



Museum Visitor Studies, Evaluation & Audience Research

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**Summative Evaluation:
Science & Art Exhibition**

Prepared for the
Arkansas Discovery Network
Little Rock, AR

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EXECUTIVE SUMMARY

INTRODUCTION

This report presents findings from a summative evaluation of *Science & Art*, a traveling exhibition created by the Science Museum of Minnesota that will travel to the Arkansas Discovery Network's (ADN) museums. The ADN contracted with Randi Korn & Associates (RK&A) to conduct the evaluation, which investigated the impact and effectiveness of the exhibition through timing and tracking observations and interviews. Data were collected in April 2010 at the Mid-America Science Museum in Hot Springs, Arkansas.

The findings presented here are among the most salient. Please read the body of the report for a more comprehensive presentation of findings.

PRINCIPAL FINDINGS: TIMING AND TRACKING OBSERVATIONS

RK&A observed 114 visitors 9 years or older. Findings are as follows:

- ◆ 60 percent of observed visitors are female.
- ◆ More than one-half of observed visitors are adults 18 years and older (55 percent), and the other one-half are children ages 9 to 17 (45 percent).
- ◆ Of the 29 exhibits in *Science & Art*, the median number of exhibit stops is six.
- ◆ The median time spent in the exhibition is 7 minutes, 10 seconds.
- ◆ The Origami Laboratory is the most visited section in the exhibition (87 percent of visitors stopped), while Electric Threads is the least visited exhibition (28 percent of visitors stopped).
- ◆ Visitors spent the most time at Origami Laboratory (median time: 2 minutes, 23 seconds) and the least time at The Elegant Worm (median time: 42 seconds).
- ◆ Females were more likely than were males to stop at the Electric Threads section and the Wired + Fashion exhibit.
- ◆ Females spent more time than did males at The Elegant Worm section and the Five Cool Facts About *C. Elegans* exhibit.
- ◆ Children (9-17 years) were more likely than were adults (18 years and older) to stop at How Many Nanometers Tall Are You?, More Bits = Better Sound, Listen to Some of Tristan's 1-Bit Compositions, and Symmetry and Origami.
- ◆ Visitors' engagement in the exhibition is high: almost all visitors used an interactive component at least once in the exhibition (98 percent), many visitors looked at the artwork and videos at least once in the exhibition (e.g., origami in display cases) (80 percent), and more than one-half of visitors read aloud/or talked about exhibit content (54 percent).

PRINCIPAL FINDINGS: INTERVIEWS

RK&A interviewed 50 adult visitors after their exhibition experience. Findings are as follows:

- ◆ When asked about their favorite aspects of the exhibition, almost one-half of visitors named the Zoom Into Water (Three Drops) exhibit, and about one-third named the Origami Laboratory section.
- ◆ When asked about their least favorite aspects of the exhibition, only about one-half offered critiques and most responses were idiosyncratic. The Music in the Machine section was most often pinpointed as visitors' least favorite section, for a variety of reasons.
- ◆ Most visitors said they stopped at Zoom Into Water, and they often described experiences with more than one of the three projections, although they used many different words, including “bubble,” “shower,” and “molecules,” to talk about the projections.
- ◆ Many visitors said they did not know what Zoom Into Water is trying to show visitors. Others provided a number of responses, including that the exhibit shows how molecules are formed or shows what you can do with a projector; no one used the words “macro,” “micro,” or “nano” to describe their experiences.
- ◆ About two-thirds of visitors said they stopped at the Origami Laboratory section. Some described their experiences with the Origami Table, while a few each talked about Symmetry and Origami, Getting Technical, and Fold It Fast, Fold It Slow.
- ◆ Many visitors said they did not know what the Origami Laboratory section is trying to show or tell visitors. Other visitors provided a number of responses—some of which were purely science-oriented (i.e., geometry and math), some of which were art-oriented (e.g., creativity and design), and some of which described science and art.
- ◆ About one-third of visitors said they read the biographies, and a few provided detailed memories of what they had read. Visitors most often recalled the Music in the Machine and Electric Threads biographies.
- ◆ When asked what they took away from their exhibition experience, less than one-third of visitors' responses indicated messages related to science and art.
- ◆ When asked explicitly about science and art messages, more than one-half of visitors said they made connections between the two subjects, although several did not talk in-depth.
- ◆ About one-third of visitors said that the Origami Laboratory section showed them connections between science and art.
- ◆ When asked to describe their thoughts about science and art, more than one-third of interviewees responded thoughtfully and in-depth; visitors' considerations ranged from responses about creativity to responses about how science is integrated into everyday life.

DISCUSSION

INTRODUCTION

Science & Art proved to be an engaging exhibition that both children and adults enjoyed. The interactive components of the exhibition, such as the Zoom Into Water (Three Drops) exhibit, were core and often peak experiences for visitor. Despite visitors' engagement with the exhibition, many did not grasp the exhibition's main message—that connections exist between science and art. This discussion focuses on aspects of the exhibition that were most successful and how these elements could better demonstrate the connections between science and art. Recommendations about traveling exhibitions are also presented for that the Arkansas Discovery Network to consider.

SUCCESSFUL ASPECTS OF THE EXHIBITION

The exhibition content and the participatory and interactive exhibits were the driving force behind the exhibition. These elements provide a solid framework for the visitor experience.

CONTENT IS ACCESSIBLE

The thesis of *Science & Art* is widely accessible to visitors because it placed familiar activities and objects, like origami and sewing, within the new context of science. Further, the exhibition sections offered entry points for a range of visitors. For instance, one visitor explained that he was able to connect with the one-bit music section because he was familiar with but not knowledgeable about computer bits. Additionally, origami seemed to be an entry point for many as a familiar craft.

The accessibility of the content was evident in the personal connections that visitors shared as well as in their responses about the exhibition's messages. That is, some visitors talked about the creativity of the objects, correlations with everyday life, and the applications of origami to mathematical problems. While none of these responses explicitly indicate that science and art are connected, they indicate stepping stones to such an understanding.

PARTICIPATORY AND INTERACTIVE EXHIBITS

Participatory and interactive exhibits were highly popular (i.e., almost all interviewees engaged with at least one interactive component in the exhibition) and memorable (i.e., often recalled in interviews). Further, the range of exhibits seemed to appeal to visitors of all ages. While exhibits like How Many Nanometers Tall Are You? and Symmetry and Origami attracted children, the Origami Table and Electric Threads appealed to adults and children (i.e., no difference in stops by age).

Also noteworthy is that certain exhibits appealed strongly to females—an audience that science museums sometimes have difficulty reaching. The Electric Threads section overall and the Wired + Fashion exhibit attracted significantly more females than males. Females also spent more time than did males in the Five Cool Facts About *C. Elegans* exhibit. The Electric Threads and The Elegant Worm sections featured female artist-scientists, which may have appealed to women and girls. Additionally, focus on sewing—a traditionally female craft—in the Elegant Threads section likely provided females with a familiar entry point. The Electric Threads section's potential appeal for females should be greater capitalized upon in future installations of *Science & Art*. At the study site (Mid-America Science

Museum), the Electric Threads section was the least visited exhibit section, likely owing to the section's poor location separate from the rest of the exhibition and not its appeal.

BARRIERS TO UNDERSTANDING THE EXHIBITION MESSAGE

While the content is accessible and the exhibits engaging, the exhibition faced two main barriers in conveying the exhibition message: physical orientation and conceptual orientation.

PHYSICAL ORIENTATION

Science & Art was displayed on the bottom floor of the Mid-America Science Museum in an open and unbounded gallery space. While the exhibit designers created an exhibit that looked visually cohesive, the exhibit was not distinct from the many other free-standing exhibits that shared the space. RK&A observed some visitors moving from the *Science & Art* exhibits to other exhibits in the shared space, not knowing that the *Science & Art* exhibits were part of a traveling exhibition. This observation was reinforced in interviews with visitors; interviewers often had to gesture or explain which set of exhibits they were inquiring about. This situation presents a considerable barrier to helping visitors make connections to an exhibition message when they are not aware that exhibits go together physically (McClellan, 1993).

Physical orientation is a constant struggle for traveling exhibitions since designers must create exhibits that will work in multiple venues, and which they rarely see (RK&A, 2008a; RK&A 2008b). There are certain things that a museum can do, however, to help strengthen the physical orientation, such as by grouping exhibit sections and using the exhibits to create temporary walls, like how the Museum created a circular space around the Origami Table that contained the exhibits for the Origami Laboratory and The Elegant Worm sections. The museum may also consider arranging exhibits so that visitors move through them in a structured and directed way to create a sense of cohesion or connectedness among the exhibits.

Along with physically orienting exhibits within the space, ADN may consider advertising the exhibition so that visitors seek it out or are at least aware that a special exhibition is on view. This is most effectively done by hanging banners or signs in the museum entry to introduce visitors to the exhibition. It is also useful to identify the exhibition space on the museum's map so visitors know where to find it.

CONCEPTUAL ORIENTATION

Conceptual orientation to the exhibition is most crucial for traveling exhibitions, since challenges of physical orientation are ubiquitous. Creating a strong introduction to the exhibition and reiterating the "big idea"—connections between science and art—throughout the exhibition are primary ways the museum can orient visitors to the exhibition's concept (Serrell, 1996). As it currently stands, the exhibition's introduction is a small text panel on the side of the Zoom Into Water (Three Drops) exhibit. While the text itself is clear and concise, only one observed visitor stopped at the Introduction panel (i.e., looked at it for more than 3 seconds).

The biographies offer another opportunity to enhance the exhibition's conceptual orientation at the introduction and at each section. While a unifying feature of each exhibition section, the biographical information is only presented in text and visitors often overlook it. Making the biographies more prominent by introducing the scientists/artists in life-size cut-outs or even through audio or video would further unify the exhibition. History museums, in particular, have found that the first-person narrative is a successful tactic to help visitors personally connect with an exhibition (Chew, 2002; Filene, 2008). Further, the ADN could showcase more scientists/artists at work as is currently done in Getting

Technical and Fold It Fast, Fold It Slow—visitors often recalled these exhibits because they enjoyed seeing their work process. In addition to capitalizing on visitors’ interest, showing scientists/artists at work may help visitors see connections between the scientific and artistic processes.

RECOMMENDATIONS

- ◆ Enhance the introduction and sections using the biographies. An audio or video introduction introducing the scientists/artists could provide a strong hook and organizer, although cardboard cut-outs of the scientists/artists may be a more cost effective alternative.
- ◆ Try to create stronger physical connections between the exhibits so that visitors recognize that the exhibits go together. Additionally, consider creating multiple introductory panels, signs, or markers to be placed around the exhibit; reiterating the “big idea” in many different parts of the exhibit further combats challenges of physical and conceptual orientation.
- ◆ While it contained the most engaging exhibit, The Digital Canvas section was only moderately successful at conveying the exhibit message. Consider tightening the physical orientation of these exhibits. Also, at Three Drops, consider projecting the words “macro,” “micro,” and “nano” on or near the screen so that the content is overlaid with the interactive; currently, the content is at the exhibit’s periphery.
- ◆ Visitors spent the least time at The Elegant Worm section; it is also the section with the fewest interactive components. Consider adding a drawing or photography activity that allows visitors to draw what they see under the microscope or take pictures of magnified worms.

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INTRODUCTION

The Arkansas Discovery Network (ADN) contracted with Randi Korn & Associates, Inc. (RK&A) to evaluate *Science & Art*, an exhibition created by the Science Museum of Minnesota that will travel to the ADN museums. The evaluation documents the impact and effectiveness of the exhibition as it was installed at the Mid-America Science Museum in Hot Springs, Arkansas.

Specifically, the evaluation explores:

- ◆ Total time spent in the exhibition and at individual exhibits;
- ◆ Visitors' interactions in the exhibition;
- ◆ Visitors' responses to the exhibition;
- ◆ Visitors' experiences in the Origami Laboratory section;
- ◆ Visitors' experiences with the Zoom Into Water (Three Drops) exhibit;
- ◆ Messages that visitors took away from their experiences with the exhibition; and,
- ◆ Connections visitors made between science and art.

METHODOLOGY AND DATA ANALYSIS

As part of the evaluation, RK&A conducted timing and tracking observations and interviews. All data were collected in April 2010 at the Mid-America Science Museum. Almost all data were collected during the week that Arkansas schools observed spring break.

TIMING AND TRACKING OBSERVATIONS

Timing and tracking observations provide an objective and quantitative account of how visitors behave and react to exhibition components. Observational data indicate how much time visitors spend in the exhibition and the range of visitor behaviors.

Trained data collectors observed 100 visitors to the exhibition. Data collectors observed eligible visitors (visitors 9 years and older) selected using a continuous random sampling method. In accordance with this method, the data collector imagined a line at the entrance to *Science & Art* and selected the first eligible visitor to cross this imaginary line.¹ Once the visitor crossed the imaginary line, the data collector started her stopwatch and followed the selected visitor through the exhibition, recording the exhibits used, noting interactions, and logging total time spent in the exhibition (see Appendix A for the timing and tracking form). When the visitor completed his or her visit, the data collector returned to the entrance to await the next eligible visitor to cross the imaginary line.

Timing and tracking observation data are quantitative and were analyzed using SPSS 12.0.1 for Windows, a statistical package for personal computers. Analyses include descriptive and inferential

¹ *Science & Art* was exhibited in an open gallery space on the bottom floor of the Mid-America Science Museum. RK&A deemed the entrance to be at the bottom of the stairs and near the introductory panel to the exhibition. However, after the Tesla coil demonstration, data collectors also intercepted people on that side of the exhibition, which they did seven times.

methods. Statistical tests employed a 0.05 level of significance to preclude findings of little practical significance.² All statistical analyses run are listed in Appendix B.

Frequency distributions were calculated for all variables. Summary statistics were also calculated for time variables. Summary statistics include the range, median (50th percentile, the data point at which half the responses fall above and half fall below)³, mean (average), and standard deviation (spread of scores: “±” in tables).

To examine the relationship between two categorical variables, cross-tabulation tables were computed to show the joint frequency distribution of the variables, and the chi-square statistic (X^2) was used to test the significance of the relationship. For example, “stop at exhibit” was tested against “age group” to determine whether exhibit stops were age-related.

To test for differences in the medians of two or more groups, the nonparametric Kruskal-Wallis (K-W) test was performed.⁴ For example, “total time in the exhibition” was compared by “age group” to determine whether time spent in the exhibition was age-related.

IN-DEPTH INTERVIEWS

In-depth interviews encourage and motivate visitors to describe their experiences, express their opinions and feelings, and share with the interviewer the meaning they constructed from an experience. In-depth interviews produce data rich in information because interviewees talk about personal experiences.

Trained data collectors interviewed 30 visitors to *Science & Art*. Trained data collectors intercepted visitors exiting the exhibition using a continuous random sampling method. In keeping with this method, data collectors intercepted adult visitors (18 years or older) upon exiting the exhibition and asked them to participate in the interview. If the visitor declined, the data collector logged the visitor’s gender, estimated age, description of the visit group, and reason for refusal. If the visitor agreed, the interview was conducted using an interview guide (see Appendix C).

All interviews were audio recorded and transcribed to facilitate analysis. Data were analyzed qualitatively. That is, the evaluator studied the transcripts for meaningful patterns and, as patterns and trends emerged, grouped similar responses.

² When the level of significance is set to $p = 0.05$, any finding that exists at a probability (p -value) ≤ 0.05 is “significant.” When a finding (such as a relationship between two variables) has a p -value of 0.05, there is a 95 percent probability that the finding exists; that is, in 95 out of 100 cases, the finding is correct. Conversely, there is a 5 percent probability that the finding would not exist; in other words, in 5 out of 100 cases, the finding appears by chance.

³ Medians rather than means are reported in the timing and tracking section of this document because, as is typical, the number of exhibits used and the time spent by visitors were distributed unevenly across the range. For example, whereas most visitors spent a short to moderate time in the exhibition, a few spent an unusually long time. When the distribution of scores is extremely asymmetrical (i.e., “lopsided”), the mean is affected by the extreme scores and, consequently, falls further away from the distribution’s central area. In such cases, the median is a better indicator of the distribution’s central area because it is not sensitive to the values of scores above and below it—only to the number of such scores.

⁴ The Kruskal-Wallis (K-W) test is a nonparametric statistical method for testing the equality of population medians of two or more groups. Nonparametric statistical methods do not assume that the underlying distribution of a variable is “normal” with a symmetric bell-shape, so they are appropriate for testing variables with asymmetric distributions such as “total time in the exhibition.” The K-W test is analogous to a One-way Analysis of Variance, with the scores replaced by their ranks. The K-W test statistic H has approximately a chi-square distribution.

REPORTING METHOD

This report presents quantitative data in tables. Percentages within tables may not always equal 100 owing to rounding. Findings within each topic are presented in descending order, starting with the most-frequently occurring.

Qualitative data are presented in narrative and with verbatim quotations (edited for clarity). For quotations, the interviewer's remarks appear in parentheses and the interviewee's gender and age appear in brackets following the quotation. Trends and themes in the data are also presented from most- to least-frequently occurring.

SECTIONS OF THE REPORT:

1. Timing and Tracking Observations
2. Interviews

TIMING & TRACKING OBSERVATIONS

INTRODUCTION

Observation data for *Science & Art* were collected at the Mid-America Science Museum during two weeks in April 2010, including the week that local K-12 schools observed spring break. The exhibition was displayed in an unbounded space on the bottom floor of the Museum near the Tesla Coil.

Observations were conducted during weekdays (62 percent) and weekend days (38 percent) (see Table 1). Most observations were conducted in the afternoon (87 percent), and most visitors experienced a low to moderate level of crowding (46 and 52 percent, respectively). In less than one-third of observations, staff were present in the exhibition (29 percent).

TABLE 1
DATA COLLECTION CONDITIONS

DAY OF THE WEEK (n = 114)	%
Weekday	62.3
Saturday	27.2
Sunday	10.5
TIME OF DAY (n = 113)	%
Morning	13.3
Afternoon	86.7
LEVEL OF CROWDING (n = 113)	%
Low	46.0
Moderate	52.2
High	1.8
STAFF PRESENT IN THE EXHIBITION (n = 113)	%
No	70.8
Yes	29.2

DESCRIPTION OF VISITORS

Data collectors observed visitors 9 years and older in the exhibition. This section describes characteristics of the observed visitor.

DEMOGRAPHIC CHARACTERISTICS

As shown in Table 2, almost two-thirds of observed visitors were female (60 percent). More than one-half of observed visitors were adults—most were between ages 25 and 44 (40 percent)—and almost one-half were children⁵—most were between ages 9 and 11 (25 percent).

TABLE 2
DEMOGRAPHIC CHARACTERISTICS OF OBSERVED VISITORS

GENDER (n = 109)	%
Female	59.6
Male	40.4
AGE GROUP (IN YEARS, n = 114)	%
9 – 11	24.6
12 – 14	12.3
15 – 17	8.8
18 – 24	5.3
25 – 34	18.4
35 – 44	21.1
45 – 54	4.4
55 – 64	2.6
65 or older	2.6

⁵ For this study, any visitor under 18 is considered a child.

VISIT GROUP

The majority of observed visitors were visiting in a group of adults and children (81 percent), while a few were visiting in adult-only groups (7 percent), children-only groups⁶ (7 percent), and alone (5 percent) (see Table 3). Additionally, the majority of visitors were observed in groups of two to five visitors (80 percent).

TABLE 3
DESCRIPTION OF VISIT GROUP

GROUP COMPOSITION (n = 114)	%
Adults and children	80.7
Adults only	7.0
Children only	7.0
Alone	5.3
GROUP SIZE¹ (n = 114)	%
Alone	5.3
2	25.4
3	18.4
4	21.1
5	14.9
6	6.1
7 or more	8.8

¹ Group size (including the observed visitor); range = 1 – 10 visitors; median = 4 visitors; mean = 3.8 visitors (± 0.18).

⁶ At the end of each observation, data collectors indicated what they observed to be the visit group of the observed visitor. That is, data collectors indicated the visit group based on the interactions they observed between the observed visitor and others in the exhibition. Therefore, “children only group” does not mean that children were visiting the Museum without adults, but rather, that the data collector could not discern the child’s visit group.

OVERALL VISITATION PATTERNS

In this section, RK&A describes visitors' engagement with the exhibition as a whole, sections of the exhibition, individual exhibits, and exhibit types by two measures: stops and time.

VISITATION TO THE OVERALL EXHIBITION

STOPS IN THE EXHIBITION⁷

In the exhibition, RK&A identified 29 distinct exhibits or exhibit components at which visitors could stop. For this evaluation, a "stop" is defined as a visitor standing for 3 seconds or longer at an exhibit.

As shown in Table 4, visitors stopped at between one and 16 exhibits; visitors stopped at a median of six exhibits. About one-half of visitors stopped at between five and eight exhibits (51 percent), while one-quarter stopped at four exhibits or fewer (25 percent). Neither gender nor age factored into the number of exhibits at which visitors stopped.

TABLE 4

TOTAL NUMBER OF EXHIBIT STOPS

TOTAL NUMBER OF EXHIBIT STOPS (<i>n</i> = 114)	% OF VISITORS
4 or fewer	24.6
5 – 8	50.9
9 – 12	21.9
13 – 16	2.6
SUMMARY STATISTICS (<i>n</i> = 114)	NUMBER OF EXHIBIT STOPS
Range	1 to 16
Median number	6
Mean number	7
Standard deviation (\pm)	3.06

⁷ RK&A did not compare *Science & Art* to similar exhibitions using Beverly Serrell's "Percentage Diligent Visitor Index" (%DV) since the exhibition was displayed in an open, unbounded exhibition space. Serrell, B. (1998). *Paying Attention: Visitors and Museum Exhibitions*. Washington, DC, American Association of Museums.

TIME SPENT IN THE EXHIBITION⁸

Using a stopwatch, data collectors documented the amount of time visitors spent engaged with the entire exhibition.⁹ Time spent in the exhibition ranged from about 1 minute to more than 30 minutes, with a median time of approximately 7 minutes (see Table 5). Neither gender nor age factored into the amount of time visitors spent in the exhibition.

TABLE 5
TOTAL TIME SPENT IN THE EXHIBITION

TOTAL TIME SPENT IN THE EXHIBITION (n = 114)	% OF VISITORS
Less than 5 minutes	24.6
5– 10	41.2
10– 15	13.2
15– 20	14.9
More than 20	6.1
SUMMARY STATISTICS (n = 114)	TIME (MIN:SEC)
Range	1:17 to 31:59
Median time	7:10
Mean time	9:26
Standard deviation (±)	6:16

⁸ RK&A did not compare *Science & Art* to similar exhibitions using Beverly Serrell’s “Sweep Rate Index” (SRI) since the exhibition was displayed in an open, unbounded exhibition space. Serrell, B. (1998). *Paying Attention: Visitors and Museum Exhibitions*. Washington, DC, American Association of Museums.

⁹ Data collectors timed visitors from the moment the visitor entered the exhibition to the moment that the visitor left the exhibition (“observation time”). Because the exhibition was displayed in an open gallery space where it was easy to wander between the *Science & Art* exhibition and other exhibits, data collectors also calculated time spent outside the exhibition. Thus, visitors’ “total time spent in the exhibition” equals the “observation time” minus any time spent at non-*Science & Art* exhibits. During their visit to the exhibition, a total of 30 visitors spent time at non-*Science & Art* exhibits for a median time of 1 minute, 20 seconds.

VISITATION TO EXHIBITION SECTIONS

STOPS AT EXHIBITION SECTIONS

The 29 exhibits in *Science & Art* are contained within five distinct sections—The Digital Canvas, Origami Laboratory, The Elegant Worm, Music in the Machine, and Electric Threads.¹⁰ Of the five sections, Origami Laboratory was most visited (87 percent of visitors stopped at one or more exhibits in this section), while Electric Threads was least visited (28 percent of visitors stopped at one or more exhibits in this section) (see Table 6).

TABLE 6
PERCENTAGE OF VISITORS WHO STOPPED AT THE EXHIBITION SECTIONS

EXHIBITION SECTION ¹ (<i>n</i> = 114)	% OF VISITORS WHO STOPPED ²
Origami Laboratory (9 exhibits)	86.8
The Digital Canvas (4 exhibits)	77.2
Music in the Machine (5 exhibits)	70.2
The Elegant Worm (4 exhibits)	47.4
Electric Threads (5 exhibits)	28.1

¹ Not included in the exhibition sections are the Introduction and Resource Area exhibit stops.

² The percentage of visitors who stopped is the percentage of visitors who stopped at one exhibit or more per section.

RK&A tested whether gender and age factored into the percentage of visitors who stopped at each exhibition section. There is one significant finding:

- ◆ Females were more likely than were males to stop at Electric Threads (35 percent versus 16 percent) (see Table 6a).

TABLE 6a
PERCENTAGE OF VISITORS WHO STOPPED AT THE EXHIBITION SECTIONS BY GENDER

EXHIBITION SECTION	<i>n</i>	GENDER		
		MALE	FEMALE	TOTAL
		% OF VISITORS WHO STOPPED	% OF VISITORS WHO STOPPED	% OF VISITORS WHO STOPPED
Electric Threads ¹	30	15.9	35.4	27.5

¹ $\chi^2 = 4.989$; *df* = 1; *p* = .026 (Cross-tabulation)

¹⁰ Not included in the exhibition sections are the exhibit stops Introduction and the Resource Area.

TIME SPENT AT EXHIBITION SECTIONS

Additionally, RK&A calculated the median amount of time that visitors spent in each exhibition section; calculations are based upon only those visitors that stopped at each exhibition section. Visitors spent the most time in Origami Laboratory (median time = 2 minutes, 23 seconds) and the least time in The Elegant Worm (median time = 42 seconds) (see Table 7).

TABLE 7
TIME SPENT AT THE EXHIBITION SECTIONS

EXHIBITION SECTION ¹	NUMBER OF VISITORS WHO STOPPED	MEDIAN TIME (MIN:SEC)
Origami Laboratory (9 exhibits)	99	2:23
Electric Threads (5 exhibits)	32	1:59
Music in the Machine (5 exhibits)	80	1:40
The Digital Canvas (4 exhibits)	88	1:34
The Elegant Worm (4 exhibits)	54	:42

¹ The Introduction and the Resource Area are not included in the exhibition sections.

RK&A tested whether gender and age factored into the amount of time visitors spent in the exhibition sections.¹¹ There is one significant finding:

- ◆ Females spent more time than did males in the The Elegant Worm (1 minute, 9 seconds versus 25 seconds) (see Table 7a).

TABLE 7a
TIME SPENT AT THE EXHIBITION SECTIONS BY GENDER

EXHIBITION SECTION	n	GENDER		
		MALE	FEMALE	TOTAL
		MEDIAN TIME (MIN:SEC)	MEDIAN TIME (MIN:SEC)	MEDIAN TIME (MIN:SEC)
The Elegant Worm ¹	52	:25	1:09	:41

¹ $\chi^2 = 9.977$; $df = 1$; $p = .002$ (Kruskal-Wallis test)

¹¹ The Elegant Worm and Electric Threads were excluded from this analysis because the median time was null.

VISITATION TO INDIVIDUAL EXHIBITS

STOPS AT INDIVIDUAL EXHIBITS

RK&A calculated the percentage of visitors who stopped at each of the 29 exhibits (see Table 8). The most stopped at exhibits are Zoom Into Water (Three Drops and text panel) (70 percent of visitors stopped), Symmetry and Origami (55 percent of visitors stopped), and More Bits = Better Sound (52 percent of visitors stopped).

The least stopped at exhibits were The Elegant Worm: Ahna Skop Bio (2 percent of visitors stopped), the Introduction (1 percent of visitors stopped), and Electric Threads: Leah Buechley Bio (1 percent of visitors stopped).

TABLE 8
PERCENTAGE OF VISITORS WHO STOPPED AT INDIVIDUAL EXHIBITS

EXHIBIT	EXHIBITION SECTION	% OF VISITORS WHO STOPPED
Zoom Into Water (Three Drops and text panel) ¹	The Digital Canvas	70.2
Symmetry and Origami	Origami Laboratory	55.3
More Bits = Better Sound	Music in the Machine	51.8
Origami Table	Origami Laboratory	49.2
Tristan Composes All Kinds of Music	Music in the Machine	48.2
Listen to Some of Tristan's 1-Bit Compositions	Music in the Machine	45.6
Five Cool Facts About C. Elegans	The Elegant Worm	39.5
Robert J. Lang's Origami	Origami Laboratory	39.5
How Many Nanometers Tall Are You?	The Digital Canvas	37.7
Fold It Fast, Fold It Slow	Origami Laboratory	35.1
Getting Technical	Origami Laboratory	33.3
Skop's Photographs and Video with Labels	The Elegant Worm	25.4
Five Special Shapes	Origami Laboratory	24.6
Wired + Fashion	Electric Threads	24.6
Electricity Workbench	Electric Threads	21.9
Scientists Know This Worm Inside & Out	The Elegant Worm	8.8
Origami: Part Art, Part Math	Origami Laboratory	7.9
Artists Can Help Us Understand Science	The Digital Canvas	6.1
Music in the Machine: Tristan Perich Bio	Music in the Machine	5.3
Resource area	Other	5.3
Janet Makes a Shirt	Electric Threads	3.5
Origami: Not Just for Fun Anymore!	Origami Laboratory	3.5
Origami Laboratory: Robert J. Lang Bio	Origami Laboratory	3.5
The Digital Canvas: Scott Snibbe Bio	The Digital Canvas	3.5
Do-it Yourself!	Electric Threads	2.6
Musical Score and Text Panel	Music in the Machine	2.6
The Elegant Worm: Ahna Skop Bio	The Elegant Worm	1.8
Electric Threads: Leah Buechley Bio	Electric Threads	.9
Introduction	Other	.9

¹ During five observations, the Zoom Into Water exhibit was broken.

For exhibits stopped at by 20 visitors or more, RK&A tested whether gender and age factored into the percentage of visitors who stopped at individual exhibits. There are several significant findings:

- ◆ Females were more likely than were males to stop at Wired + Fashion (35 percent versus 16 percent) (see Table 8a).
- ◆ Children (9-17 years) were more likely than adults (18 years and older) to stop at How Many Nanometers Tall Are You? (50 percent versus 27 percent), More Bits = Better Sound (64 percent versus 42 percent), Listen to Some of Tristan’s 1-Bit Compositions (56 percent versus 37 percent), and Symmetry and Origami (65 percent versus 47 percent) (see Table 8b).

TABLE 8a

PERCENTAGE OF VISITORS WHO STOPPED AT INDIVIDUAL EXHIBITS BY GENDER

EXHIBIT	n	GENDER		
		MALE	FEMALE	TOTAL
		%	%	%
Wired + Fashion ¹	26	13.6	30.8	23.9

¹ $\chi^2 = 4.240$; $df = 1$; $p = .039$ (Cross-tabulation)

TABLE 8b

PERCENTAGE OF VISITORS WHO STOPPED AT INDIVIDUAL EXHIBITS BY AGE

EXHIBIT	n	AGE		
		CHILDREN (9-17)	ADULTS (18 +)	TOTAL
		%	%	%
How Many Nanometers Tall Are You? ¹	43	50.0	27.4	37.7
More Bits = Better Sound ²	59	63.5	41.9	51.8
Listen to Some of Tristan’s 1-Bit Compositions ³	52	55.8	37.1	45.6
Symmetry and Origami ⁴	63	65.4	46.8	55.3

¹ $\chi^2 = 6.138$; $df = 1$; $p = .013$ (Cross-tabulation)

² $\chi^2 = 5.248$; $df = 1$; $p = .022$ (Cross-tabulation)

³ $\chi^2 = 3.975$; $df = 1$; $p = .046$ (Cross-tabulation)

⁴ $\chi^2 = 3.927$; $df = 1$; $p = .048$ (Cross-tabulation)

TIME SPENT AT INDIVIDUAL EXHIBITS

See Table 9 for the amount of time visitors spent at each exhibit. By far, visitors spent the most time at Origami Table (more than 3 minutes). Visitors also spent considerable time at Zoom Into Water (Three Drops and text panel), Electricity Workbench, and Symmetry and Origami (about 1 to 2 minutes each).

Visitors spent the least time at Scientists Know This Worm Inside & Out, Origami Laboratory: Robert J. Lang Bio, Electric Threads: Leah Buechley Bio, Skop’s Photographs and Video with Labels, Janet Makes a Shirt, and Artists Can Help Us Understand Science (less than 15 seconds each).

TABLE 9
TIME SPENT AT INDIVIDUAL EXHIBITS

EXHIBIT	EXHIBITION SECTION	NUMBER OF VISITORS WHO STOPPED	MEDIAN TIME (MIN:SEC)
Origami Table	Origami Laboratory	56	3:18
Zoom Into Water (Three Drops and text panel)	The Digital Canvas	80	1:40
Electricity Workbench	Electric Threads	25	1:19
Symmetry and Origami	Origami Laboratory	63	1:13
Tristan Composes All Kinds of Music	Music in the Machine	55	:49
More Bits = Better Sound	Music in the Machine	59	:45
Listen to Some of Tristan’s 1-Bit Compositions	Music in the Machine	52	:44
Five Cool Facts About C. Elegans	The Elegant Worm	45	:38
Fold It Fast, Fold It Slow	Origami Laboratory	40	:35
Resource area	Other	6	:35
Introduction	Other	1	:31
How Many Nanometers Tall Are You?	The Digital Canvas	43	:30
The Elegant Worm: Ahna Skop Bio	The Elegant Worm	2	:28
Wired + Fashion	Electric Threads	28	:25
Getting Technical	Origami Laboratory	38	:24
Music in the Machine: Tristan Perich Bio	Music in the Machine	6	:21
The Digital Canvas: Scott Snibbe Bio	The Digital Canvas	4	:19
Musical Score and Text Panel	Music in the Machine	3	:18
Five Special Shapes	Origami Laboratory	28	:17
Origami: Part Art, Part Math	Origami Laboratory	9	:17
Do-it Yourself!	Electric Threads	3	:15
Origami: Not Just for Fun Anymore!	Origami Laboratory	4	:15
Robert J. Lang’s Origami	Origami Laboratory	45	:15
Artists Can Help Us Understand Science	The Digital Canvas	7	:14
Janet Makes a Shirt	Electric Threads	4	:13
Skop’s Photographs and Video with Labels	The Elegant Worm	29	:13
Electric Threads: Leah Buechley Bio	Electric Threads	1	:11
Origami Laboratory: Robert J. Lang Bio	Origami Laboratory	4	:11
Scientists Know This Worm Inside & Out	The Elegant Worm	10	:10

¹ During five observations, the Zoom Into Water exhibit was broken.

For exhibits stopped at by 20 visitors or more, RK&A tested whether gender and age factored into time spent at individual exhibits. There is one significant finding:

- ◆ Females spent more time than did males at Five Cool Facts About C. Elegans (1 minute, 6 seconds versus 21 seconds) (see Table 9a).

TABLE 9a
TIME SPENT AT INDIVIDUAL EXHIBITS BY GENDER

EXHIBIT	n	GENDER		
		MALE	FEMALE	TOTAL
		MEDIAN TIME (MIN:SEC)	MEDIAN TIME (MIN:SEC)	MEDIAN TIME (MIN:SEC)
Five Cool Facts About C. Elegans ¹	43	:21	1:06	:38

¹ $\chi^2 = 14.937$; $df = 1$; $p = .000$ (Kruskal-Wallis test)

VISITOR BEHAVIORS

This section describes visitors' behaviors in the exhibition. For a complete list of behavior frequencies by exhibit, see Appendix D.

DESCRIPTION OF BEHAVIORS

RK&A collected information about six specific behaviors that visitors may do in the exhibition; each behavior was not applicable at all exhibits. Definitions of the behavior are:

LOOK – to look at a work of art (e.g., origami in display case or photos/video) for 3 seconds or longer—more than a passing glance;

USE – to use the interactive element of the exhibit appropriately (e.g., push buttons, listen to music, make origami);

MISUSE – to use the interactive inappropriately, and, sometimes, aggressively (e.g., smacking buttons, throwing pieces, smashing probes against materials);

WATCH – to watch another visitor use an exhibit;

READ ALOUD/TALK ABOUT CONTENT – to read labels or text aloud to other visitors or talk about exhibit content with other visitors (e.g., “this is interesting about ..., origami is really hard to make,” “how long do you think it took to make this?”);

COACH/BE COACHED – to coach someone else on how to use an exhibit component or to be coached on how to use an exhibit component; this could include giving verbal directions or physically showing someone how to do something.

BEHAVIORS EXHIBITED

RK&A calculated the percentage of visitors to exhibit each behavior. Overall, “use” was the most frequent behavior (98 percent of visitors used an interactive component at least once in the exhibition) followed by “look” (80 percent of visitors looked at a work of art at least once in the exhibition) (see Table 10). Misuse happened least frequently (1 percent of visitors misused an exhibit at least once in the exhibition).

TABLE 10
PERCENTAGE OF VISITORS WHO EXHIBITED SPECIFIC BEHAVIORS

BEHAVIOR	% OF VISITORS (n = 114)
Use (applicable at 14 exhibits)	98.2
Look (applicable at 9 exhibits)	79.8
Watch (applicable at 14 exhibits)	64.9
Read aloud/talk about (applicable at 29 exhibits)	53.5
Coach/be coached (applicable at 14 exhibits)	28.9
Misuse (applicable at 14 exhibits)	.9

RK&A tested whether gender and age factored into visitors’ behaviors. There are several significant findings:

- ◆ Females were more likely than were males to read aloud/talk about exhibit content (63 percent versus 39 percent) (see Table 10a).
- ◆ Adults were more likely than were children to coach/be coached and to watch another visitor use an exhibit (42 percent versus 14 percent, 77 percent, and 50 percent) (see Table 10b, next page).

TABLE 10a
PERCENTAGE OF VISITORS WHO EXHIBITED SPECIFIC BEHAVIORS BY GENDER

EXHIBIT	n	GENDER		
		MALE	FEMALE	TOTAL
		%	%	%
Read aloud/talk about ¹	109	38.6	63.1	53.2

¹ $\chi^2 = 6.295; df = 1; p = .012$ (Cross-tabulation)

TABLE 10b**PERCENTAGE OF VISITORS WHO EXHIBITED SPECIFIC BEHAVIORS BY AGE**

EXHIBIT	<i>n</i>	AGE		TOTAL
		CHILDREN (9-17)	ADULTS (18 +)	
		%	%	
Coach/be coached ¹	114	13.5	41.9	28.9
Watch ²	114	50.0	77.4	64.9

¹ $\chi^2 = 11.148$; $df = 1$; $p = .001$ (Cross-tabulation)

² $\chi^2 = 9.335$; $df = 1$; $p = .002$ (Cross-tabulation)

PRINCIPAL FINDINGS: INTERVIEWS

INTRODUCTION

RK&A conducted 50 interviews with visitors to *Science & Art*. More than one-half of interviewees are female, and interviewees' median age is 39. The refusal rate was 5 percent.

GENERAL EXHIBITION EXPERIENCES

This section describes how visitors responded to open-ended questions about the exhibition, including their thoughts about the exhibition, favorite aspects, and least favorite aspects.

IMPRESSION OF THE EXHIBITION

When asked to discuss their overall opinion about the exhibition, all but one interviewee responded positively about it. Most said it was enjoyable for their children, with a couple noting that it is enjoyable for children of all ages (see the first quotation below). Some praised the exhibition for being educational and interactive (see the second quotation). Some others made general, positive comments, such as describing the exhibition as “neat” or “fun.” A few appreciated the exhibition's spaciousness.

Actually, I thought it was really creative, particularly the water exhibit; it was very cause and effect for even a young child. And as far as the other stuff that was a little bit more electronically-oriented, it was well suited to my older child, so I think it hit a wide range of ages—appealing to my three-year-old and my nine-year-old. [female, 28]

I enjoyed it. I really liked the hands-on—pretty much entirely about it. It teaches the kids the different sound effects as far as the bits of music that it takes in order to hear that sound. [female, 39]

The one interviewee who expressed a negative opinion said that the exhibition is not appropriate for anyone younger than high school age (see the quotation below).

For a child [in] first grade, [the exhibition] is too complicated—it may not be for a 10th [grader] or [other] high school kid, but most of the kids that come here are what age? It's probably a little too complicated for the average kid. [male, 60]

FAVORITE ASPECTS OF THE EXHIBITION

When asked what they liked most about the exhibition, nearly all interviewees discussed specific exhibits or exhibit sections. Almost one-half talked about the Zoom Into Water (Three Drops) exhibit, referring to it by various names, including the “water,” “bubbles,” “shower,” or “molecules” exhibit. Many of these interviewees appreciated the exhibit's interactive nature (see the first quotation below and second quotation, next page), while a few were intrigued by how the exhibit works (see the third quotation).

(So what did you like most in this exhibit?) I think this new water exhibition with the computer. (Okay. And what was appealing about it to you or to your child?) Well, [for us] both—that you could manipulate it, and then you're not touching anything; it's using light, the reflection, and everything, and it's simulating. I think it's really neat; you're getting wet, but you're not getting wet. [male, 39]

I really noticed all of the kids, my son included, really liked the water exhibit, the interactive where they can make the shapes on the wall change just by touching it. They just think it's magical, so that's really awesome. [female, 46]

I think it's cool, especially this thing here. . . the digital canvas, yeah. (So what did you like most about it?) Just how it makes you think, 'How in the world did they do that? How does it work?'" [male, 36]

About one-third of interviewees talked about exhibits in the Origami Laboratory section. A few enjoyed making origami at the Origami Table because it was "hands-on," while a few others liked seeing how origami is made in the exhibits Fold It Fast, Fold It Slow and Getting Technical (see the first quotation below). A couple enjoyed Symmetry and Origami, which one visitor called the "little puzzles," and one interviewee said he liked the artworks (i.e., origami examples) (see the second quotation).

(What did you like most?) . . . The origami, yeah. (Origami, okay. And what was appealing? Why did you like that one?) Well, [in] that one you can fast-forward and rewind it. You can see how long it takes, how he starts it out with the whole sheet of paper, and then it ends up being a little turtle about this big. [male, 26]

(Anything in particular that appealed to you?) . . . The origami, I found very interesting. (What did you like most about this exhibition?) The artwork that he [Robert Lang] had already completed. [male, 27]

A few interviewees named the Music in the Machine section as their favorite because of the sound of the "one-bit" music compositions. A couple liked the Five Cool Facts About *C. Elegans* exhibit in The Elegant Worm section because they could look at a real worm under the microscope. A couple interviewees talked about the Electric Threads section, although they did not specify what they liked about it.

In contrast, a few did not mention a specific part of the exhibition as their favorite. Rather, these interviewees said they enjoyed that it was a hands-on exhibit, while one liked the unique objects, and one liked everything (see the quotations below).

(What did you like most about the exhibition?) I would say just being hands-on; the kids being able to push the buttons and that sort of thing. [male, 27]

(What did you like most about it?) The uniqueness of it. It's just odd stuff you don't see every day. [female, 66]

LEAST FAVORITE ASPECTS OF THE EXHIBITION

More than one-half of interviewees did not identify any negative aspects of the exhibition. The majority said that they found everything interesting (see the quotation below).

(What was the low point for you? Or what did you like least about it?) . . . Nothing really, I don't think. I think it was pretty much all very interesting. [female, 36]

The other one-half offered critiques of the exhibition. Some identified parts of the Music in the Machine section as their least favorite aspect for various reasons. A few said the exhibition was uninteresting in general, either because of the content or because it was not particularly interactive (see

the first and second quotations below). Other negative responses included visitors who said they could not hear the music, those who said the one-bit noises were shrill, or those who said that the More Bits = Better Sound exhibit was too complicated.

(What did you like least in this area?) The little radio thing over there. I'm just not into that.
[male, 37]

(What did you like least about the exhibition?) Probably the ones that you have to sit still and listen to. It's not as hands-on interactive for the smaller kids. If they get to physically move and do it, it seems to engage their attention much more. [female, 46]

The remaining negative comments were somewhat idiosyncratic. A few interviewees said they did not like parts of the Origami Laboratory section either because they simply did not like folding paper or they were disappointed that the materials were not available, including paper at the Origami Table and wood shapes at Symmetry and Origami. A couple interviewees said they did not like the Electric Threads section, including one who said she did not understand how the shirt at the Wired + Fashion exhibit was made. One interviewee said he did not like Zoom Into Water (Three Drops) because the media changed before he was finished with the bubbles. Another said he did not like the microscope in The Elegant Worm because he thought the worm looked “a little disgusting.”

SPECIFIC EXHIBIT EXPERIENCES

This section describes the specific exhibit experiences that ADN was interested in learning about, including experiences with Zoom Into Water (Three Drops), Origami Laboratory, and the scientist/artist biographies.

EXPERIENCES WITH ZOOM INTO WATER (THREE DROPS)

OVERALL USE

Most interviewees said they stopped at Zoom Into Water (Three Drops), although more than one-half of these interviewees described what their *children* (grandchildren or young relative) did at the exhibit rather than what *they* did (see the quotations below). The few interviewees who did not stop at Zoom Into Water (Three Drops) said that it was too crowded, they did not see it, or were not interested in it.

(Did you happen to use the interactive exhibit with the large projection screen?) No, I didn't. (Okay. Did you take a look at it?) Oh yeah. I watched the kids go in there and chase stuff around. [male, 66]

(Did you happen to use or watch him use the interactive exhibit on the large screen?) He didn't [use it] but my granddaughter did. (Okay, and can you talk a little bit about what she did or how that appealed [to her]?) She just thought it was neat to touch it and see how it would kind of flow around her, and they did the one with the waterfall that looked like you step into it and water goes around. She liked that a lot. [female, 48]

INTERACTION

Visitors often experienced more than one of the three projections at Zoom Into Water (Three Drops)—the macro, micro, and nano projections—although none of the interviewees used the words “macro,” “micro,” or “nano.” More than one-half of interviewees said they experienced the “bubble,” “ball,” “ball of water,” or “water droplet” projection (micro projection); these interviewees described catching, holding, bouncing, controlling, playing with, and throwing the droplet (see the first quotation below).

Almost one-half said they experienced the “shower,” “waterfall,” or “spout” projection (macro projection); these interviewees described taking a shower, letting the water fall on them, changing the flow of water, and catching the water (see the second quotation). A few talked about the “molecules” and “atom” projection (nano projection); these interviewees said they allowed the molecules to move toward them or played with the molecules (see the third quotation).

(Can you tell me exactly what the kids did [at Zoom Into Water]?) They played with the ball of water, the giant ball, and tried to throw it up. [female, 38]

(Can you describe exactly what she was doing in there [Zoom Into Water exhibit]?) From what I’ve seen, it looked like it possibly could be maybe water, like a waterfall, and some of the waterfall drops you could actually position it where you’re able to not let any drop [by putting] your arm on the screen [to] keep it from falling. So that’s what I got out of it. [female, 37]

(Did you happen to use the interactive exhibit with the large projection screen?) Yes. (Okay. And can you talk a little bit about what you actually did there or what your kids did?) Well, we were able to hold the bubble in our hands and then I watched how the little molecules would come to you. More so playing with it [the bubble] and bouncing the bubble in your hand and one even bounced off my hand. [female, 41]

UNDERSTANDING OF CONTENT

When asked what the Zoom Into Water exhibit is trying to show visitors, many interviewees said they did not know (see the first quotation below). A few visitors said the exhibit showed how water molecules are formed (see the second quotation), and a few others said it was about what you can do with a projector. A few responses were idiosyncratic but related to water (see the third quotation).

(What do you think that one might be trying to show visitors?) Wow, I don’t have a clue. I’m probably not the right one you wanted to talk to. [female, 48]

(Can you tell me a little bit about what you all did over there?) Basically, they caught the molecules and moved them together so you can show them . . . what they do when they gather together—they form the raindrops. So, it’s more a physical demonstration to handle the things he’s learning in science, and the fact that when you interfere with the path of water it creates a different flow for things. (Okay, well you may have answered this question, but what do you think that exhibit is trying to show visitors?) Just basically how water molecules are formed and the flows and patterns of water. [female, 46]

(What do you think this exhibit is trying to show visitors?) Probably just the effects water has as it bounces off your body. [male, 33]

EXPERIENCES WITH ORIGAMI LABORATORY

OVERALL USE

About two-thirds of interviewees said they stopped at Origami Laboratory, although more than one-third of these interviewees described what their *children* (grandchildren or young relative) did at the exhibit rather than what *they* did. The interviewees who did not stop at Origami Laboratory said that it was too crowded or that they were not interested in it.

INTERACTION

When asked about their experiences in Origami Laboratory, some interviewees said they used or tried to use the Origami Table exhibit; the majority described making origami, while a few others said there was no paper at the exhibit or the paper there was already folded or not fresh (see the quotations below). A

few said they used Symmetry and Origami, either making the tree, turtle, or clown, while one complained that some pieces were missing. A few interviewees said they watched the video of making origami at Fold It Fast, Fold It Slow and Getting Technical but did not make any origami themselves. One interviewee talked about Robert Lang's origami. Several did not specify the exhibits that they used but spoke generally about origami.

(And did you happen to use the origami section?) We did. (Can you tell me a little bit about what you did in that section?) We did the water bomb, the bird, and the cootie catcher; we did all three of them. [female, 42]

(And then what about the origami?) I tried it, but it was really hard, and all the papers were already folded. Somebody had already done that, so there wasn't any plain paper to start from scratch. [female, 41]

UNDERSTANDING OF CONTENT

When asked what the Origami Laboratory is trying to show visitors, many interviewees did not respond to the question or said they did not know. A few talked only about science outcomes, such as showing geometry, math, and angles (see the first and second quotations below). A few others talked only about the art outcomes, such as design and origami as art (see the third quotation). A few others explicitly stated that science and art go together (see the fourth quotation). A couple interviewees said the exhibit was about developing coordination and other developmental skills. Visitors rarely talked in-depth.

(What do you think that exhibit is trying to show?) Different ways it [origami] can be used for math. [female, 47]

(What do you think those exhibits were trying to show visitors?) I don't know. I feel a little bit more intellectual about some things. It taught me some scientific things. [female, 41]

(What do you think those exhibits over there are trying to show visitors?) Well, I think it [origami] is an art form and I think they're trying to teach them how you can take a simple object and how you can make art out of it. [female, 61]

(What do you think that exhibit is trying to show visitors?) . . . Well [for] one, it shows [people] how to work with their hands and teaches them how art and science come together. [female, 34]

EXPERIENCES WITH BIOGRAPHIES

Two-thirds of interviewees said that they did not read the biographies. Several said that they were with children so they could not read them (see the first quotation below). A few each said they were only visiting the hands-on exhibits, provided no explanation for bypassing the biographies, or said that they did not notice, did not have time, or do not like to read exhibit text (see the second quotation).

(There are profiles or stories about the people. Did you happen to read any of them?) No, I did not. (Okay, is there any reason why you didn't?) I guess I was just following my child around as he went from—he was more into doing and not as much reading. [male, 39]

(And the exhibition has profiles about the people. Did you all happen to read any of them?) Not at all. (Okay. Was there any reason why you didn't?) Probably because I didn't have an activity right there at it. We were just doing activities. (Okay. The hands-on stuff?) Yeah. [female, 41]

One-third of interviewees said that they read the biographies in the exhibition. Several made detailed comments about the biographies and some mentioned more than one biography (see the first quotation below). These interviewees most often recalled the Music in the Machine biography and the Electric Threads biography (see the second quotation), while one each recalled the Origami Laboratory biography and the Digital Canvas biography. A few interviewees talked about the text in general and did not provide evidence that they had read any biographies, and a few others could not remember which one they had read.

(And the exhibition features some profiles about people; did you read any of them?) . . . I read the ones with the ladies who made the electronic clothing and the one for the one-bit musician and also the one for the man who makes the origami. (Did you find out anything specific that stands out to you about any of those?) It sounded like all three of those people started out in one field and used the one field they had a background in to branch off into all different areas. Like he said with the origami, that man started out with a doctorate in physics, but then ended up doing all these things with computers and applying it to artwork through paper like the origami. And, these ladies were both interested in fashion and design and then coupled technology with fashion to make something new and different that other people hadn't thought of. Same thing with that guy; the musician was into math and into science and then he applied that knowledge to make another newer form of music. [female, 24]

(Did you happen to read any of those?) I did. The musician with the bit music, I thought that was fascinating. (Do you remember anything that you read in particular?) I read that he grew up in Romania, and he said something like, 'We never realized how many shades of black there are until you're in an area where there aren't so many city lights.' [female, 46]

EXHIBITION MESSAGES

This section describes the messages that visitors took away from the exhibition. The section is organized by the layers of questioning used to tease out visitors' understanding of the exhibition's thesis: the connections between science and art.

OVERALL TAKE-AWAY

To begin to uncover the meaning that visitors constructed, interviewees were first asked about the ideas or messages they took away from the exhibition. About two-thirds of interviewees did not glean anything specific from the exhibition. Some said that they or their children learned something in the exhibit but did not specify what they learned; rather, they spoke generally about the exhibition being educational and a learning opportunity (see the first quotation below). Some others did not answer the question; instead, they talked about their satisfaction with the exhibits, saying they were "interesting" or "fun" (see the second quotation). Several interviewees said they were not sure what ideas or messages they took away or could not think of anything in particular.

(Based on your experience in this exhibition as a whole, what are your ideas or messages that you can take away from this?) Oh, it's great learning for the kids. They love it. [male, 40]

(Based on your experience in the exhibition as a whole, what are some ideas or messages that you take away from this exhibition? No wrong or right answer.) I don't know. It was just a lot of fun; we had a lot of fun. [female, 42]

In contrast, one-third discussed specific content they learned. Some talked about ideas and messages related to science and art, but their associations were mostly implicit. For instance, a few talked about creativity, experimentation, and “thinking outside the box” (see the first quotation below). Additionally, a couple talked about the connections between math and origami (see the second quotation), while a couple others contemplated how things in the exhibition were made, such as the origami or the shirt. Several interviewees talked about the specific topics that they had learned about in the exhibition, but did not make any connections between science and art. For example, a couple mentioned seeing new technology, learning to make origami, or learning about bits, but did not talk in more depth about the connections they made (see the third and fourth quotations).

(Based on your experience, what are some ideas or messages that you took away? Like what do you think it means?) I thought that this—I don’t know what this section’s called—but this section over here with, like, the tones and the young man creating the music from the tones and stuff, I thought that was so creative and original. And we’ve been all over the country to large museums in and out of Chicago and it was just a very creative and interesting idea that I hadn’t seen before. I saw that and the lady that’s doing electronics with the fabrics and stuff, and I thought ‘how cool.’ [female, 32]

(Based on your experiences in this exhibit area as a whole, what are some of the ideas or messages you took away from it?) I think one of the messages was the math piece of it; there’s a lot of math involved in this area. In origami—I didn’t realize how much math was involved in it and I thought that was kind of neat. [male, 36]

(Based on your experience in this exhibition, what ideas or messages did you take away from this?) Oh, just the new technology of it all is really amazing to me—how technology has changed. [female, 56]

(Based on your experiences as a whole, what ideas or messages did you take away from this exhibition?) . . . I never understood computer bits, and I work with computers every day. I never understood computer bits until I sat down at the display here and listened to the sounds made with the one-bit music. [male, 26]

MESSAGES ABOUT SCIENCE AND ART

Interviewees were next asked what they found out about science and art specifically. More than one-half of interviewees articulated connections between science and art. While several did not talk in-depth about the connections but simply stated it or struggled to articulate the connections, several others went into detail, with some describing how science is used to make art and commonalities in the scientific and artist processes (see the quotations below and on the next page). A few said they already had made connections between science and art, although a few said it broadened their realization of the connections.

(What, if anything, did you find out about science or art, how those two go together?) Oh, I believe it does go together. I think both compliment the other. I don’t know how to explain it. I’m not good at talking about [this kind of thing]. (That’s okay. Take your time.) Well, I think it’s good for kids to see how it reflects as far as how the science aspect of it, it’s not—it can be fun and learning new things and how to apply it to everyday life and the art of it. I like being able to see different objects and how people can put things together and see. So it gives kids ideas that they can also try to accomplish such things as far as the learning the aspect of it. [female, 39]

(What, if anything, did you find out about science and art?) Science and art—it [the exhibit] made me see that the art of origami is very mathematical and very, very precise. It [the exhibit] made me think about with art sometimes you—well, I mean I know better than to think this—but sometimes we think sometimes you look at a painting and think, ‘Oh, someone just put that together,’ and you don’t think about the process they went through to get to the finished product. But in science, we sort of assume there’s lots of trial and error. It [the exhibit] made me think that origami scorpion must’ve taken how many—I don’t know. The text said it was like the person had done four versions before. So it [the exhibit] just definitely made me think there’s a lot more to that folded little piece of paper than you would imagine. [male, 33]

(What, if anything, did you find out about science and art?) Well, that they’re interrelated; I think the shapes and designs are all interrelated and work together. [female, 61]

Less than one-half of interviewees did not explain any connections they had made between science and art in the exhibition. Some of these simply responded to the question with a comment on an exhibit or made a vague comment about the exhibition (see the quotation below). A few said they were not sure of the relationship between the two disciplines.

(What, if anything, did you find out about science and art?) I found out—I always thought origami was pretty cool and had a lot of fun with that. [male, 33]

EXHIBITS THAT SHOWED VISITORS CONNECTIONS BETWEEN SCIENCE AND ART

Interviewees were then explicitly asked which exhibits showed them a strong connection between science and art. Most named at least one exhibit area. About one-third talked about the Origami Laboratory section, although interviewees’ lack of explanation and responses suggest that this was a natural association for them (see the first and second quotations below). About one-fifth talked about the Zoom Into Water (Three Drops) exhibit in the Digital Canvas section (see the third and fourth quotations, next page). Approximately another one-fifth talked about the Music in the Machine section. A few interviewees mentioned the Electric Threads section.

(Which ones do you think show the strongest connection between science and art? Do you think there’s any particular ones that show that strongest?) . . . For me, I would probably have to say that stands out at the dimensional [exhibit], as far as with the paper. How they can fold—that’s art and also the concept of the different shapes and everything. So, I would have to say that stands out the most for me. [female, 39]

(In thinking about the exhibits he used, which ones do you think show a strong connection between science and art?) That I’ve used? Well, I know I didn’t use it, but I know the origami was one of them that would do. . . . There’s probably more but I can’t think of them off the top of my head. [female, 42]

(In thinking about the exhibits you used, which ones do you think show a strong connection between science and art?) I would have to say it’s the water thing because the visual art of it on a projection screen and the interaction between that and the molecules just making the water form—it would have to be that more than anything else to be science and art together. [female, 46]

(In thinking about the exhibits you used, which ones do you think show the strongest connection between science and art?) I would say the music one. I did do the one about the bits and how that makes a difference on what we hear when we listen to music. [male, 39]

The few interviewees who did not name a specific exhibit section either said they were not sure, talked about the exhibition generally, or provided an idiosyncratic response.

THOUGHTS AND FEELINGS ABOUT SCIENCE AND ART

Finally, interviewees were asked to identify thoughts or feelings about science and art that they left the exhibition with; about two-thirds did not answer the question, but rather, spoke generally about their enjoyment of the exhibition. Others simply did not respond, made miscellaneous comments, or spoke about the importance of science and science education.

Conversely, more than one-third of interviewees talked in-depth about the connections between science and art. These interviewees responded to the question thoughtfully and in detail, although their responses varied greatly. A few interviewees each talked about creativity and the ability to make art from anything, about science as part of our everyday life, and about science as inspiring (see the quotations below).

(What thoughts or feelings about science and art did the whole exhibition leave you with?) That it can be fun; that you can enjoy what you're doing. Science doesn't have to be drudgery, and to inspire her [my daughter]; I would want her to have ideas and [a sense] that no idea is too small. . . . A shirt that you could sell or just inspire other people to have fun in science. I think that's important to me. [female, 40]

(What thoughts or feelings about science and art did the exhibit leave you with?) You mean about being more creative myself? Something like that. . . . [male, 66]

(What thoughts or feelings about science did all of it overall leave you with? When you walk away, what do you think?) That they have started doing some very interesting things. . . . I think it's trying to get across that, with all the things around you, that science is somewhere behind everything in daily life. [female, 24]

APPENDICES

APPENDIX A: TIMING AND TRACKING OBSERVATION FORM

Removed for proprietary purposes

APPENDIX B: TIMING AND TRACKING STATISTICS

DESCRIPTIVE STATISTICS

FREQUENCY DISTRIBUTION

Day of the week (weekday, Saturday, Sunday)
Time of day (morning, afternoon)
Level of crowding (low, moderate, high)
Staff present in the exhibition (yes/no)
Gender (male, female)
Age group: 9-11, 12-14, 15-17, 18-24, 25-34, 35-44, 45-54, 55-64, 65+
Group composition (adults and children, adults only, children only, alone)
Group size (Alone, 2, 3, 4, 5, 6, 7 or more)
Number of exhibit stops in the exhibition
Time spent in the exhibition
Stop at exhibition sections
Stop at individual exhibits
Behaviors (e.g., read aloud/talk about)

SUMMARY STATISTICS

RANGE, MEDIAN, MEAN, AND STANDARD DEVIATION

Time spent in the exhibition
Number of exhibits stops in the exhibition
Time spent exhibition sections
Time spent at individual exhibits

INFERENCEAL STATISTICS

CROSSTABS

Stop (yes/no) at exhibition sections (at least one exhibit per section)		
Stop (yes/no) at individual exhibits visited by 20 or more visitors	by	Gender (male/female) Age (children/adults)
Behaviors (e.g., read aloud/talk about)		

INFERENCEAL STATISTICS

ANOVAS AND KRUSKAL-WALLIS TEST

Number of exhibit stops		
Time spent in the exhibition		
Time spent at exhibition sections	by	Gender (male, female) Age (children/adults)
Time spent at individual exhibits visited by 20 or more observed visitors		

APPENDIX C: INTERVIEW GUIDE

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APPENDIX D: VISITOR BEHAVIORS FOR EACH EXHIBIT (BY SECTION)

Introduction/The Digital Canvas

	Exhibit Name	Number of Visitors Who Stopped	Number of Visitors Who Displayed Behavior
1	Introduction	1	read aloud/talk about content = 1
2	Zoom Into Water (Three Drops and text panel)	80	use (interact with screen) = 52 misuse = 0 broken = 5 watch = 48 read aloud/talk about = 16 coach/be coached = 11
3	The Digital Canvas – Scott Snibbe Bio	4	read aloud/talk about content = 3
4	How Many Nanometers Tall Are You?	43	use (measure oneself) = 34 misuse = 0 broken = 0 watch = 14 read aloud/talk about = 13 coach/be coached = 4
5	Artists Can Help Us Understand Science	7	use (look at picture books) = 2 misuse = 0 broken = 0 watch = 0 read aloud/talk about = 0 coach/be coached = 0

Origami Laboratory

6	Symmetry and Origami	63	use (move pieces) = 54 misuse = 0 broken = 0 watch = 11 read aloud/talk about = 6 coach/be coached = 7
7	Robert J. Lang's Origami	45	look at display case = 41 read aloud/talk about = 9
8	Origami: Part Art, Part Math	9	read aloud/talk about = 3
9	Origami Laboratory: Robert J. Lang Bio	4	read aloud/talk about = 0
10	Origami – Not Just for Fun Anymore!	4	read aloud/talk about = 0
11	Five Special Shapes	28	look at display case = 25 use (flipbook) = 15 misuse = 0 broken = 0 watch = 0 read aloud/talk about = 2 coach/be coached = 0
12	Fold It Fast, Fold It Slow	40	look at display case = 25 use (knobs/watch video) = 25 misuse = 0 broken = 0 watch = 0 read aloud/talk about = 5 coach/be coached = 1

Origami Laboratory continued

	Exhibit Name	Number of Visitors Who Stopped	Number of Visitors Who Displayed Behavior
13	Getting Technical	38	look at display case = 30 use (push button/watch video) = 22 misuse = 0 broken = 0 watch = 0 read aloud/talk about = 7 coach/be coached = 0
14	Origami Table	56	look at cards = 43 use (make origami) = 26 misuse = 0 broken = 0 watch = 10 read aloud/talk about = 12 coach/be coached = 9

The Elegant Worm

15	Scientists Know This Worm Inside & Out	10	read aloud/talk about = 1
16	Skop's Photographs and Video with Labels	29	look at photos/video = 27 read aloud/talk about = 2
17	Five Cool Facts About C. Elegans	45	use (microscope) = 36 misuse = 0 broken = 0 watch = 10 read aloud/talk about = 19 coach/be coached = 4
18	The Elegant Worm: Ahna Skop Bio	2	read aloud/talk about = 0

Music in the Machine

19	Listen to Some of Tristan's 1-Bit Compositions	52	use (listen to music) = 43 misuse = 1 broken = 0 watch = 10 read aloud/talk about = 19 coach/be coached = 4
20	More Bits = Better Sound	59	use (changes bits or sound/freeze wave) = 48 misuse = 0 broken = 0 watch = 10 read aloud/talk about = 17 coach/be coached = 4
21	Tristan Composes All Kinds of Music	55	use (listen to music) = 43 misuse = 0 broken = 0 watch = 8 read aloud/talk about = 5 coach/be coached = 1
22	Musical Score and Text Panel	3	read aloud/talk about = 0
23	Music in the Machine: Tristan Perich Bio	6	read aloud/talk about = 0

Electric Threads (Electronics and textiles)

	Exhibit Name	Number of Visitors Who Stopped	Number of Visitors Who Displayed Behavior
24	Electric Threads: Leah Buechley Bio	1	read aloud/talk about = 0
25	Janet Makes a Shirt	4	read aloud/talk about = 0
26	Wired + Fashion	28	look at display case = 27 use (push buttons) = 18 misuse = 0 broken = 0 watch = 1 read aloud/talk about = 5 coach/be coached = 0
27	Do-it Yourself!	3	read aloud/talk about = 0
28	Electricity Workbench	25	look at cards = 12 use (test materials w/ probe) = 17 misuse = 0 broken = 0 watch = 9 read aloud/talk about = 9 coach/be coached = 4

Resources

29	Resource area	6	look at books = 3 read aloud/talk about = 0
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