eligible visitor.

Interviews about the Dinosaur Painting

Ft. Worth MSH staff conducted interviews in front of the Museum's dinosaur hall. Eligible adult visitors (16 years or older) were selected (following the continuous random sampling method described above) and were asked to respond to a dinosaur painting by artist Karen Carr (see Appendix C) and then answer a few questions (see Appendix A).

ANALYTICAL FRAMEWORK AND METHOD OF REPORTING

The data presented in this report are qualitative, meaning that results are descriptive, following from the conversational nature of the interviews. In analyzing the data, the evaluator studies the responses for meaningful patterns. As patterns and trends emerge, similar responses are grouped together. Verbatim quotations (edited for clarity and conciseness) are presented throughout this report to illustrate interviewees' thoughts and ideas as fully as possible. Within each section all findings are presented in descending order, starting with the most frequently occurring.

Findings are reported in two main sections as follows:

I. Interviews about Specimens
II. Interviews about the Dinosaur Painting

I. INTERVIEWS ABOUT SPECIMENS: PRINCIPAL FINDINGS

A total of 20 interviews were conducted over three days in November 1997. Of the 24 visitors who were approached, one declined to participate and three did not complete the interview because of time constraints related to timed IMAX tickets.

DEMOGRAPHICS

As Table I.1 shows, the sample includes slightly more women than men. Interviewees range in age from 29 to 60; over one-half are between the ages of 35 and 44, and their median age is 36 years old. One-half of participants had completed four or more years of college.

Table I.1.
Demographics (n=20)

Gender	***n***
Female	11
Male	9
Age (median = 36 years)	***n***
25-34	6
35-44	11
45-54	2
55+	1
Highest Level of Education	***n***
Some high school or less	1
Graduated high school	4
Some college (1-3 years)	5
Graduated college	6
Some postgraduate work	1
Postgraduate degree	3

RESPONSES TO SPECIMENS

Visitors were asked to look closely at seven specimens (see Table I.2) and, for each one, to describe what they saw. Visitors were encouraged to talk about the colors, shapes, and textures of the specimens and to ask questions rather than trying to name the specimens. Visitors were also allowed to handle the specimens. Since some interviewees were more inclined to try identifying the specimens, the interviewer had to sometimes rephrase the request multiple times before interviewees would begin to describe the specimens.

Table I.2.
List of Specimens[1]

Specimen	Description
1. Lava rock	Various shades of black, porous, rough surface, heavy, irregular organic shape due to once-liquid state, 7 x 3 in.
2. Limestone with fossil crinoids	Cream-colored, chalky rock, fragments of tubular, segmented, fossilized sea lily stems embedded within it, 6 x 2.5 in.
3. Dinosaur vertebra	Dark brown, heavy, fossilized, tall projection on top (spinous process), intact except for broken end of one projection (transverse process)
4. Cow vertebra	White, light, osseous, broad projections (processes) intact
5. Cow rib	White, light, osseous, porous ends, joint (articular facet) intact
6. Dinosaur rib	Dark brown, cracked surface, heavy, fossilized, cylindrical, central portion of rib (body) intact, both ends broken off, 6 x .5 in.
7. Pigeon skeleton	Articulated, light, osseous, professionally prepared and mounted, covered by clear plastic case and labeled

[1]Specimens were arranged on a cart in pairs to encourage comparison, with the two rocks placed together, next to the two vertebra, followed by the two ribs, and then ending with the lone skeleton.

Specimen 1: Lava Rock

About three-fifths of the interviewees identified the first specimen as lava rock. Several interviewees identified the specimen because its appearance matched their conception of what lava should look like (see the first quotation below). Others used their background knowledge of how lava forms to conclude that the first specimen was lava (see the second quotation). One interviewee took the discussion even further by comparing the lava rock's appearance with that of the fossil rock with crinoids and attributing the differences to the processes that formed the rocks (see the third quotation).

> [The first specimen is] a big glob of lava. (What makes it look like lava to you?) I guess from previous experience of thinking [about] what lava looks like. It just looks like what my mind thinks lava looks like. It's kind of black and crusty, which is what you see on the top of hardened lava.

> [The first specimen] is very coarse, rough, heavy, and dark, and it looks like something that was burned or like lava. (What makes it look like it's burned or like lava?) It's just so charred. It looks charred. Like it was on fire at one time or really, really hot. It just has the burned look to it.

> [The first specimen] looks like it was formed in great heat. It looks like it's been melted. And it looks like lava. (What about it makes it look like it's melted or a piece of lava?) Just the shape of it. It looks like it was part of a flow, as opposed to something that was stratified like a sedimentary rock. It looks more like something that was formed quickly out of heat, and not an accumulation of layers like some of the earlier rock, like [the second specimen].

About two-fifths did not identify the first specimen as lava rock. All but two of these interviewees talked about how the appearance of the specimen gave clues to how it was formed. A few interviewees did not identify the specimen but instead talked about the processes responsible for creating such a rock (see the first quotation below). A few others talked not only about the processes that formed the rock but also identified it as "tar" or "coal" (see the second quotation below).

> [The first specimen is] black, molten, rough, something [formed] after some heat loss. (What gives the appearance that there was heat involved?) It [has] a smooth surface and the [shape] of it was probably formed because of [the way] it cooled.

> It to me [the first specimen] looks like coal. It looks like something that was formed from intense heat. (What in particular gives you that impression?) The texture, the density and the surface is smooth, and the interior is I guess more grainy. . . . [The] color and texture, the shape and everything makes it look like [the rock] was [formed by] intense heat.

The two interviewees who did not identify the specimen as lava, as noted above, did not talk about the processes involved in rock formation. Instead, one guessed that the first specimen was granite because of its "black and granular" appearance. The other thought the specimen was a "fossilized piece" with a "porous surface" that "animals or insects might have lived in."

Specimen 2: Limestone with Fossil Crinoids

All but one of the interviewees identified the second specimen as a fossil. Most interviewees spoke little about what they actually saw but rather drew conclusions about the specimen's identity, age, origin, and formation. The following quotations demonstrate the variety of responses.

> [The second specimen is] crystalline, fossilized, looks tubular in structure. It's probably plant. (It looks like a plant because?) Because of the tubular structures, [they must be] from some ancient plant life.

> [The second specimen contains] fossils. (Could you describe what you see?) Fossils embedded in rock with the rock [eroded] away from them. It looks petrified. I mean really old. (What makes it look petrified or really old?) Just the way [the fossils] stand out from the rock—that some [of the fossils] are on the surface and others are deeper inside [the rock]. . . . The fossils all look the same, just some are longer pieces and some are short. (Can you describe the fossils?) Yeah, animals. [What do you see?] Long and short pieces.

> I notice that [the second specimen] has all these little tubes, but I don't know what [they are]. Maybe that it's been in the water, on the ocean floor or something like that. (Anything in

particular that makes it look like it's been in the ocean?) Just that it looks like it has different little animals or small shells stuck in it, like it might have been in the ocean. (And which parts are you calling shells?) Well, they're too perfectly formed to be shells really, but [in the middle of the rock there are] all these little round beads attached to it [that] makes it look like it might have been in the ocean.

[The second specimen] looks like a fossil. Pieces of something that may be layers and layers of sand and gravel preserved beneath the surface. I guess the part that looks more like fossils [are] in the center of it. You can see [the fossils] running through [the center of the rock], and they are too even to have been a chance formation of stone. It's more like some sort of reptile or some sort of skeleton from [a once] living organism that was fossilized [in the] sand and rock.

Two interviewees made comparisons between the first specimen (lava rock) and the second (rock with fossil crinoids). Both compared the different physical appearances of the rocks, and one further stated that the second rock's texture looks like an "accumulation" as opposed to something that was "melted together like [the first specimen]."

The one interviewee who did not identify the second specimen as a fossil thought the tubular structures were "plastic screws" and that the specimen was "modern or recent."

Specimen 3: Dinosaur Vertebra

One-half of the interviewees made comparisons between the third specimen (dinosaur vertebra) and the fourth (cow vertebra). By making comparisons, some interviewees were able to conclude that the third specimen is a fossilized bone (see the first quotation below). Others saw similarities between the third and fourth specimens but remained uncertain as to the identity of the third specimen (see the second quotation).

[The third specimen (dinosaur vertebra)] looks like a bone [that has] been replaced by minerals. Like rock. It resembles [the fourth specimen (cow vertebra)] in its shape. [The third specimen] came from a bigger animal than [cow vertebra]. [The third specimen] looks much older, too. (How so?) Well, since it's not bone [but rather] rock, that indicates that it has fossilized over a long period [of time].

[The fourth specimen (cow vertebra)] looks like bone, but I'm not sure about [the third specimen (dinosaur vertebra)]. It doesn't look like bone; it looks like rock. (What makes it look like rock?) The color and its heaviness. I bet it's wood. It's strange. It looks like a bone because of the way [the transverse process] come out of the center [of the bone], like it does in the [cow vertebra]. . . When I first glanced at the [dinosaur vertebra] it looked like a rock. Now [when I look at it] I see how rounded it is and how all the parts [of the vertebra] are connected, just like in the [cow vertebra]. I'm not sure what it is.

The other one-half of interviewees did not make comparisons between specimens. As the first quotation below shows, some interviewees found clues in the third specimen itself that enabled them to determine its identity. Others cited very general characteristics and appeared to guess its

identification (see the second quotation), and a few had very specific anatomical knowledge stemming from either medical or veterinary professions (see the third quotation).

> [The third specimen] looks like a bone of some kind because of its unique shape. . . . It looks like it might be some sort of joint because it [has] a round part [at the bottom] where it looks like it fits into some sort of socket. It also looks like it might have had a muscle or something going through the middle of it.

> I guess [the third specimen] is a dinosaur bone because of its shape and it's a big bone. All of these are dinosaurs bones, right?

> [The third specimen] is weathered, striated, irregular shaped. It looks like a thoracic vertebra to me. (How so?) Because of the shape, the transverse process, conjugated surfaces. (It sounds like you know a lot about bones.) Well, I'm a veterinarian.

Specimen 4: Cow Vertebra

While all of the interviewees identified the fourth specimen as bone, most did not state the specific kind of bone. Three-quarters of the interviewees made comparisons between specimens. Most compared the cow vertebra with the dinosaur vertebra, as exemplified by the quotation below. One interviewee compared the cow vertebra with the fifth specimen (cow rib) determining that both were bones because their "shape, pores at the ends, textures, and edges look[ed] like bones."

> [The fourth specimen] definitely looks like bone. (And that's because?) The shape. It looks like it might even be the same bone as [the third specimen] but from a smaller animal. The shape, the form, the color make it look like a bone to me.

One-quarter of the interviewees were unable to give specific reasons for identifying the fourth specimen as a bone but rather relied on their familiarity with bones in general (see the quotation below).

> [The fourth specimen] looks like a real bone, in my opinion, like one you'd find out in a pasture somewhere. (What about the specimen helps you identify it as a bone?) It just looks like a bone, like I've seen before. I don't know. It just looks like a bone.

Specimen 5: Cow Rib

Again, all of the interviewees identified the fifth specimen as bone. Many interviewees were uncertain as to the kind of bone, suggesting it was a rib, leg bone, antler, and tusk. Three-quarters of the interviewees used either physical characteristics of the specimen as clues for its identity (see the first quotation below) or relied upon their prior experience (see the second quotation). It is unclear whether the interviewees who simply described the specimen as bone understood that recent and fossilized bones differ in appearance. In fact, one individual stated that the fifth specimen (cow rib) was from a dinosaur.

> [The fifth specimen] definitely looks like a bone. [It] looks like a rib. (What in particular makes it look like a bone?) I can see some porous material and maybe some cartilage—the upper jointed end looks like it [would] fit into a skeleton, it has a slender shape, and [it's] light [weight].
>
> [The fifth specimen] is a bone of some type, probably a rib cage bone. [That's] just a guess, a wild guess. It seems to have some structures and makeup of a bone. It's what we're used to seeing in fowl or something like that. It looks like a bone.

One-quarter of interviewees made comparisons between the fossilized and recent bones, as the quotation below shows and were able to offer a plausible identification for the fifth specimen as well as an idea of its age.

> [The fifth specimen] is obviously bone, too. It's still bone because of the minerals. (What do you see that helps you know this is bone?) It's weight, texture. [The fourth and fifth specimens] are both pretty light, [which] means they are bone and younger, and [the third specimen] is heavy like a rock, [which] means it's a fossil and older.

Specimen 6: Dinosaur Rib

In contrast with the other fossil and bone specimens, none of the interviewees compared the sixth specimen with any of the others. Instead, all of the interviewees discussed the physical characteristics of the specimen as they attempted to identify it as bone, fossilized wood, rock, or a tool. Three quotations are given below to demonstrate the variety of descriptive comments.

> [The sixth specimen] has thin, white lines through the dark brown. It's not hollow, but it's light feeling. I would maybe guess by looking at the ends of it, [that] it's a bone. It looks crystallized at one end. If I had to make a guess, I'd say it's bone because of the shape and texture of it.
>
> [The sixth specimen] looks like a petrified tree just in its texture and appearance. Could be a bone, though. I don't know, it's pretty weathered. There [seems to be] layers missing, but it has the texture of wood. (How so?) It looks like it has [wood] grain.
>
> [The sixth specimen] looks long and thin. It looks like it might be a bone, but probably not because of the color. It looks like it's more of a piece of stone or petrified wood, some very hard wood, but it also looks like a tool. (How does it look like a tool?) Because of the shape. It looks like it was carved out of something. It looks like something that was made small enough to go in someone's hand, maybe it's part of a knife or an arrow or something that somebody used. [It's] kind of deceiving because it almost looks like it's porous on the interior, but very smooth rock outside, so I'm not sure.

Specimen 7: Pigeon Skeleton

The last specimen, the pigeon skeleton, was unique in that it was an articulated skeleton, covered by a clear plastic case, and labeled. Two-fifths of the interviewees referred to the identification label as they described the skeleton. Some of these interviewees described characteristics of the

pigeon skeleton that seemed unusual or surprising (see the first quotation below), while others reiterated characteristics that proved the specimen was indeed pigeon (see the second quotation).

> [The pigeon skeleton] is easy. It has a sign. I don't think I ever realized their beak was attached to part of the skull. I always thought it was more separate.

> Well, it definitely looks like a bird, and you can see the wings and where the beak was. [It has] hollow bones. It looks like a pigeon skeleton. I wouldn't have known it was a pigeon [without the label], but by looking at it, you [can tell that] it's a little bird. (What in particular indicates it's a bird?) Wings, beak, the hollow wings, the little balls of the feet, skinny, little legs. Looks like a bird to me.

About one-quarter of interviewees made comparisons between the pigeon skeleton and other specimens (see the first quotation below) as well as to dinosaurs and other prehistoric animals (see the second quotation). Another quarter of interviewees described physical characteristics of the skeleton and then drew conclusions about its age (see the third quotation) and how it was mounted (see the fourth quotation). A few interviewees simply described what they saw but did not infer any meaning or conclusions (see the last quotation).

> [The pigeon skeleton] reminds me of [the cow vertebra] and [the cow rib]. This skeleton has those same bones. I mean, they're not identical—the bird ones are a lot smaller, but you can see the similarities between [the cow rib] and the bird's rib.

> [The pigeon skeleton] surprises me that it looks like a miniature dinosaur. So, it resembles quite a bit some of the exhibits that you see [about] larger dinosaurs from prehistoric times. . . (What in particular reminds you of a dinosaur?) Well, the way the wing turns [towards] me, kind of resembled the pterodactyl a little bit. I don't know. Maybe it's just the rib cage and all that, and the neck looks so much longer than when it [has] skin and feathers around it. It looks so long, and that reminds me of a dinosaur, certain dinosaurs that have the long necks.

> [The seventh specimen] is a bird, and it's a recent sample rather than a fossil. (How can you tell that?) Because of the color and the lack of fossilization. It has very thin bones.

> [The seventh specimen is] a recent bird skeleton. It looks like it was a prepared specimen. The bird was put down or it when it died the bones were prepared in that fashion. (What features make it look like it was prepared?) Well, it's complete for one thing, and it looks so pristine and perfectly prepared to show the shape of the bird.
> [The seventh specimen] looks like a little bird. It looks very fragile and light and you can see through them. . . . It's clean and complete. You can even see the little nails on the feet.

RELATIONSHIPS AMONG SPECIMENS

After discussing all of the specimens, interviewees were asked, "As a group, all the specimens together, what, if anything, do they have in common. Does one gives clues about another?"

While all but one of the interviewees thought the specimens had something in common, many did not think that looking at one specimen could give clues about another.

About two-fifths of interviewees suggested that all the specimens were concerned with living organisms. Most of these interviewees thought the specimens were bones, with some simply stating that fact (see the first quotation below) and others discussing how the differences and similarities among the bones related to their relative ages (see the second quotation). Two other interviewees made more general comments, suggesting that all the specimens were either animals or "organic life."

> As a group, if I have to try to figure out something in common, I'd probably guess they were all bones. All winged animals maybe? I don't know. I must be missing something. . . . The only thing that I might guess other than that is that they're all bones.

> Well, after looking at all of them, they're probably all bone or have some bone in them, I don't know. . . . I'd be surprised if they all weren't bones. That seems to be the theme. I don't know about the pigeon, but the rest they look like they've been around a while. (Anything in particular that makes you say that?) Well, they're either yellowed or very dark. I would think that the darker ones are probably older than the lighter ones, I don't know. They all look like bones, at least to me.

Two-fifths of interviewees had idiosyncratic ideas about how the specimens were related to one another. Three interviewees saw complex stories being told by the assemblage of specimens. One thought the specimens showed how fossils form, stating that if bones "like this [the cow vertebra and rib] sat in medium like this [the fossil rock with crinoids] long enough, they would wind up looking like that [the dinosaur vertebra]." The second saw the "rise of dinosaurs to birds," and the third thought the specimens were showing the "passage of time" with each one representing a different time period.

Two other interviewees also thought the specimens were showing time relationships, with one talking about how all the specimens were from the same "precivilization" time period and the other deciding that half of the specimens were "prehistoric" and half were recent. One individual saw similarities in shape and composition between pairs of specimens such as between the two rocks, the two ribs, and the two vertebrae. The only similarity another interviewee could determine was that all of the specimens are "hard."

About one-fifth of interviewees thought some of the specimens gave clues about others. Two interviewees thought that looking at the cow vertebra helped them identify the dinosaur vertebra. One individual determined by looking at the dinosaur vertebra that the dinosaur rib was also a fossil, and by comparing the color and size of the cow vertebra with the cow rib determined that these bones came from the same animal. Another interviewee thought that the recent bones were meant to show what the "petrified ones" looked like before they were fossilized.

One individual did not see any relationship among the specimens or how looking at one specimen might gives clues about another.

WAYS TO IDENTIFY SPECIMENS

After talking about the relationships of the specimens, interviewees were asked, "If you were given the task of having to identify any of the specimens, what might you do?" Most interviewees said they would look to external reference resources rather than depending on their own observation skills and knowledge when trying to identify the specimens.

About one-half of the interviewees said they would use the library, books, the Internet, knowledgeable people, or a combination of these resources. The following quotations exemplify these responses.

> I'd probably go to the library and look in a book about skeletons or maybe talk to my first-grade teacher because she's a nut about fossils. I'd probably look on the Internet and maybe look in the phone book for—what do you call a rock person or bone person? (What about just looking at the specimens and comparing them—would that help you identify them?) No, not really, I mean, not if we're just looking at them.

> I guess [I would] ask somebody who knows a lot about dinosaurs. (Who might you ask?) I don't know—a science teacher or maybe an archaeologist. (Do you think you might be able to figures out what they are just by looking at them?) No, I don't know really anything about dinosaurs.

One-quarter of interviewees said they would look to museum exhibitions and staff for help identifying the specimens. The following quotation summarizes these interviewees' sentiments.

> [If I had to identify one of the specimens] I would hope that the Museum would have someone or something available to help me identify [the specimen because] otherwise I'd just be relying on very limited education on these kind of things. I really wouldn't be much good in identifying any of them really . . . unless somebody else would tell me what [these specimens] are.

Unlike most of the interviewees who relied on external sources of information, three interviewees said they would try to identify the specimens by working with the specimens themselves. Two said they would "run some tests" such as "carbon dating" on the specimens in order to determine their ages as well compare the specimens with "recent species" and "fossilized species" of the "same size, texture, and shape" to determine their identities. The other interviewee said he would "look at all [the specimens], touch them, and turn them to look at all [the] sides" like he did during the interview activity, make an educated guess, and then "read the Museum sign" to find out if his guess was correct.

One interviewee did not know how to go about identifying any of the specimens, and, furthermore, he said that he did not think looking at and comparing the specimens would be helpful.

RESPONSES TO ROCK WALL

Similar to the specimen activity, interviewees were asked to look closely at a simulated rock wall (depicting layers of limestone, shale, and sandstone) in the *Dino Dig* area and to describe what they saw. All of the interviewees described the wall as having "layers."

About two-thirds of interviewees said the wall was composed of layers of different kinds of rock. Of these interviewees, some simply described the different layers (see first quotation below), while others talked about the different layers in relation to the effects of erosion (see second quotation). A few interviewees talked about the layers of rock and remarked on how these layers show environmental change over time (see the third quotation below). Two other interviewees also talked about the relationship of the rock layers to time but were more concerned with the process itself, of how rocks build up over time and then are "weathered back down through the centuries," rather than with its meaning. A few interviewees also mentioned that the rock wall reminded them of places they had visited or looked like their own "backyard."

> [The rock wall is] striated. It definitely [has] layers in it. (Does it look like one kind of rock or several, or is it kind of hard to tell?) Looks like different kinds—like the top layer is heavier and the bottom layer seems to be a little more sedimentary. (How so?) Well, the bottom part just looks softer and more sandy and has, what looks like, fossils in it. The top layer looks more like granite or something hard.

> I see different layers, and I see it's probably been washed by water and there's some erosion on the bottom level. . . . (And what clues did you see to make you say the wall had been eroded?) The smoothness of the edges and the fact that the bottom layer is set farther back than the top. (Do you think there's more than one kind of rock, or one kind or rock, or is it kind of hard to tell?) There's definitely more than one kind of rock because [there are] like shale layers up [at the top] and then [at the bottom there is] a more bumpy kind of rock instead of the flat shale-type layers.

> [The wall has] different types of rocks, the different strata. [There is] vegetation on top versus what's underneath it, [that is], dry vegetation on top showing that now [this area is] more of a woodland, while at the bottom there [are] seashells. I guess different strata [show] different environments. Like the seashells, the large nautilus shells, they're near the water, and I see the small seashells and other small fossils in the area, showing before there was more of a sea life.

About one-third of interviewees thought the wall was composed of layers of a single type of rock, and all of these interviewees also discussed how erosion shaped the wall. The following quotation demonstrates this point of view.

> I see the different levels [in the rock wall], that [have been] worn away with time, I guess. And I can see where the water [has] been. (Could you say a little more about that?) Is that what happened? (What made you think it happened?) Well, probably because [there is a] stream down below. I just figured [after] a heavy rain or something [the river] would rise. (Anything about the rock hint that that might have happened?) Well, the different colors of the top layers. It's darker . . . and the smooth shape of the overhang. (Do you think it's one kind of rock, or is it a lot of different kinds, or is it hard to tell?) Well, my guess is it's all the same because it all looks alike, but I've never studied geology, so I don't know.

THOUGHTS ON DINOSAUR BONE AND ARROWHEAD BEING FOUND TOGETHER

After interviewees commented about the specimens and rock wall, the following situation and question were posed to them: "Let's say you were digging here, and next to a dinosaur bone you found an arrowhead. What would you think about that?" Interviewees fell into three categories: those who thought dinosaurs and humans did not live in the same time period, those who thought dinosaurs and humans coexisted, or those who were uncertain.

Eleven individuals, slightly over one-half of the interviewees, stated that humans and dinosaurs did not coexist. Of these interviewees, about one-half stated that although they knew humans and dinosaurs did not live at the same time, they could not explain how an arrowhead could have been buried next to a dinosaur bone (see the first and second quotations below). The other half of these interviewees strongly stated that humans and dinosaurs did not coexist and offered explanations of how an arrowhead and dinosaur bone could have been found together (see the third and fourth quotations).

> [If an arrowhead was found] next to some dinosaur, that's a good question, and they're sure it's a dinosaur bone? (Yes.) Well, I wouldn't know how to explain how there could have been a man-made object near dinosaur bones. I don't know what I would think. I'd be puzzled. (And that's because?) To my knowledge man did not exist when dinosaurs did.
>
> [The arrowhead and dinosaur bone are from] really different time periods. Well, what would I think about it? It depends on the placement of this kind of stuff. It takes a lot of training to figure out the time periods and [a problem like this]. (Would you find it odd that the two were together?) Yes, but I don't know enough about it.
>
> [The arrowhead was found] at the same level that you found the dinosaur bone? I would say that the arrowhead was either washed in or [was] transported in somehow. It's out of time with the dinosaur bone. Obviously, you would try to date the fossil or the arrowhead. [The arrowhead] could not be the same date as the dinosaur bone . . . because [no creature] 65 million years ago, when [dinosaurs] lived, created tools. [The arrowhead] was brought in or washed in. It couldn't be of the same level as the bone unless the Indians came along and [the bone was already] exposed due to erosion, and they camped at that particular spot and it later it was covered up again. [Dinosaurs] and humans did not live at the same time. Okay, something's afoul, because man and dinosaurs did not live at the same time. So, first assuming that [the arrowhead] is real, you'd have to assume that [the person] who made the arrowhead was digging in the area or maybe looking for food or water or something and unearthed [the dinosaur bone]. Maybe [the arrowhead] is not real, it was planted, planted by someone as a joke, to see that he got his word in. (Can you say a little more about that?) I don't know. Some people might want to mess things up and show people and dinosaurs together.

Eight interviewees stated that humans and dinosaurs lived at the same time (see the first quotation below). Only one of these interviewees stated religious reasons for believing humans and dinosaurs coexisted (see the second quotation).

> I'd think that maybe somebody shot that dinosaur or maybe used the [arrowhead] to take some of the meat off the dinosaur. (Would you think anything else about that?) That the Indians were there that wherever this [arrowhead] was found, that's where the Indians probably were. (Would it be evidence for anything else, do you think?) Well, not that I can think of.

> [The arrowhead was found] right next to [the dinosaur bone] on the same level? (Yes.) Well, I would think one of two things. Either the person or creature that made the arrowhead existed at the same period as the fossilized structure, or that the arrowhead creator was doing the same thing we were doing, exploring that site. (Do you want to say anything more about either one of those two scenarios?) Well, those are the only two that I can really think of. You know, I guess that kind of throws you back into some basic beliefs as far as creationism versus evolution. So, I personally believe in creationism and micro-evolution. (Would you say a little more about that?) What you believe can influence how you study something. There are a lot of different ways to study fossils. It depends on what you believe. There is evidence that supports creationism and gradual change over time.

One individual was uncertain as to whether people and dinosaurs coexisted and was unsure as how to interpret the dinosaur bone and arrowhead's being found together.

LABORATORY STATIONS

Interviewees were shown conceptual drawings of the new dinosaur exhibition and were told about the possibility of including lab stations with computers and scientific equipment and a mystery for families to solve. They were then asked, "How comfortable would you be doing activities like these in an exhibition about dinosaurs?"

Comfort Using Laboratory Stations

Most interviewees said they would feel comfortable using an exhibition with lab stations. One-quarter of the interviewees simply stated the ease with which they would use such an exhibition. A few other interviewees said that even though they did not have a science background they would still feel comfortable using computers and scientific equipment because their children are computer literate and study science in school.

If interviewees did raise concerns about the exhibition, it was more often regarding their children's comfort level rather than their own. About one-quarter of interviewees were concerned that an exhibition with lab stations might not be age appropriate for their very young children (see the first quotation below). Other interviewees felt that the exhibition would have to be highly hands-on for their children to benefit (see the second quotation).

> I guess, you're trying to reach an audience of preteens and teens. (We're trying to attract all kinds of families, and so I was wondering how comfortable you would be doing these kinds of activities with your family?) I was thinking that it may be too involved for [my children]. The *Dino Dig* area is good for toddlers and young children. I don't know if the research would hold the interest of a 4-year-old as opposed to a 12- and 16-year-old. (Do you think they might like to look at it maybe under a microscope or using computers or handling real things?) Yeah, touching and holding is always kind of fun. I'm not so sure about the other stuff.
>
> I think we would use computers and microscopes, but at the lab stations could you actually touch [fossils]? (Would that be of interest to you?) Absolutely. I think the more hands-on, the more beneficial it is to the parents and the children. Because a lot of times you learn from reading or looking at pictures, but when you can actually touch things—I noticed today with [my child], it was his first time touching things [at this Museum], that he remembered things better.

Three interviewees said they would need help to feel comfortable using lab stations in a dinosaur exhibition because they do not know how to use scientific equipment and computers, and because their children know more about dinosaurs than they do.

Interviewee Suggestions for Encouraging Use of Laboratory Stations

Following discussing their comfort level using lab stations in a dinosaur exhibition, interviewees were asked, "What should the exhibition include to encourage you and help you use the lab stations?" Interviewees gave a variety of suggestions, most of which where specific to their individual concerns.

Several interviewees suggested similar ideas. A few interviewees want museum staff in the exhibition to answer questions, conduct tours and activities, and help with the scientific equipment. Others would like to walk through a simulated environment complete with whole dinosaurs and plants rather than skeletons. Two interviewees suggested that the exhibition have activities for different ages and knowledge levels to accommodate families with both younger and older children and parents with little background knowledge. Two others want the exhibition to include tips to help them focus and direct their looking at specimens, and two others would like "things you can touch," including real specimens.
All of the other interviewees made unique suggestions that fell into two categories. Four of the interviewees made suggestions aimed at helping parents use the exhibition: provide easy-to-understand directions for the activities, include background information, give answers to any questions or games in the exhibition, and use audio labels because "parents get tired, too" of reading all the labels to their children. Four other interviewees made comments based on what their children would like to do in an exhibition. They suggested the exhibition include: an activity sheet or booklet for their children to take home with them to remind them what they learned, a variety of things to experience, animatronic dinosaurs, and clothing props that let children pretend to be scientists as they go through the exhibition.

OTHER INTERVIEWEE COMMENTS

Two individuals made additional comments that did not specifically address any of the interview questions. They are included below because they present two perspectives useful to keep in mind when developing an exhibition about dinosaurs.

> My husband never believed in [dinosaurs] before we had our son, I mean, I don't know if he does now. I think he does now, because [our son] started going crazy about [dinosaurs]. [My husband] never believed [in dinosaurs], but now after he came to the Museum and sat and looked at the bones, I think now he believes in them. But before he thought, it was, like, it was all made up to him.

> Education in exhibits [like the one being planned] is important, and I think all sides, whether it be evolution and creationism, should be presented in an equal manner.

II. INTERVIEWS ABOUT THE DINOSAUR PAINTING: PRINCIPAL FINDINGS

A total of 20 interviews were conducted over three days in November and December 1997. Of the 25 visitors who were approached, three declined to participate and two completed interviews but are not included in the findings[1].

DEMOGRAPHICS

As Table II.1 shows, the sample includes more slightly more women than men. One-half of interviewees are between the ages of 25 and 34. Also, almost one-half of interviewees had completed four or more years of college.

Table II.1.
Demographics (n=20)

Gender	***n***
Female	11
Male	9
Age	***n***
16-24	3
25-34	10
35-44	5
45-54	0
55-64	1
65+	1
Highest Level of Education	***n***
Some high school or less	0
Graduated high school	1
Some college (1-3 years)	10
Graduated college	5
Some postgraduate work	3
Postgraduate degree	1

[1] One interview was not included in the analysis because when the parent was being asked questions her child answered for her. The other interview, upon transcription, was found to have poor recording quality as well as a participant under the sample's base age requirement of 16 years.

RESPONSES TO DINOSAUR PAINTING

Visitors were asked to look closely at a print of a Karen Carr dinosaur painting (see Appendix C) and were told that the artist who created it had worked with scientists to make an accurate image of what dinosaurs and their environment looked like. They were then asked to describe what they noticed about the environment depicted in the painting. Interviewees were encouraged to describe the content of the scene including plants, animals, and relationships between animals and to ask questions rather than to describe the painting's stylistic qualities. Since some interviewees were more inclined to discuss the artistic merits of the painting, the interviewer had to sometimes rephrase the question multiple times before they would begin to talk about content.

Overall, interviewees made a variety of comments and drew a number of different conclusions about the environment depicted in the painting. All of the interviewees made comments about the dinosaur, and in addition to describing the dinosaur, some interviewees discussed the plants, and a few mentioned aspects of the climate.

One-half of interviewees discussed the plants and animals depicted in the painting. Several described the appearance of the plants, commented on the presence of the mammal, and inferred the dinosaur's behavior from its physical characteristics (see the first quotation below). One individual, in particular, discussed all of these aspects of the scene and then talked at length about how the dinosaur hunted and what it ate, concluding that it probably ate other animals and might have eaten people. Other interviewees talked mainly about the dinosaur and only briefly mentioned the plants (see the second quotation).

> I noticed that [the artist] put a mammal [in the painting], so I don't know if a mammal should be there. I don't know if that is a sign that [mammals] were starting to appear or not. The trees look like basically trees we have today except for these in the foreground. I don't recognize [them], but they kind of look like palm trees. . . . I don't want to say if [this painting] is lifelike, because I don't know if this is the realistic way that [the plants and animals] looked or not. But [the dinosaur] is ferocious. (Tell me more about the dinosaur. What clues does his appearance give you?) He looks like, I would guess, a meat eater. . . . He has sharp teeth and claws and scrawny forearms like a Tyrannosaurus supposedly does. He's running on back feet.

> [I see] lots of big, green trees and plants and a big dinosaur. (From the picture, what can you tell me about the dinosaur?) [It has] large, big teeth. (Anything else you notice about him?) He walks on his two hind legs and uses his front ones to, probably to eat and grab prey.

Some interviewees described not only the plants and animals depicted in the painting but also mentioned climatic conditions (see the first quotation below). One interviewee took these ideas even further and saw complex meanings emerge from the scene (see the second quotation).

> [The dinosaur scene] looks like a rain-forest-type environment [because of] the trees [and] there's a lot of green foliage. It seems like it's humid and misty, because [there is] mist, and when the sun breaks through you see fog. There are also animals in the forest. (Tell me about the animals.) The dinosaur looks like he is hunting. He is taking a stroll.

(Anything else about the dinosaur?) It has big teeth. (What does that tell you about the dinosaur?) That he is a carnivore.

[The scene] is interesting [with] all of the small details, the little critters, spiral ferns. It makes me think it's tropical, humid. . . . (What else do you notice?) When I look at [the dinosaur] I think that I wouldn't want to run up on it myself. Obviously it's very big. . . . (What else do you notice about the dinosaur?) Its teeth tell me it's a carnivore. But I wouldn't think it's terribly intelligent—probably [has] a real small brain. But you don't need to be real smart to tear things apart I suppose. (What about his appearance makes you think he has a small brain?) He has an awfully big mouth and awfully big teeth, but the rest of [his head] is kind of small, so it can't house a whole lot. . . . It [looks like] he uses his tail for balance, the small front legs there maybe for grabbing things, holding onto things, certainly not for getting around. (You mentioned this little critter, what does that look like to you?) It looks like a rat. (So if there were something like a rat in existence, what would that maybe tell you about it living during dinosaur times?) Mammals were just starting to evolve in small ways. As opposed to these reptiles who had already been around for a long time, had the chance to evolve into much larger creatures. So we were just getting started.

HOW SCIENTISTS KNOW WHAT THEY KNOW

After describing the environment depicted in the Carr painting, interviewees were asked a series of four questions about how scientists are able to determine what prehistoric plants, animals, and their environment were like. Throughout their responses, interviewees made general comments about scientists while also describing specific ways in which scientists uncover the past.

Interviewees' views on scientists follow a continuum with a few interviewees forming the two ends of the spectrum. Their opposing views are represented by the two quotations below. Others, as shown in the quotations throughout the rest of this section, fell in between these two extreme views as follows: interviewees were either confident in some aspects of scientists' knowledge and not in others, commented upon what scientists actually know versus what are "guesses," or did not discuss the nature of scientists.

I trust [that] scientists do their job. They know a lot more about dinosaurs than the rest of us do. So if they show a dinosaur [a certain] way that's how it must have been.

A lot of [what scientists know about prehistory] is their own personal opinion based on limited evidence. I don't think anything is one hundred percent accurate in this picture [especially] because I don't think they have the dating system down perfectly.

How Are Scientists Able to Piece Together the Past?

The first question asked interviewees, in light of what they had seen in the Carr painting, "How do you think scientists are able to figure all of this stuff out?"
Most interviewees, as the first quotation below demonstrates, said that scientists depend upon physical evidence such as dinosaur fossils and tracks to learn about the past. Some interviewees,

in addition to talking about this physical evidence, suggested that scientists can learn much by looking at how these materials were deposited (see the second quotation) and where they are found (see the third quotation).

> [Scientists know about dinosaurs] just from the bones and footprints they dig up, and that's about all they know about them. . . . The stuff [scientists] know about [dinosaurs] is from bones and is like 40 percent knowledge and 60 percent guessing.

> [Scientists' knowledge about prehistoric life] is based on skeletons and the plant remains that they [find] around the skeletons. [By] knowing some of the history of the time [period] and then [taking] soil samples, they can date when the [dinosaur] died.

> I think a lot [can be figured out] just by the fossils, but a lot of it is guesswork, too. [Scientists] certainly don't know exactly what color [dinosaurs] were by the fossils. I mean [scientists are] assuming. We don't know that's really the way it was because none of us lived back then to say. . . . I wonder, like this particular animal, I mean, who knows whether [it] actually liked to go in the jungle part? Maybe it liked taller grasses instead, or a cave. . . . I wonder how they would figure that out. (Do you have any guesses how they might know?) Tracks and maybe finding [dinosaur] bones in a jungle-type area like in South or Central America.

Three interviewees did not talk about physical evidence when asked how scientists determine what prehistoric life was like. Two posited legends or paintings as sources of information. The third said "carbon dating" could be used, but then could not elaborate on his answer.

How Do Scientists Know about Prehistoric Plants?

Following the general question about how scientists piece together the past, interviewees were asked, "How do scientists know what kinds of trees existed?" Three-quarters of interviewees said that scientists use fossils to determine the kinds of plants that lived millions of years ago.

Several interviewees simply stated that plants fossilize or become "petrified" (see the first quotation below), while others discussed the significance of fossilized plants and dinosaurs being found together (see the second quotation). A few interviewees thought scientists study fossils and use their knowledge of how the Earth has changed through time (e.g., plate tectonics) to determine the kinds of plants that existed (see the third quotation).

> I really don't know [how scientists determine what plants lived] unless [scientists] find something that is petrified. We [found] part of a petrified tree one time.

> [Scientists would be able to determine what plants lived] from fossils, too, like dinosaur fossils. I don't know how good they are at really dating [fossils], you know, if [the plants and the dinosaur] really came along at the same time or many years later or earlier. So [scientists] probably just look at [plant fossils that] they find right along with the dinosaur fossils.

> [Scientists determine what plants existed] just by physical evidence, by plants that are in rock now. That's the only way, and the geographical location. (The geographical location of?) Of certain plants [in] the Cretaceous and Triassic . . . because the coastline wasn't where it is right now. I think [scientists] can tell a lot by that.

Three interviewees did not talk about fossils but instead explained that scientists can determine what trees lived millions of years ago by looking at modern ones because "a tree is a tree." One interviewee did not have any idea how scientists could know about ancient plant life.

How Do Scientists Know How Dinosaurs Walked?

Interviewees were asked, "How might scientists know how dinosaurs walked—on two legs or four?" Most interviewees said scientists could determine how a dinosaur walked by looking at its bones.

About one-half of interviewees, as the first quotation below demonstrates, discussed how the relative sizes of bones help scientists determine whether a dinosaur walked on two legs or four. Other interviewees talked about how bones "fit together" (see the second quotation), and a few interviewees took the idea of bone structure further by stating that scientists could compare dinosaur bones with those of modern animals (see the third quotation). A few other interviewees simply stated that bones and "footprints" serve as evidence of how an animal walks, while one individual said that looking for the "wear and tear on the bones" is the key.

> How do [scientists] know how dinosaurs walked? I guess by the fossils they find. [Referring to the *Acrocanthosaurus* in the Carr painting] the upper body arms are smaller than the hind legs, and it has a tail balancing him up. So you would figure the long tail [was used] for balance so [the dinosaur] walked on hind legs.

> [Scientists can determine how a dinosaur walked by] the bone structure and the way [the dinosaur] is built because these are the bones [scientists] found [referring to fossils in the Dinosaur Hall] and this is how they fit them together. Some of [the Carr painting] is imagination, [but] a lot of it is common sense.

> Hopefully [scientists determine how a dinosaur walked] by putting the bones together. Whoever puts [the bones] together would certainly have enough knowledge to know how the bones would work. I mean, just by studying our everyday animals, like a dog or a cat, they just have some sense of how bones work together and hopefully their assumption is right.

Of the interviewees who did not discuss dinosaur bones, two said that tracks and "foot patterns" serve as evidence of how an animal walks, but when asked follow-up questions, they were unsure exactly what information might be learned from them. One interviewee did not know how scientists might go about learning how dinosaurs walked.

How Do Scientists Know What Kind of Habitat Existed?

The last question about how scientists learn about prehistoric life asked, "How might scientists know what kind of habitat existed millions of years ago? What clues do they have in today's

environment to indicate what existed millions of years ago?" Three-quarters of interviewees gave answers similar to those given for the first question, which asked how scientists know about the prehistoric environment depicted in the Carr painting.

Several interviewees simply restated that scientists get most of their information from fossils. As exemplified by the two quotations below, others suggested that scientists learn about dinosaurs and their habitat by analyzing fossils, looking at the terrain and the strata in which fossils are found, and using carbon dating.

> [Scientists study] fossilized plant material, fossilized creatures like this [dinosaur], or sea creatures. [They could also look at] the terrain itself; the landscape around us tells us where water has been as opposed to dry land and so on.

> [Scientists] dig back through the different layers and carbon, and do carbon dating. . . . I think they can [look at] the layers of sediment or times when water was covering the earth and made layers of minerals and rock over the fossils. A lot is conjecture, but a lot is fact.

About one-quarter of interviewees suggested that scientists could learn about prehistoric habitats by studying things other than physical evidence. A few interviewees, as the first quotation below exemplifies, said scientists could study modern animals to better understand prehistoric ones. One individual suggested that scientists should study modern plants that are relatives of prehistoric ones and "marshland and rain forests that currently exist." Another thought scientists are learning a lot about past environments by knowing how the climate has changed over time (see the second quotation). One interviewee combined several ideas (see the last quotation).

> [Scientists use] fossils, but I think it's half-subjective. Everybody assumes [the habitat] was a swamp. I guess a lot of fossil trees have been found next to animal fossils. (What clues in today's environment give us clues about the past?) Besides fossils and all that stuff? (Yes. Any other ideas?) If you believe in evolution you can look at today's organisms and get clues to the past.

> I think [scientists] have developed a history of weather. . . . They have evidence of different ages, ice ages, and things. I'm sure all of that applies to understanding [the habitat]. I have no real concept of how you go about doing that, but I have enough faith in the scientific community to know that they know.

> [Scientists learn about the] habitat probably from piecing together research from fossil records from all over the [world]. . . . (Are there other clues in today's environment?) I'd be curious if they were ever able to somehow extract DNA, to see if something traces back to that date. Right now I understand that they speculate that birds are descendants [of dinosaurs]. I would imagine by comparing birds [and dinosaurs] they would find similarities.

KNOWLEDGE OF WHAT ARCHAEOLOGISTS AND PALEONTOLOGISTS DO

At the end of the interview, participants were shown two cards: one with the word "archaeologist" and the other with "paleontologist." They were then asked to describe what each

scientist does. Table II.2 summarizes interviewees responses. Because comments did not generally go beyond naming the scientists' activities, no quotations are provided in this section.

As Table II.2 shows, interviewees had numerous ideas about what archaeologists and paleontologists do. Overall, a greater range of responses were elicited by "archaeologist" than by "paleontologist," as interviewees were uncertain whether archaeologists concentrate on animals, or humans, or the Earth. One-half of interviewees thought archaeologists either excavate or study fossils. Only one-fifth thought archaeologists study human remains, human-made artifacts, and civilizations.

Interviewees' responses to "paleontologist" lack the variety found in those about archaeologists, as interviewees thought paleontologists study animals or plants. One-quarter of interviewees thought paleontologists study dinosaurs. Another quarter said paleontologists analyze and assemble fossil skeletons as opposed to excavating fossils, a task that, as stated earlier, many thought the responsibility of archaeologists.

Table II.2.
Interviewee Perceptions of Archaeologists and Paleontologists

Archaeologist	
Interviewee Response	***n***
Excavates fossils	6
Studies fossils	4
Studies human remains, human-made artifacts, and civilizations	4
Studies "artifacts" (fossils, human bones, rocks, human-made objects)	2
Involved with the "history of finding art"	1
Studies the Earth	1
Studies minerals	1
Broad term for scientists who study anything ancient (includes paleontologists)	1

Paleontologist	
Interviewee Response	***n***
Studies dinosaurs	5
Analyzes fossils, including assembling skeletons	5
Studies plants	3
Studies plant and animal life	2
Studies ancient animals	2
Don't know	2
Studies dinosaur tracks	1

OTHER INTERVIEWEE COMMENTS ABOUT THE DINOSAUR PAINTING

Throughout the interview, several interviewees made comments about the painting's stylistic qualities and the artist's intention. While a few simply stated that they liked the "style" or thought the painting was "very lifelike" and "really good," others made more involved analyses and suggestions. Quotations from these interviewees are given below, because understanding how visitors respond to the content of the pictures as well as to the picture's artistic nature is insightful. For example, interviewees either complemented the realism and perceived accuracy of the painting (see the first and second quotations below) or commented on the emotional impact intended by the artist (see the third and fourth quotations).

> I think [the artist] did a good job. [The dinosaur in the painting] is so 3-D. I mean if you look at [its] face and then match it up with the skeleton—I think [the artist] did an excellent job.

> This is a picture of what you imagine [dinosaurs and their environment] to look like. You don't know for sure. It's the artist's best interpretation using what information [she] has available, I'm sure. I think [the picture] is pretty straightforward. So I don't think there's much to question. I'm sure the artist is trying to get everything right. [The picture] makes you curious—to want to read more, so [the Museum should] have a lot more information available for the people to look at throughout the Museum, because you need more than just the pictures.

> We don't really know if a scene like this [one in the painting] ever happened. I mean, I don't think that big dinosaur would have been hunting that little rat, so maybe the artist is just trying to hint that the dinosaur is a meat eater and that rats were alive back then. Or maybe it's meant to show that dinosaurs ruled the Earth and little mammals had to scurry away to survive. I don't know how [the artist] could possibly know if this kind of scene ever happened—it's so dramatic, like in the movies.

> (You mentioned the little mouselike animal in the picture. What do you think that means?) Well, I don't know. I can kind of give you an emotional kind of thing here. You have this big threatening, dangerous looking, ominous, huge creature and then a little, small, nonthreatening creature—maybe there is a little contrast here that the painter wanted to put in to give you a little bit of contrasting feelings.

APPENDICES

Removed for proprietary reasons