



Summative Evaluation of

Robots & Us

at the
**Science Museum of
Minnesota**

research report prepared by:
People, Places & Design Research

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Executive Summary

This summative evaluation of the temporary exhibition *Robots & Us* was designed to investigate how visitor audiences used and experienced this exhibition in relation to the project's objectives and challenges. Two phases of qualitative 'front end' research as well as some formative evaluation set the stage for this analysis, as summarized under the heading 'Background and Challenges' below. The 'Highlights of Results' section presents some of the direct findings about visitors' perceptions as well as interpretations about what those findings suggest about the kind of experience that this exhibition provided. In general, the results of this evaluation should be useful in offering the planning team an opportunity to reflect on the project's strengths and weaknesses, while also contributing to knowledge about the effectiveness of informal science exhibitions that can be applied to future projects.

Research Method

The main method used in this study consisted of interviews with samples of randomly selected adults and children as they exited from the exhibition. A sample of 330 visitor groups was interviewed, including 169 children in the target age group for this project (age 7 to 10), including some data from 169 parents who accompanied those children; plus an additional 161 adults (some in adult groups without children, some in families with children who were not in the target age group). The cooperation rate for these exit interviews was 74%. In addition, a supplemental method (brief interviews with 142 adults entering the Museum) was used to create some context for visitors' perceptions of broad themes. The exit interviews with adults were primarily verbal, with a few photos to investigate which exhibits were used; the exit interviews with children focused on their reactions to 26 photos, investigating exhibits used and their ratings of those exhibits, as well as follow-up questions for more detail on a few exhibits, supplemented by some verbal questions that did not rely on the photos. Interviews were conducted between May and August, 2004.

Background and Challenges

The planning process for this exhibition began under a different title: "Cyborgs: A Natural History of Machines and Humans." It evolved to "Robots and Us" (although graphically represented as 'Robots + Us') for a variety of reasons including mixed reactions to the term 'cyborgs' among those who even understood it, plus a much less compelling interest in the history (or 'natural history') of this topic than in the prospects for the future or at least novel and

fascinating developments that are ‘cutting edge’ today, and a need to create a more robust and appealing image than ‘machine’, which evolved to be the framework of robots. However, there was no doubt that the audiences were likely to be receptive to the main overall theme of the interrelationship of ‘machines and humans.’ In all the ‘front end’ and formative studies (preliminary discussion groups, two rounds of formal focus groups, title testing at the state fair, group reactions to a model, and a major mock-up of an array of several full-size prototypes), it was clear that the human connection and relationship to technology (machine, robot, etc.) prompted more interest than the technology alone. For example, in a typical reaction to some early phrases-topics-titles some people picked out the phrase ‘Technology affects People / People affect Technology’ and said “*That’s the idea, but it’s not the title that’s going to get me to come to this.*”

Summarizing the perceptions of potential visitors, the concept for this exhibition began with some advantages and disadvantages. The positives of people’s perceptions were: seeing new ‘cutting edge’ advances in technology, seeing how robots could help people (to lead better quality lives such as with bionics, or to have robots do the grunt work on household chores), and a strong expectation for hands-on experiences. The negatives were: it’s techno-toys for boys, battle bots are too violent, worries that robots are smarter than us and are taking our jobs, and that people will expect humanoid/android robots (the Honda robot, Terminator, Rosie from the Jetson’s, R2D2) and will be disappointed when those types of robots are not present in three dimensional form.

Concerns about visitors’ expectations are important because such expectations are likely to affect their ability to perceive the principal interpretive messages. The messages in this project revolved around several main ideas:

- machines (and robots) have for centuries imitated humans and other life forms;
- the boundaries between mechanics and human bodies-and-capabilities have become less distinct (with our use of technology to accomplish tasks that were previously done by hand, or with bionic replacement parts in human bodies, etc.); and
- the human-machine relationships and imitations have advanced beyond just movement and physical tasks to the point where sensory perceptions, rudimentary ‘thinking’ and group interactions are now being explored.

This background of visitors’ expectations and perceptions in relationship to the project’s content goals prompted the summative evaluation to focus on these

challenges:

- ♦ ***attitudes and perceptions about technology:*** do visitors still tend toward the modern and futuristic examples as being the most interesting? does this exhibition prompt the fear of technology that was expressed in the ‘front end’ studies (i.e., that robots are smarter and faster than people, that people are being replaced in their jobs by robots)? do visitors come away with a broader sense of what a robot is or can be (not just a butler in the Jetson’s) or is the ‘robot’ in the title interfering with people’s perceptions of the varied technology?
- ♦ ***connections between robots and people:*** what types of connections do visitors perceive or discover between robots and people? – e.g., similarities in how we function, sense the world around us, and make decisions based on logic and generalizations of rules?
- ♦ ***appeal to a broad audience:*** considering the repeated indications during the ‘front end’ studies of gender differences in interest on this topic, it was important to investigate the perceptions of women and men, and of girls and boys
- ♦ ***reactions to specific exhibits:*** it was generally expected that the hands-on exhibit activities would be the most ‘popular’ but aside from Jitterbugs (making primitive contraptions that move, using a battery, Styrofoam block, paper clips, feathers, wires, and other materials) which exhibits would be most appealing or least appealing, and why?

Highlights of Results

A variety of quantitative and qualitative findings are presented here, representing issues that are grounded in the project’s interpretive objectives and challenges.

Expectations about robots

- ❖ finding: Only 8% of the visitors interviewed said they expected to see more high-tech, life-sized androids (a concern of the exhibit team due to visitors’ comments during ‘front end’ studies), but they weren’t necessarily disappointed by the variety of different kinds of robots.
- ❖ finding: On the ‘flip side’ of that concern, 10% said they were pleasantly surprised by the interactive opportunities, as they had thought the experience would just involve looking at non-working robots (this was unexpected by the exhibit team including the evaluators).
- ❖ finding: Most adults (60% and 71% on two differently worded items) left the exhibit thinking that machines are becoming more capable and helpful. This is probably lower than we expected, considering the strength of comments

in the ‘front end’ studies about robots/machines being more efficient, smarter, and taking away people’s jobs. However, some people may have been reacting to how simple the robots/robotics were (e.g., the Jitterbugs or Leg Lab) and seeing robotic designs fail (e.g., the Flamingo, or Screen Life creations), perhaps limiting the idea that robots are increasingly helpful and realizing that many efforts are experimental.

- ❖ interpretation: Visitors’ expectations varied somewhat more and in slightly different ways than had been anticipated. However, the worry about people expecting humanoid/android robots was probably somewhat justified; interviewed as they left the exhibition, visitors’ expectations and perceptions had already been offset by seeing a wide variety of interesting robotics/mechanics, ranging from the industrial robot arm competing with people to assemble a puzzle, to the surprising and delightful activity of making a Jitterbug as one’s own “robot.” Visitors’ expectations were probably also satisfied by having a copy of David, the imitation boy from the movie *AI*, and other media examples of robots from movies and TV, as well as the human-size robot in the café.

Attitudes and perceptions about technology

- ❖ finding: Almost all adults (94%) had a positive comment about robots being able to perform tasks that had once required a person. However, half of those were unqualified positive reactions and half expressed ambivalence by also offering a negative comment, primarily about the loss of jobs. Younger adults were significantly more likely to be ambivalent.
- ❖ finding: The principal ideas or themes that people expressed when leaving the exhibition were about how robots work, the amazing things they can do, and how much they are becoming or will become a part of our lives.
- ❖ finding: Most adult visitors (74%) noticed and appreciated the humorous elements in this exhibition, especially Android Café, Jeremiah, and competition with the Robot Arm.
- ❖ finding: Most visitors did not pay much attention to the historical exhibits (collage panels, the puppets display) which set a context about early developments in technology and precursors of robots. Exiting adults had no better sense that robots have been around for a long time compared with adults who had not seen the exhibition.
- ❖ interpretation: This exhibition engaged visitors with technology, at various levels. It did not come across as mechanistic or hard-to-understand, even though engineering was the dominant discipline and

even though some of the exhibits required complex thinking and big leaps from first impressions to understanding abstract messages (e.g., group ‘intelligence’ in ants as they followed simple rules that could be programmed into bots, or considering the relevance to robotics of the various parts of Sensor Garden). It’s very likely that part of the reason for this broadly engaging experience was due to at least two factors: first, that there were so many variations of exhibits, from tangible to abstract, illustrating sensing and interacting with machines as well as mechanical movement; and secondly, the fact that this exhibition did not use a “look-and-feel” design context from engineering – it used a much more playful and colorful style which made an important contribution to the sense of fun and novelty for visitors at a variety of skill levels. For example, Low-Life Labs set a tone for visitors’ perceptions, a play-like experience that doesn’t seem to be too complicated, with a background of distorted walls and surrounded by exhibits with colorful banners or playful spaces (e.g. the ‘arena’ feel of Robot Arena).

Imitating life forms

❖ finding: Most adults (79%) and children (70%) in the target age group of age 7 to 10 said they saw in this exhibition the idea that robots can be designed to imitate living creatures or have body parts like people do. About half (54% adults, 50% children) say they got the idea that robots and people are becoming more like each other.

❖ finding: Visitors’ examples of similarities and connections between life forms and robots tended to focus on physical movement – the most common examples were the walking mechanical flamingo, Leg Lab, the Robot Arm, the mechanical fish, and bugs.

❖ interpretation: Visitors’ fascination with physical movement seems to have overshadowed the other levels of relationships, such as how robots or creatures use sensors (light, temperature, air pressure) in ways that imitate how live animals sense the world around them, or experimental ways in which robots are being programmed to interact and ‘think’ (e.g., the implications of mimicking facial expressions with tone of voice, or the Common Sense project). While people accepted the wide variety of examples under the general rubric of ‘robots’ they seemed to be not as reflective about the evolving layers of relationships between people and technology, at least not by the time that they were exiting from the exhibition.

Appeal to a broad audience, and to different genders

❖ finding: The target age group of 7 to 10 year olds found this exhibition to be very engaging and enjoyable: two-thirds of them spent at least 25 minutes in the exhibition and 57% gave ratings of 9 or 10 on a 10-point scale, indicating very high satisfaction.

❖ finding: Girls and women enjoyed this exhibition as much as men and boys, according to further analysis of those ratings.

❖ finding: There were very few gender differences in the use of the exhibition or in reactions to specific elements. The one pattern of differences that did emerge was that women and girls were more likely to notice and respond positively to the elements dealing with language and communications (e.g., Vocalization, Voice Recognition, and “talking” with Lena in the café).

❖ finding: This exhibition had broad appeal among a diversity of audience segments, e.g., less educated visitors enjoyed it as much as highly educated visitors, and people with no science training enjoyed it as much as those with technology-related careers.

❖ interpretation: The initial gender differences (noted in ‘front end’ research: women indicated less interest than men did in this exhibition topic) presented a challenge that was embraced and resolved. Perhaps due to the variety of elements, the fact that the ‘mechanical’ things were intuitively easy to understand, and that the exhibition space didn’t feel like a technology lab, but whatever the reasons the appeal and experience of the exhibition was not gender-biased.

Reactions to specific exhibits

❖ finding: There was widespread use of multiple exhibits – not just a handful of “popular” or “successful” elements – indicating that the exhibition provided a multi-faceted landscape of opportunities for children and adults. The data show that of the 26 exhibit photos that children were asked about, more than 70% of the children (age 7 to 10) used 8 of the exhibits, at least 50% of the children used 17 of the exhibits, and only one exhibit was used by less than 40% of the children (37% was the lowest recognition of all exhibits, a very high threshold).

❖ finding: Among children in the target age range the most highly rated exhibits were Jitterbugs, Robot Arena, Sensor Garden, Robot Arm, Screen Life, and Toy Robots (47-68% said these were ‘great’). Children were less impressed with the static, non-interactive exhibits (AI-boy, Puppets, Historic Collages).

❖ finding: The Ant Colony was the most unexpected piece of this exhibition – something that had both intrigued and perplexed people throughout the ‘front end’ and formative studies. Some people made the connection to the idea of a colony’s rules being the structure of behavior, but few understood this as an example of ‘group intelligence’ among beings who themselves had only limited information (as a robot might).

❖ interpretation: These exhibits work well as hands-on interactives, and people enjoyed playing with the action they could control (e.g., using a flashlight to move bots in Robot Arena, or moving around in front of the Jeremiah avatar to try to change the expression on its face). Children also enjoyed some of the more visual, non-interactive elements (e.g., Ant Colony, Toy Robots, videos), as long as there was something interesting to watch (usually some movement or video). There were so many different opportunities in this exhibition – lots of features to explore, some that were constantly busy, some that were rarely busy – that this fostered a pattern of browsing. People could explore a highly varied terrain (from the bustling Jitterbug area to the people playing chess on upholstered chairs, from the group activity that tended to occur around Jeremiah to the individual or single-group use of Face Recognition or the Hearing Aid activity, or the multiple stations of Screen Life), without feeling that they were waiting in line or being ‘crowded out’ of a few highly popular activities.

Synthesis of findings and interpretations

The *Robots & Us* exhibition successfully met most of the project goals and overcame some challenges that were identified in front-end research. The exhibition appealed to a broad audience, including some segments that the team worried could be “turned off” by the technology-heavy topic (girls, women, older adults, and in general people who don’t have a specific interest or career in technology). It is likely that visitors came away with an expanded awareness of robots given the varied examples in the exhibition – high-tech as well as low-tech robots (Cog, Jitterbugs), humanoid and talking robots (e.g., at the Android Cafe) as well as simple recognizable “body parts” (Jeremiah, Leg Lab). Visitors appreciated the humorous aspects of the exhibition and expressed mainly positive attitudes toward robots. People were amazed by what robots can do, but even more appreciative of the capabilities and complexities of the human body/brain and how difficult that is to imitate.

A. Use of the Exhibition

The first section of the report summarizes the extent of use (time spent, components viewed), as a context for interpreting the other results. The key points are:

- ◆ Families with 7-10 year old children spent 30 minutes in *Robots & Us*, on average. This finding suggests that it was an engaging experience for this target age group (longer time spent than in previous temporary exhibitions).
- ◆ Boys and girls saw a variety of exhibit components and there were few gender differences in patterns of use (the same applies to men and women). The findings suggest that boys were especially interested in the ants (girls were interested too, but not quite as universally). Girls took more notice of the verbal communication activities (Vocalization, Voice Recognition).

A.1. Time spent viewing the exhibition

PARENTS

OVERVIEW: Families with children in the target age range (7-10) spent an average of 30 minutes in this exhibition.¹ There were no significant differences among various audience segments, e.g., more educated vs. less educated parents, younger vs. older kids. This was an engaging exhibition and it had broad appeal.

20 minutes or less	33%
25-40 minutes	36%
45 minutes or more	31%

Mean = 32.7
Median = 30

Note about conventions for identifying the source of the data presented:

PARENTS – indicates that the question was answered by a parent who was accompanying a child in the target age group (who was also interviewed)

KIDS – indicates that the question was answered by a child aged 7-10

ADULTS – indicates that the question was answered by an adult (representing both adult-only groups and families with children).

** Asterisks indicate statistically significant differences ($p < .05$) between the columns of figures, for example on the next page there are some differences between boys and girls.

++ Plus signs indicate borderline relationships that are not statistically significant ($p < .10$) but that may be intuitively useful in interpreting the pattern of results.

Bold figures indicate the percentages that are significantly *higher*.

¹ For comparison purposes, the average amount of time spent by families with school-age children in two previous temporary exhibitions (Mysteries of Catalhoyuk and When the Dinosaurs Were Gone) was 20 minutes.

A.2. Which parts did people see?

OVERVIEW: Kids in the 7-10 year old age range stopped at a lot of different components, and there really were no ‘missed exhibits’ among the 26 components we asked about (i.e., at least 37% of the children saw each of these parts of the exhibition). The five most viewed elements were Robot Arena, Ant Colony, Jeremiah, Robot Café, and AI-Boy. There were very few significant differences between boys and girls (or men and women) in their patterns of use. The differences indicate that while girls were less likely than boys to stop at the Ant Colony, they were more likely than boys to engage in the voice/communication activities (Vocalization, Voice Recognition). Additional analyses of use by various audience segments are presented on the next page, again showing only a few isolated differences.

*Here are some photos of parts of the exhibit:
Which parts did you see?*

	KIDS			ADULTS		
	Overall (n=169)	Boys (n=96)	Girls (n=73)	Overall (n=161)	Men (n=63)	Women (n=95)
Robot Arena	86%	88%	84%	64%	68%	62%
Ant Colony	86%	91% **	79%	87%	83%	89%
Jeremiah	84%	85%	82%	80%	78%	81%
Robot Café	81%	82%	81%	68%	75%	66%
AI boy	79%	81%	75%			
Leg Lab table	74%	78%	68%			
Flamingo	71%	66%	++ 78%			
Jitterbugs	71%	69%	72%			
Sensor Garden	62%	59%	64%	49%	57%	++ 43%
COG	60%	64%	56%			
Toy Robot display	57%	62%	52%			
Puppets	56%	50%	++ 64%	65%	60%	68%
Robot Arm	54%	59%	++ 47%			
Screen Life	54%	51%	59%			
Chess playing	54%	54%	55%			
Facial Expressions	51%	49%	53%			
Historic Collages	50%	52%	47%			
Media images	49%	47%	51%			
Face Recognition	49%	47%	52%	37%	38%	38%
Video of black box robots	48%	48%	48%			
Game of Life	47%	43%	52%			
Hearing Aid activity	46%	46%	47%			
Vocalization	45%	38%	** 54%			
Voice Recognition	43%	34%	** 55%	47%	46%	47%
Kismet	40%	36%	47%			
Spotting Changing Images	37%	34%	41%			

Only 8 photos were used with the adult interviews.

Which parts did people see? (continued)

OVERVIEW: Of the many possible comparisons and potential differences across the samples,² there were only four statistically significant differences in visitor behavior. Families with preschool-aged children were less likely to stop at the Robot Café. People who had seen this exhibition before were more likely to see the Ants. Older kids were more likely to stop at Robot Arena and Hearing Aid.

Comparisons of family vs. adult visitor groups:

SAW JEREMIAH

- ++ 87% of families with kids age 6+
- 72% of families with any preschoolers
- 73% of adult-only groups

ADULTS
(adult-only groups,
and adults with kids)

SAW ROBOT CAFÉ

- ** **76%** of families with kids age 6+
- 47% of families with any preschoolers
- 71%** of adult-only groups

Comparisons of first-time and repeat visitors to the exhibit

SAW ANT COLONY

- ** **97%** of visitors who have seen the exhibition before
- 84% of visitors who were seeing the exhibition for the first time

Comparisons by level of education

SAW ANT COLONY

- ++ 93% of people with high school / some college
- 87% of college graduates
- 76% of people with graduate school

SAW JEREMIAH

- ++ 86% of people with high school / some college
- 79% of college graduates
- 70% of people with graduate school

Comparisons of younger vs. older kids

SAW ROBOT ARENA

- ** **91%** of 9-10 year olds
- 78% of 7-8 year olds

KIDS

SAW HEARING AID ACTIVITY

- ** **52%** of 9-10 year olds
- 37% of 7-8 year olds

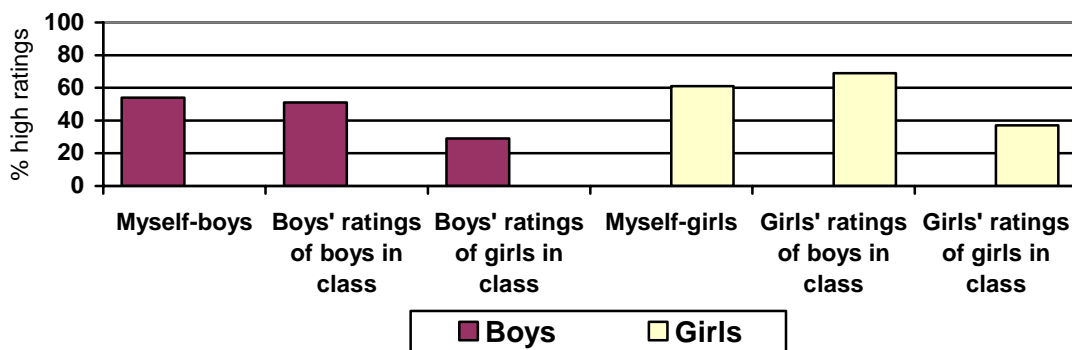
² Analyses of the adult sample included 48 relevant crosstabs – 8 exhibit photos times 6 visitor characteristics (gender, age, education, occupation/training, group composition, and familiarity with Robots & Us). Analyses of the kid sample included 52 crosstabs – 26 photos times two visitor characteristics (gender and age).

B. Appeal of the Exhibition

This section presents information about visitors’ ratings of the exhibition and what parts of it were most appealing. Highlights of the results are:

- ◆ Kids really liked *Robots & Us* (57% gave it a ‘9’ or ‘10’ on a 10 point scale). Adults gave lower ratings (26% ‘high’ – approximately the same as ratings for previous temporary exhibitions such as *When the Dinosaurs Were Gone* and *Mysteries of Catalhoyuk*).
- ◆ There were no statistically significant differences in overall ratings among boys and girls or men and women. However, children *perceive* that boys would be more interested in this than girls.
- ◆ The highlights of the exhibition for children were making Jitterbugs, seeing the different robots and learning about them, and the interactive activities in general. They thought Robot Arena, Sensor Garden, and Screen Life were great. Adults liked the Ants and Sensor Garden best.
- ◆ The *only* gender difference in ratings was that young girls and women were more positive toward Robot Café compared to boys and men (was it the food or talking with Lena?). (There were also some differences in use, cited in the previous section.)

Despite nearly-identical ratings by boys and girls, most kids believe boys-in-their-class would be more interested, and girls-in-their-class less interested.



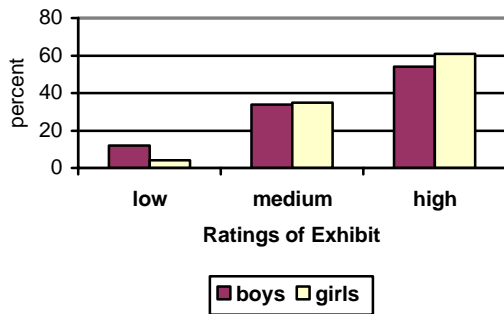
B.1. Ratings of interest

OVERVIEW: Adult ratings of this exhibition are similar to previous temporary exhibitions at SMM – 26% gave ‘high’ ratings, indicating moderate appeal. The initial concern that women would be less interested in this exhibition was overcome (in fact they gave slightly higher ratings than men). Kids gave much higher ratings than adults (57% ‘high’)³, and there was no difference between girls and boys.

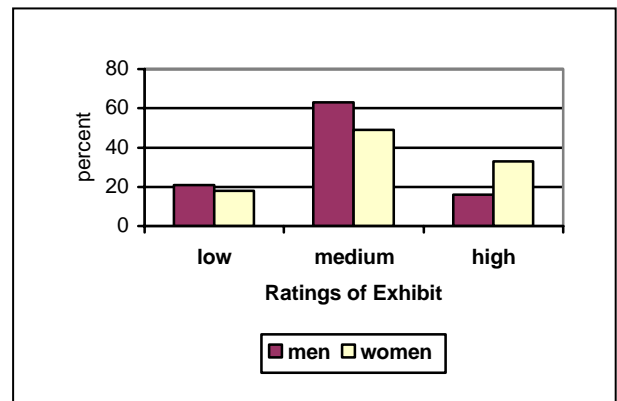
On a scale from 1 to 10 how would you rate your interest in this exhibit?

	KIDS			ADULTS		
	Overall (n=169)	Boys (n=96)	Girls (n=73)	Overall (n=161)	Men (n=63)	Women (n=95)
High rating (9-10)	57%	54%	61%	26%	16%	33%
Moderate (7-8)	35%	34%	35%	54%	63%	49%
Low (1-6)	8%	12%	4%	20%	21%	18%

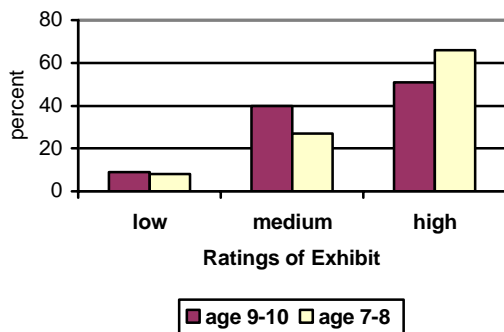
Similar ratings among boys and girls



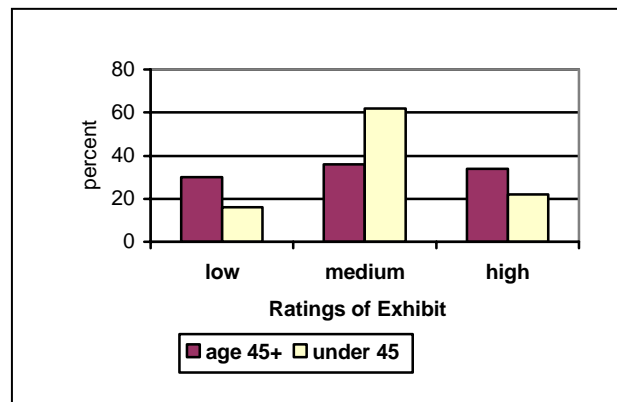
Slightly higher ratings among women



7 and 8 year olds especially liked it



Older adults gave more medium ratings



³ In the 1997 Visitor Experience Study, kids tended to give higher ratings than adults for the Experiment Gallery, but not for the other three Halls; *Robots & Us* is similar to E.G. in that there were extensive hands-on opportunities for children.

B.2. Perceptions of gender differences in appeal

OVERVIEW: Although boys and girls rated the exhibition similarly (previous page), they both feel that boys in their class would like it more than girls in their class (boys especially think girls would not be interested). This attitude exists among both the younger and the older kids.

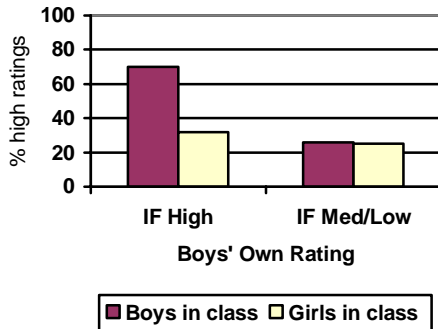
How would the girls/boys in your class rate this exhibit?

	GIRLS		BOYS	
	Girls <u>in class</u>	Boys <u>in class</u>	Girls <u>in class</u>	Boys <u>in class</u>
high rating (9-10)	37%	69%	29%	50%
medium rating (7-8)	40%	16%	23%	35%
low rating (1-6)	23%	15%	48%	15%

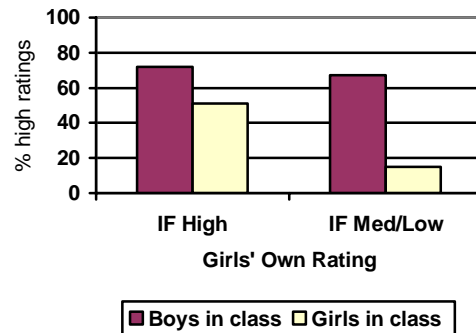
Although 7-8 year olds are more likely to attribute high interest to classmates compared to 9-10 year olds, both age groups believe that boys in their class would enjoy this exhibition more than girls.



BOYS who really liked the exhibit feel that other boys would like it also; most boys think girls won't like it.



GIRLS who really liked the exhibit feel that other girls might enjoy it also, but girls think that boys will like it more.



B.3. Highlights of the exhibition

OVERVIEW: Children liked that there were so many things to see and do, and they especially liked making Jitterbugs.

What's interesting about it?

KIDS

22%	Jitterbugs, making robots
21%	everything, so much to see and do, all the robots, I love robots
11%	learning about robots, how they're made, what they can do
9%	interactives, computer activities
9%	it was fun / cool
8%	Ants
7%	Leg Lab
7%	Robot Arena, where they followed the flashlight
5%	Jeremiah, the face
5%	Videos
5%	robot you can talk to
4%	Robot Arm / where you race the robot to put the puzzle together
2%	Sensor Garden
2%	negative comment (some parts I didn't like, I don't like robots)
9%	other (cartoons, toys, collage, chess, etc.)
4%	don't know, no answer

Sample of children's comments:

It had so many robots that people made

I liked the jitterbugs and the robots you can make with the motors

I think it's cool, the robots are cool

All the different things you have hands-on to do, it was really fun

I love science and robots and I want to make stuff like that someday

Lots of machines and they can help people learn

Lots of robots and fun stuff and computers and you can develop your own things

All the stuff moving around, tons of stuff to look at and you can move a lot around

The ants were cool, I liked watching them

I liked to learn about all the robots, I liked building robots

I like doing inventions and making stuff

Because you had to think and had fun

Because when I was making a robot it was very fun

All robots are interesting to me, it was wall to wall robots, best one was jitterbug

I think robots are really cool, we have robo-kitty at home and you have one here too

How robot would pick up things and put the puzzle together, and we would race it

The robots and how they can talk back to you and stuff

The face and all the stuff that looks at you

I like how it shows how much the world has advanced, it's very hands-on too

I learned stuff about robots that I didn't know before

Really neat learning about robots, how they move by themselves, electronics

You can learn a lot, it's fun to see what you can do, figure things out by yourself

B.4. Children’s reactions to individual exhibit areas

OVERVIEW: The most enjoyable components for kids were Robot Arena and Jitterbugs, followed by Sensor Garden, Screen Life, Robot Arm, Toy Robots, Leg Lab, and Ants. There was minor but notable disinterest among children in several of the non-interactive exhibits (AI-boy, Puppets, Historic Collages), and in one interactive element (Hearing Aid). Again, boys and girls gave very similar ratings, with only one significant difference – girls liked Robot Café better than boys (another activity involving a social setting and verbal communication). Analyses on the next page also show that older kids were more appreciative of Robot Arm (maybe the puzzle was a bit hard for the younger kids).

Here are some photos of parts of the exhibit; [26 photos]

KIDS

For each one you saw, put it in one of the slots in this box depending on whether you didn’t like it, thought it was okay, good, or great.

Components listed in order of proportion who saw it:	<u>Great</u>	<u>Good</u>	<u>Okay</u>	<u>Didn’t Like</u>
Robot Arena	61%	21%	16%	1%
Ant Colony	44%	30%	20%	6%
Jeremiah	28%	32%	28%	12%
Robot Café	33%	29%	29%	8%
AI boy	15%	25%	45%	15%
Leg Lab table	43%	31%	24%	2%
Flamingo	25%	38%	29%	8%
Jitterbugs	68%	19%	11%	2%
Sensor Garden	52%	32%	15%	1%
COG	26%	38%	30%	6%
Toy Robot display	47%	25%	27%	1%
Puppets	14%	28%	38%	20%
Robot Arm	47%	29%	22%	2%
Screen Life	49%	27%	22%	2%
Chess playing	30%	24%	32%	14%
Facial Expressions	38%	30%	23%	8%
Historic Collages	15%	35%	32%	18%
Media images	24%	34%	34%	7%
Face Recognition	40%	30%	23%	7%
Video of black box robots	26%	37%	36%	1%
Game of Life	17%	35%	34%	14%
Hearing Aid activity	19%	17%	47%	17%
Vocalization	28%	24%	30%	18%
Voice Recognition	21%	29%	38%	12%
Kismet	24%	35%	35%	6%
Spotting Changing Images	25%	32%	30%	13%

Children's reactions to individual exhibits (continued)**Comparisons by gender**

ROBOT CAFÉ

- ** **70%** of 7-8 year old girls said 'great' (but small sample size, n=20)
29% of 9-10 year old girls
26% of boys (no difference between older and younger)

KIDS

Comparisons by age

ROBOT ARM

- ** 32% of 7-8 year olds said 'great'
56% of 9-10 year olds

VOICE RECOGNITION

- ** **35%** of 7-8 year olds said 'great'
14% of 9-10 year olds

ROBOT CAFÉ

- ** **45%** of 7-8 year olds said 'great'
26% of 9-10 year olds

Children's reactions to individual exhibits (continued)

OVERVIEW: Children were asked a follow-up question – why did you like it? – about two of the exhibits they had rated highly. A representative sample of the answers is presented and one can see from these comments that children understood the main idea of many, but not all, of these exhibits. Specifically, most children seemed to get the point of Robot Café, Flamingo, Leg Lab, Robot Arm, Jitterbugs, and Screen Life. They didn't really get the point of the Ant Colony; it was just cool to watch. There weren't sufficient answers about the other, less popular, exhibits to make a judgment about children's understanding.

Why did you like Robot Arena? (n=46; every other answer presented)

Kids thought it was fun to remotely control the robots and set up blockades.
They got the idea of controlling the robots with the lights.

Interact with robots

Challenging

That they had light sensors, robots are cool

It was cool how you could set the box up and make the robot move

Really fun when you had to go through the block

It was fun to do, knock the blocks down

They're easy to control

Interacting with them, you get to block them and stuff

Can control robot without touching it, you can fence them in, I wish they made sound

I liked how the robots moved towards the light and how they didn't hit things

It tells you a lot about how it moves, you see interesting stuff

Good design for a robot, they respond better to a red light on my key chain

It was cool, you could control them with light & watch them run around & bump into things

I liked that they can move around and have a mind of their own

You could race, you could make a maze and have it go through it

Because it was remote control

They were like Battle Bots

Because you see how robots work and it's almost like having one

Because the robots ran into each other

It was fun using the flashlight to make it go

You can make it follow the light

Liked to drive it around

Because I got to control them

Children's reactions to individual exhibits (continued)***Why did you like Jitterbugs?*** (n=46; every other answer presented)

<p>Children liked building their own robots and then watching them move around. It's not clear from these answers what message kids got by doing this activity.</p>

*It didn't have a face, you make it into whatever you want**Because they jitter**They can move around**That they twirled around**I like making it and seeing it move around**I like building stuff**It was fun, you can think and build stuff**It was fun to build things**You can make your own creature and it moves**I liked how they moved and I could decorate them**It was cool to make your own machine**Because of the jingles**Because you can make them and they jump around**I liked how my bug moved in circles**They moved around and mine can fly**It was fun making them and seeing if they worked**Fun to make it, we were the first to make a skiing one**My robot ruled!**I like making robots**You got to create something new, it's really fun**I liked that you could make it your own, be creative**I like to do art and make things****Why did you like the Ant Colony?*** (n=30; every other answer presented)

<p>Children liked watching the ants move around and carry things. Very few kids got the point of this exhibit.</p>
--

*I don't like bugs but this was creepy and fun to look at**I like watching them carry stuff**What the ants did was interesting**I saw one ant carrying something so big, I thought it was funny**I like to watch them, sort of like cars**I like ants, cool seeing what they're doing and they're not hiding**You can see the nest and how they work**I liked to see them eat their food**They are creepy and I like to see them climb around**I liked seeing how the ants live**I read a book in school about an ant colony**Interesting to read the cards that told what they did**Cool to watch them**I like bugs**It was cool to see how the ants live and how they rely on each other*

Children's reactions to individual exhibits (continued)***Why did you like Leg Lab?*** (n=25; every other answer presented)

Kids liked building these, seeing how they moved, and changing the designs.
Most kids seemed to get the main idea of this exhibit – how function relates to form

Could see how legs move

You got them to move around

It was cool because you can experiment with it and make it move

It was cool how they could walk and stuff

It was fun putting them together

I liked making it turn over

I like changing the legs

You can run it by yourself

You can learn how to fix it

It can walk up stairs

I liked that you could put the legs in different places

I liked driving it over the hills

Why did you like Robot Arm? (n=19; every other answer presented)

Children found it challenging to compete with the robot and they liked the way it zoomed around and bowed at the end. Most kids got the point of this exhibit – that robots can do some things faster than people.

It was super fast and it did a dance when it won

That you could pick the pieces up and move them and race

Trying to compete with it, I copy-catted it

Cool how it moved and if it won it would bow

Interesting how it could move

It was cool when it flipped and twisted pieces over

Cool it can go against 2 people and still beat both of them

It's a challenge, I don't see how it can put the pieces in the right spots

It was cool, I beat it once

It zoomed, it tells you something, if you concentrate you can understand it better

Why did you like Sensor Garden? (n=19; every other answer presented)

Kids liked doing different things and getting the flowers to move.
They seemed to get the point of this activity – understanding how sensors work.

I like making them move

I liked all the neat stuff you can do, interactive

It was like using your senses

I liked that you can do a lot of different things

You could make the robots do stuff

How it could sense the heat

Showed how sensors work

When you rub your hands together it knows how your temperature is

I blew into one and pressed a button and stuff moved

I liked how the flowers moved

Children's reactions to individual exhibits (continued)

Kids liked designing a robot and experimenting with different options.
Most children got the point of this activity.

Why did you like Screen Life? (n=18; every other answer presented)

I got to create things

Mess around with gravity and friction, build own things

Because you can change things on it, I like the gravity

How you moved and built them

It was interesting, helped me understand balance

I liked making it go back and forth

It was fun to see what it would look like when you build it

I liked playing around and seeing what all the buttons and things did

You get to design a robot kinda like a video game

You can make so many creations and it's just cool to make them move

Because you can make them float in the air

Why did you like Robot Café? (n=14)

Kids liked asking Lena questions and they appreciated the humorous aspects here.
They seemed to get the point of this area.

I liked the robot and I liked the idea of it

I liked the guy at the counter, Larry?

You got to ask questions

I just like it

Songs, kind of funny, asking questions

Because you could type in and ask the person a question

Dinner menu was funny, computer said it had a pet toaster but it ran away

I liked talking to the robot, Lena

I liked looking at it

I liked the android that talked back to you

It was like if robots would be at a café

I liked pretending to be the café owner and people were ordering food

Children's reactions to individual exhibits (continued)***What did you like about Robot Toys?*** (n=14; all presented)

Kids liked looking at the different kinds of robot toys and seeing what they could do.
--

*I liked looking at the animals**They looked really fun**Really liked looking at them, I want one**Because they're toys**It looked cool and I wanted most of the stuff in there**I liked all of the toys, the turtle was best**I always wanted one of those and never got one, my sister had one she fed**Seeing all the creatures and how they can move like pets**It was fun to look at all the robot things**It had funny characters in it**I liked the video of the kids playing**They were cool to look at, some had different languages**I liked seeing what they could do, the puppy was cool**Shows you all the different kinds of robots and how they are made****Why did you like Face Recognition?*** (n=11; all presented)

Kids understood and liked this idea – making different faces to try and trick the computer.

*Fun seeing how many ways you could trick the computer into thinking it wasn't a face**I just like making faces**I liked trying to trick the computer**It was kinda funny because you can be different faces**Make your own faces, I liked masks, glasses**I don't know, it was okay**Tricking the camera freaked me out**It circled the faces and pictures**Because it was fun making faces**It was sorta fun seeing it move and stuff**I liked how it went in slow motion****Why did you like the Flamingo?*** (n=10; all answers presented)

Kids liked how the flamingo was put together. They seemed to get the message.

*I like how you assembled the knees, and how it showed them working**Interesting how you could put together a robot, have it walk on legs, fall**I love seeing machines like these, maybe I can make one like that**I really liked where they make things that can do automatic stuff**Because I like Flamingos and it was cool to watch**When it falls down in the video**It was just weird and cool**How it has so many parts and looks so cool**It was just straight up weird**Videos of robots that actually worked*

Children's reactions to individual exhibits (continued)

There were too few comments about the following exhibits to make a judgment about whether children got the point or not.

Why did you like Jeremiah? (n=9; all answers presented)

It was fun to play with and seeing what he felt like when did things

Liked the really cool pictures

I liked how it looked at you when you moved

When you went to the side the head turned

Looks at people when you walk by

More robotic-like

He scared me, I didn't know he was there, then I realized that he wasn't real

I thought it was kind of neat

It did whatever it wanted to

Why did you like Facial Expressions? (n=9; all presented)

Fun to do

You could see different emotions

My brother and I had a lot of fun playing with it

I liked making faces, my brother made a really silly one

It was fun to guess what the person was feeling

I did funny faces

I liked making faces

It was funny when you make funny faces

It was a little hard to do but it was fun

What did you like about Chess? (n=7; all answers presented)

I like to play chess

I was in chess club

I love playing chess and I can beat everyone

Me and my dad play chess

I just like to play

I like to play chess

Why did you like Kismet? (n=6; all answers presented)

That you learned about a robot you can see and it can already do stuff

He's cute and he would be cuter with fur

I liked when the boy talked to Kismet

How it explained about the robot

Because it was like a baby and it could talk to people

He was just funny

Children's reactions to individual exhibits (continued)***Why did you like Vocalization?*** (n=5)

Funny hearing what you wrote on computer

I could make it say what I wanted it to say

It was cool that it could talk

You can type things and it will say it fast or slow

I made it call me a really funny name

Why did you like Media Images? (n=5)

It was cool that the channels changed but annoyed it changed when you were getting into the show

I liked the videos

I watched Donald Duck on TV

Because it had TV

I like how they mix Mickey Mouse characters and robots

Why did you like Voice Recognition? (n=4; all answers presented)

You get to move them around without touching them

Because it looked at you

That you could talk to it

You can make funny noises and the machine will make stuff up

Why did you like Black Box Video? (n=4; all answers presented)

There were little robots running around everywhere

It was neat to see them working

Bees and ants, they can fly and sting, ants can pick up things over their weight

I like all the ideas there, it was really exciting, they look like bugs

Why did you like AI Boy? (n=3; all answers presented)

It looked so much like a real person

I recognized him

It freaked me out because he looked so real

Why did you like Spot Changing Images? (n=3; all answers presented)

It was cool to see which things changed and stuff

Mystery, it's like a game, it was funny

It was hard to find the changes at first but then I got used to it

Children's reactions to individual exhibits (continued)

Why did you like Game of Life? (n=3; all answers presented)

Fun to do

You got to make different shapes

Touching the screen

Why did you like Hearing Aid? (n=2; all answers presented)

I have a friend with a hearing aid and I wanted to learn about it

When you hear the bad and the good

Why did you like COG? (n=2)

Neat to see how complicated robots can be, guy who explains it was funny looking

I liked how he was holding a slinky, looks like he's going to break out of his cage

B.5. Adults’ reactions to individual exhibit areas

OVERVIEW: Ant Colony and Sensor Garden were the most popular exhibits among adults. Women were more likely than men to say they liked Robot Café.

ADULTS

Here are some photos of parts of the exhibit: [8 photos]
Which ones did you like most?

	<u>Overall</u>	<u>Men</u>	<u>Women</u>
Ant Colony	52%	58%	48%
Sensor Garden	49%	50%	49%
Jeremiah	42%	49%	38%
Robot Arena	38%	33%	42%
Face Recognition	27%	17%	33%
Voice Recognition	25%	31%	22%
Robot Café	16%	6%	** 22%
Puppets	12%	8%	14%

Why did you like that one? [Ant Colony]

Adults liked seeing live animals and found the ants interesting. Only a few people understood the point of this exhibit.

- I'm a big fan of living things, I like zoos*
- Ants are nice, descriptions well done*
- Unexpected, more interesting than I realized*
- Connection to nature*
- Could see ants up close*
- Spent most of our time there, thought it was interesting*
- Interesting to watch ants move around*
- I love ants*
- The ants were working and busy*
- Interesting to see ants interact in a man-made environment*
- We like to watch animals*
- I like the biology of ants, learning about the ants themselves*
- I learned what ants have to do with robots*
- Ants are everywhere, I liked seeing them work together as a team*
- Didn't realize ants work together to accomplish things*
- Could relate to words inside the maze as they applied to humans*
- Showed ants' ability to reason*
- I'm more familiar with ants than robots*
- Ants were interesting, new perspective*

Adult reactions to individual exhibit areas (continued)***Why did you like that one? [Sensor Garden]***

Adults appreciated the hands-on nature of this exhibit and seeing the cause & effect.
They seemed to get the point.

Easy to work, easy to understand

My grandson liked them

You could make them do things, very interactive

Hands-on

Because of the interactive components

Liked the hands-on, being in control

Different hands-on things, quickly see the effects

Cool technology

Could move things around

Liked the different stuff they did

Artistic way to show movement of each, intriguing way they follow you around

A lot to do

Why did you like that one? [Jeremiah]

Adults liked interacting with Jeremiah and they thought it was creepy.
They seemed to get the point.

I like cutting edge technology

Interesting without responding to me

Creepy

Looks at you, following with eyes

The face exhibit was creepy

Visual response, human likeness

Face is creepy, gets your attention

Interested in face movement, drew attention

Reminds you of face in mirror

Interaction between people and computers is interesting

Fun to watch Jeremiah

Liked eyes following you

It was interactive

To see how he reacted to you

I was a little freaked out but thought it was neat

Why did you like that one? [Face Recognition]

Accurate

Was pulled into it, asking questions of myself, more and more intrigued

Making faces, interactive

Hands-on, fun to make faces

Stuff you can pay attention to, interactive

Realistic interaction

Adult reactions to individual exhibit areas (continued)***Why did you like Robot Arena?***

Adults enjoyed this interactive activity and most seemed to understand the point.

*You could make them do things, very interactive**Hands-on**Flashlights hard to reach, directions not clear**Most interactive**I liked playing with light and robot**Light robots were cool**I liked how they worked, robots were attracted to light**You get to control robots, see the way they work**They are neat to watch**Interesting principles**You could do something with it**Fun to watch kids**Watching the kids work it**You could do things with them**How it follows around, kind of acts like a human**The fact that you can simulate complex behavior with simple rules**Fun trying to make the robot follow your light****Why did you like Voice Recognition?****Talk to me was funny**Interactive with voice and noise**What it could do, cool technology**Very educational**Really demonstrated how hearing would improve****Why did you like Robot Café?****Interactive**Robot talked back to you**Caught attention, menu was cute**Looked great**See this happening in future**Liked robot at android café counter**The setting just appealed to me****Why did you like Puppets?****Marionettes were interesting**Interested in puppets as early robots**I like old stuff, cool to see where robots came from**Interesting to see all the different puppets**Before robots there was only art and I'm interested in art**Gave you history**Colorful marionettes were pretty*

C. Interpretive Issues

A variety of interpretive issues and questions are explored in this section of the report, such as:

- what expectations did visitors' come in with and were their expectations met?
- did this exhibition expand people's images of robots?
- what did visitors learn about robots?
- were visitors confused by anything in the exhibition?
- did people notice and appreciate the humor?

The key findings are:

- ◆ Visitors' Expectations: The Ant Colony was the most unexpected aspect of the exhibition (17% mentioned it). Only 8% of the visitors said they expected to see more high-tech, life-sized androids, but they weren't necessarily disappointed by the variety of different kinds of robots. Also, 10% of the visitors were pleasantly surprised by the interactive opportunities (i.e., they thought it would be just looking at robots).
- ◆ Robots & Human Forms: Visitors came out of the exhibition with an *enhanced* sense that robots have body parts like humans, and that robots can be designed to imitate living creatures – a “main message” of this exhibition.
- ◆ Additional Messages: The main ideas that visitors came away with are about how robots work, the amazing things they can do, and how much they are becoming or will become a part of our lives.
- ◆ Historical Content: Visitors didn't pay much attention to the historical panels and weren't able to accurately guess how long robots have been around.
- ◆ Humor: Most visitors noticed and appreciated the humor, especially in the Android Café.

C.1. Expectations

OVERVIEW: Half of SMM visitors had heard about *Robots & Us* before arriving at the Museum (22% had already seen the exhibition at least once). About half of the first-time visitors said the exhibition was what they expected and half cited something unexpected, such as the ants or all the interactives. Few people mentioned disappointment about not seeing life-sized androids.

Did you know about this exhibit before coming to the Museum today?

ADULTS

	Overall Sample	1st-time Visitors	Repeat SMM Visitors
yes, seen it before	22%	0	** 40%
yes but hadn't seen it	28%	26%	29%
no	50%	74%	31%

Give me an example of something that was different from what people (you) would expect from the title, "Robots & Us?"

- 52% nothing, it's what I expected (no difference between repeat & 1st-time visitors)
- 17% the ants
- 10% all the interactives, Jitterbug building, computer activities
- 7% specific displays (toys, AI boy, Sensors)
- 6% many different kinds of robots, not life-size androids
- 3% the history & cultural references, the puppets
- 2% correlations between robots and people
- 2% expected it to be more high-tech, advanced
- 1% not interactive enough
- 2% other

Sample of answers: (if not what expected)

- More interaction than expected*
- The ants*
- Things built by University students*
- There were different things other than just robots*
- There weren't any robots walking around*
- Interactive computer screens*
- Computerized and motion sensors*
- We could build a Jitterbug, the ant colony*
- Correlations between robots and humans*
- Cultural references to robots through the years*
- More hands on stuff should have been included*
- Didn't know about the "us" part*
- Expecting a little more higher-tech applications*
- Expected more robots*

Something that was different from expectations (continued)

More human robots

Gives a clue to movies and kinds of movies made about robots

Expected more working robots

Expected more robots as kids know them

Light that moved things was unusual

Intrigued with facial expressions, thought it would be more mechanical

The human connection, how humans work and how robots work

Face that follows you, ant colony, pictures changing, didn't expect things like that

Stuff about old robots like marionettes

Robot Arm

Expected display models, didn't expect to be able to interact

The animal/robot together

Ants, almost everything was different, screen where you could manipulate figures

Didn't expect to see AI Boy exhibit

Walking robot

Hands-on activity unexpected

Just being able to see actual robots

The hands eye things along back wall

Teaching the machine common sense

Jitterbugs

There's a lot more out there than I thought

Ant colony and toys

It was playful, more interactive

The walking legs without a motor

C.2. Perceptions of interpretive messages about robots

OVERVIEW: A high proportion of adults and kids (79%; 70%) saw something about the theme ‘life inspires and informs technology’ (a ‘main idea’ of the exhibition). People mentioned a variety of specific exhibits providing examples of this idea (Flamingo, Leg Lab, Robot Arm, AI-Boy, COG, Insects, Dinosaurs, etc.). The theme ‘our machines are becoming more human-like’ was somewhat less evident (seen by 50-60% of kids and adults). People who saw this idea mentioned exhibits such as AI-Boy, Jeremiah, Lena, and Kismet. The theme ‘robots are becoming more capable and helpful’ was also perceived by a majority of adults (60-71%).

Did you see these ideas presented here?

EXIT Interviews	
Adults	Kids
<u>[Message: <i>Life inspires & informs technology</i>]</u>	
Most robots have body parts like people do (arms, head, etc.)	79%
Robots can be designed to imitate living creatures [kid phrasing]	70%
<u>[Message: <i>Our machines are becoming more human-like</i>]</u>	
People & robots are becoming more like each other	54%
Robots can be made to think like human beings [kid phrasing]	60%
<u>[Message: <i>Our machines are becoming more capable and helpful</i>]</u>	
Robots can replace people doing routine jobs	71%
Robots are generally faster & more efficient than human beings	60%
People often use robots in science & engineering	49%

Perceptions of interpretive messages about robots (continued)***Give an example of: Most robots have body parts like people: (ADULTS)***

18%	Legs (Leg Lab, Passive Walker)
12%	Robot Arm
12%	Flamingo
10%	David, AI boy
8%	COG
6%	Jeremiah
6%	dinosaurs
4%	Lena, ones in Café
4%	insects, cockroaches, Jitterbugs
3%	fish
2%	animals
1%	videos
12%	other
<u>4%</u>	not sure where, general impression
79%	Total who saw this presented in the exhibition

Where did you see Robots can be designed to imitate living creatures? (KIDS)

25%	Flamingo
9%	Tuna, fish, shark
8%	David, AI boy
8%	Crickets, Cockroaches
8%	Dinosaur
5%	Robo-friends, dogs, cats, pets
4%	Jeremiah
4%	Robot Arm
4%	Jitterbugs
2%	Lena
9%	other
<u>8%</u>	not sure where, general impression
70%	Total who saw this in the exhibition

Perceptions of interpretive messages about robots (continued)***Give an example of: Robots have more industrial than personal uses: (ADULTS)***

14%	assembly line, building cars
7%	Robot Arm
6%	robots are better at repetitive tasks, not creative, follow commands
6%	factory/manufacturing area
4%	Video – moving crates & boxes
4%	gave a personal use example (vacuuming, home computer, COG)
3%	World Trade Center robots
3%	cockroaches, Flamingo, Tuna
1%	Sensor Garden
1%	Leg Lab
11%	other/unclear
<u>15%</u>	not sure where, general impression
75%	Total who saw this presented in the exhibition

Where did you see People use robots in science & engineering? (KIDS)

4%	TV, videos
4%	Robot Arm
3%	building cars
2%	World Trade Center & Moon robots
2%	Hearing Aid
2%	Leg Lab, walking
2%	Flamingo
1%	Tuna
10%	other
<u>20%</u>	not sure where, general impression
49%	Total who saw this presented in the exhibition

Perceptions of interpretive messages about robots (continued)***Give an example of: People & robots are becoming more like each other:***

<u>Adults</u>	<u>Kids</u>	
8%	19%	David, AI-boy
5%	8%	Jeremiah
5%	6%	walking and arm exhibits
6%	3%	everywhere, robots designed with legs, arms, faces, etc.
6%	3%	better technology, robots can do more things now, they move like us
4%	4%	Lena, café lady
4%	<1%	Facial Expressions
4%	<1%	COG
<1%	4%	Kismet, the baby one
1%	3%	Sensor Garden – they can sense things, robots are getting smarter
6%	7%	other
<u>7%</u>	<u>6%</u>	not sure where, general impression
54%	50%	Total who saw this presented in the exhibition

Where did you see Robots can be made to think like human beings? (KIDS)

11%	David, AI-boy
7%	Face
6%	Lena, Android Cafe
5%	thoughtful answers (where you train them, special computer chips)
4%	Robot Arm
3%	Kismet, baby
2%	Robo-Pets
1%	COG
6%	other
<u>18%</u>	not sure where, general impression
60%	Total who saw this presented in the exhibition

Perceptions of interpretive messages about robots (continued)

OVERVIEW: Nearly all the adults (93%) could articulate something positive about robots – about half had completely positive attitudes toward the idea that robots can perform tasks that once required a person, and approximately half expressed ambivalent feelings (both positive and negative aspects). The positive aspects are that robots can do boring or hazardous jobs, and are more economically efficient. The negative perspective is primarily about loss of jobs. Younger adults are significantly more likely to be ambivalent.

Robots are now able to perform many tasks that had once required a person. Do you think of this as a positive or negative development?

ADULTS		<u>Overall</u>		<u>under 35</u>	<u>35-44</u>	<u>45+</u>
	positive	47%		** 33%	47%	62%
	negative	6%		12%	5%	2%
	ambivalent	47%		55%	48%	35%

Why is it POSITIVE? (includes ambivalent people, nearly all of whom listed a positive and a negative)

- 22% for boring, repetitive jobs, things that we don't want to do
- 22% for hazardous jobs
- 17% more efficient, faster, economical
- 11% frees up people's time for creative pursuits
- 7% more precise, better at highly technical jobs, e.g., surgery
- 5% medical advances for disabled
- 3% stronger, don't get tired
- 6% other positive
- 93%

Sample of POSITIVE answers:

- If it's repetitive*
- Increase production*
- Things that were boring or tiring could be done by robots*
- Allows people to do other things*
- Robots can replace dangerous jobs*
- Works in surgery*
- We do their thinking and we'll always get along*
- They can come clean my house*
- How they can aid the handicapped, make manufacturing more efficient*
- Useful in industrial functions, some factories have employed robots, this is good if you want to get more work done*
- They can work in areas not safe for people*
- I think there's a lot of tasks humans don't want to do*
- Enhance the ability to do more*
- Give humans more time to enjoy life*
- They can help you with things, more efficient, work faster*

Perceptions of interpretive messages about robots (continued)**Why is it NEGATIVE?** (comments made by negative and ambivalent people)

36%	loss of jobs
4%	human element is lost, emotions, thinking, communication
2%	loss of control, people not in charge
1%	cost of upkeep, they may break down
4%	other negative

Sample of NEGATIVE answers:*Long term loss of jobs**People should be running the show**Once they take over we won't make money**Taking control away from humans**People need the jobs robots will take**If they are doing what we are doing, what are we going to do?***Sample of AMBIVALENT answers:***Sometimes it can be good but it can be dangerous too**Replacement of jobs is bad, requiring me to do less is good**Overall good, it'll take time to be more productive because we are still learning about them**Humans will never be replaced though efficiency & cost is more effective**Emotional aspect not duplicated**Depends on what you use robots for**It could have reverse effect, they could be helpful or harmful**Maybe work without taking breaks but taking jobs away from people**Helps us do stuff but takes away jobs and personal contact**Robots can replace people in certain tasks but they can't overtake people, it'd be impossible**House cleaning – if you don't tell it exactly what to do it will miss corners**Some people may program them for negative things and some program for positive**Can do routine jobs people don't want to do but may take away jobs from less educated**It is changing our economy and hurting a lot of people, but progress is good in general**People feel that jobs are being lost but there are just as many jobs created, only low-end jobs may be being lost**Potential to be positive but depends on how it ends up being used**No simple answer, it's such a complex question**They can exactly duplicate movements in assembly line but can't adjust to unusual, not flexible, lacking judgment**Okay but they can't think on their feet, if something goes wrong they can't correct it**We will have less and less relations between humans and it's not good, but it can do things that aren't healthy for humans*

C.3. Other learning outcomes

OVERVIEW: The vast majority of adult visitors (78%) found out something interesting about robots (e.g., how advanced they are, how they are made, how they are modeled after living things, etc.). The historical part of the exhibition did not have much impact – visitors’ guesses about how long robots have been around did not change after seeing the exhibition.

ADULTS

What did you find out that was important or interesting about robots?

- 16% amazing what they can do, how advanced, how complex to build
- 11% how to make them work, everything programmed, have sensors
- 9% how much they are like humans, trying to imitate humans
- 7% everything was interesting, just seeing everything
- 6% robots modeled after animals or bugs
- 6% learned about ants, how components work together
- 4% history & evolution of robots, how long they’ve been around
- 3% all the different kinds, they can do different things
- 2% robots are positive, useful
- 2% something negative about robots
- 9% specific exhibits of interest but no real content
- 4% other
- 22% not much, didn’t read

How long would you guess robots and life-like machines have been around?

	<u>Entrance</u>	<u>Exit</u>	<u>Exit</u>
		<u>1st-Visit</u>	<u>2+ Visits</u>
30 years or less	18%	15%	14%
30-50 years	34%	32%	46%
50-100 years	21%	29%	29%
over 100 years	26%	24%	11%

Sample of answers: What did you find out?Amazing how advanced:

Ones beginning to think for themselves
How they develop memory interactive with us
Robots can be programmed to almost think
What was science fiction as a child is now reality
They are making advances, robots can help us do a lot of stuff
That they can show emotion
They're quicker than I am at the puzzle thing
They can answer questions and tell jokes
Robot was amazing, all the parts to make it work were so complex
Design and development of robots takes a lot of effort

How to make them work

The different ways you can make them work
Sensors
Everything has to be programmed in
Machinery behind it
Showing how each robot works
The kind of jobs they do and mechanics

How much like humans

They study human behavior
How they mimic real life
How robots relate to us, how scientists use robots to simulate human sensory experience
Human factor
That most of it is based on man-like attitude

Everything was interesting

Fun to watch technology advance
It was interesting to see all the machines and robots
Artificial intelligence stuff is interesting

Robots modeled after animals

A lot of robots were fashioned after cockroaches
That some robots are modeled after animals
The fish thing, robots can simulate nature
The movement from natural to more mechanical things

Learned about ants

Ant colony and their connection to the human brain
I thought the ant colony was interesting, cool to look at
Ants – component parts that come together to make a whole
Seeing the ants work

History of robots

How long they've been in existence

How it evolved, history

How long people have been interested in robotics

All the different kinds of robots

Robots are different, they all have different purposes

They are used in more things than I thought

Robots are positive

How robots are a part of our everyday society

The value they have for society these days, their potential

Robots are negative

Reinforce my fear

Humans depend too much on artificial intelligence

Other learning outcomes (continued)***Seeing this exhibit makes me realize that . . .***

24%	technology is so advanced, robots are so intricate, complicated
21%	the future is here, robots are part of our present and future daily life
12%	robots have important uses (and other positive comments)
12%	robots can't replace people, human body is so complex, still a long way to go in designing robots
6%	there's a lot I didn't know about robots
4%	fearful, negative
4%	robots and humans have similarities
3%	robots are fun for the kids
3%	robots have been around for a long time
2%	robots are faster/more efficient than people, can replace humans for some tasks
7%	other
9%	no answer, irrelevant answer

Sample of answers**Technology is so advanced***How intricate things are**Robots are amazing**What a technical world we live in**Changes in robots in last few years**More to robots than I thought**Progress has been made in developing robots**World is far more advanced and moving forward**Technology has come a long way and it still can go a lot further with robotics**How complicated robots are***The future is here***Machines are an important part of our future**There is a future in robots**Robots are our future**We have a new future and robots are a part of it**Robots are part of our life**There's more robotics work going on than I thought**We are further into the future than expected**The idea of robots isn't science fiction**We use robots more than we think*

Robots can't replace humans

Human body is incredible

We have a long way to go with robots

I am still smarter than robots

We won't be overcome by robots

It's harder to replace man than we thought

Positive, important uses

Robots are important to all of us

Robots are cool

Robots can do amazing things

How useful robots could be, if you lost a limb, for disabled

How much robots can do

Robot-human similarities

We are like robots

Robots can think

There is still a great emphasis on robots which are human-like

Negative/fearful

Trouble is near

I prefer humans to robots

Robots could rule the world

All other categories

How interesting it is to the kids, the kids seem so excited, it makes me feel good

Man may be replaceable

Humans have been thinking about robotic processes since writing of the Bible

Fascinated by artificial intelligence

We can do this at home, toys from Target, Legos

It is absolutely necessary for us to use our imaginations to make life better for other people

How little I know

C.4. Minor points of confusion or difficulty

OVERVIEW: The majority of kids (63%) said there was nothing confusing or hard to understand in this exhibition. There were no differences by age or gender. Some kids were confused by the ants, the Jitterbug instructions and Leg Lab.

Tell me something that was confusing or hard to understand:

KIDS

8%	Ants – why were they in the exhibit?
5%	Jitterbug - instructions not clear, it didn't work
5%	Leg Lab
3%	Robot Arm – the puzzle was hard, it was hard to beat the robot
2%	Jeremiah - why did he look around like that? how did it work?
2%	talking into machine
1%	Game of Life
1%	blindness
12%	other
63%	nothing, blank

All answers with content:

The fish thing, I thought it would explode

Android Café info

Big face, I didn't get it, camera and target?

I didn't understand why the ostrich legs bend the other way

Some confusing parts, if you rated my understanding from 1 to 10 it would be a 5

Computer that when you spoke into microphone was supposed to speak back

The Jitterbug instructions

It was difficult to make it work

Some of the stuff was hard to figure out how to make it move

That guy on the big screen, I couldn't understand why he looked around

How they moved without anyone helping

Ant Colony

How to get the motors on the Jitterbugs

One about blindness

Flamingo

The ant farm

Things on wheel that goes around

Why the ants ate the fruit

One where the robots move with the lights

Ant colony was a little hard

The ants – why were they in there?

The first time I came I was a little confused with making the Jitterbugs

How to make a robot

Couldn't get the Jitterbug to work because the battery was dead

What the TV show was about, the one by Android Café

What was confusing? (KIDS, continued)

The machine you talk into
The ones you had to talk into
It was hard to understand why the walking robot fell over
The ants – I don't know what they do
Making the battery work on Jitterbug
The thing where you have the robot with 6 legs
Leg Lab never works right
Couldn't understand why ants were there
How the Jitterbug worked
Why the ants were there
The little robots where you moved the legs
The scary ones – Jeremiah and Larry
One where you race robot to put pieces together
I couldn't figure out how to work robots that went on the wheel
The parallelogram robot, the one that puts together the puzzle
How to put together the puzzle faster than the robot
Some of the hands-on stuff, the ants too, I didn't really get that
The flashlights, couldn't get them to move around the robots
The dinosaur robot – his legs were very confusing
Why the chess board was there
Talking robot
Hard to make pieces stay on Jitterbug
Moving robots
It could have been more descriptive in some parts
The one where you slide back and forth, the blindness one
The ant exhibit – why it was there
Why the ants were there
The box on the face thingy
Why is the ant colony in the robot exhibit?
The life game exhibit
The one where you try to beat the robot building the puzzle
Puzzle robot was hard

Minor points of confusion or difficulty (continued)

OVERVIEW: As with children, most adults (63%) indicated that none of the exhibits was confusing. Each of eight exhibit photos was chosen by some people as confusing or hard to understand.

***Which part will people find confusing or hard to understand?
(chosen from 8 photos)***

ADULTS

8%	Jeremiah
6%	Voice Recognition
5%	Sensor Garden
4%	Robot Arena
4%	Face Recognition
3%	Puppets
3%	Ant Colony
2%	Robot Café
3%	something else
63%	none of these were confusing

Why is Jeremiah confusing?

I didn't know why he was following me

Did not make sense

The purpose

No response from screen

Where to stand

I think it might be broken

No matter how I moved I could not get the face to focus in on me

If you didn't read you would not understand why he smiled

You've got to think more, it's not just a pass me by thing

I don't think people were looking at how the display really worked

I just didn't take the time to really see it

I didn't really feel like he was watching like he was supposed to be

Why is Voice Recognition confusing?

I know speech recognition has a long way to go, I confused it with long words

Misunderstood everything we said, frustration

Mixed words up

Was kind of confusing, didn't work so good

Couldn't decipher voices

Too wordy and too long to sit in one spot, not enough action

A little confusing and it didn't work

The kids didn't really understand it that well

What parts are confusing? (ADULTS, continued)***Why is Sensor Garden confusing?***

Not a lot of explanation, didn't tell you how it could be used for other things

You didn't realize how to make them work until attendant came around and told us

Looked like it was harder to understand

Took a lot of reading

Sensor eye piece

Didn't notice it

Why is Robot Arena confusing?

Mobile robots wasn't working

Wasn't quite sure if light source was working

Little confusing they didn't always follow light

Sometimes robots weren't moving with the lights, I don't know if they need to be restarted

Hard to get the light to shine in the sensors

Why is Face Recognition confusing?

Didn't seem to have much of a point

I just didn't understand it

Kind of hard to see how it worked

Need to read more to work it

I didn't stay long, seemed confusing

Why are Puppets confusing?

Don't get what the puppets are about

Didn't read text but tried to understand big picture

Not compelling, didn't fit in exhibit

Make them move around

Confused about how it works

Why is Ant Colony confusing?

Couldn't see how it related to robots

Depends on age level

Movie thing didn't work

Don't think of ants as part of robots

Didn't understand how ants relate to robots

Why is Robot Café confusing?

Wasn't interactive

Could not figure out what to do

Could not focus on it

C.5. Visitors' perceptions of the humorous aspects

OVERVIEW: The humorous characteristics of this exhibition were noticed by three-quarters of the adult visitors. People cited numerous humorous aspects, including Android Café, Jeremiah, Robot Arm and Morphing Faces.

Was there anything humorous or funny in the exhibit?

yes	74%
no	26%

ADULTS

What?

20%	Android Café, Lena
10%	Jeremiah
10%	Robot Arm, made a face and bowed when it won
9%	making faces, face that morphs
5%	Ants
4%	Jitterbugs
4%	Video – animal movement
4%	Sensor Garden
2%	walking robots, Leg Lab
11%	other

Sample of answers:

How you typed things into computer, typed back to you - that was cool

The flamingos looked funny

Jeremiah

Exhibit where you make faces

Talking head

Gas station guy (change blindness activity)

Sensor one

Lena, ants

Leg lab

Communication gap, Lena

Android cafe

Spoke into speaker, robot got none right

Walking robot video, flamingo splits

Making faces, cockroach movement

Video of ants' progress

Ant colony, trying to follow leader

Face that morphs

Voices, videos

Faces

Toy area, head shiny and embarrassing

Joey Osman (AI-boy)

The seeing face exhibit

Humor (continued)

Sensors seeing the uses and a seeing how busy ants were
Face recognition
Little sensors, make voices
Android cafe how she made faces, told a joke
Sensors were funny the way they moved when you touched them
The video on how animals move
Home helper was funny (video)
Jitterbugs moved funny
Making faces
Machine talking about animals
Ants and talking into speaker to interpret
Moving face
Computer answering questions
Children making jitterbugs
Some of the faces, motions and actions were funny
Watched cartoons
Robot at cafe-missing pets
Doing the puzzle
Robot arm, bows to you
The walking, how they went up the incline
The personalities, the robot arm
Light hearted in general, the cafe
The walking robot
The one where it makes faces
The big brother, android cafe
Android cafe and the robo pets
Face recognition and old ideas exhibits
Dogs looking at robot
The robot arm was sassy
Watching goose & people compete, goose giving emotional response
It was all cute, nothing specific
The cartoon style
All of it
How we couldn't get the puzzle together before the robot
The videos
Kismet

D. Characteristics of the Samples

The three samples of visitors who were interviewed for this study have similar demographic characteristics and appear to be representative of SMM's summer audience.

D. Characteristics of the Samples

OVERVIEW: The majority of visitors have been to SMM before, and about two in ten have seen the *Robots & Us* exhibition on a previous visit. Two-thirds of the visitor groups during this *summer* sampling period included children. There were more women than men interviewed (60% vs. 40% in the Adult sample; 71% vs. 29% in the “with Child” sample). One-fifth of the adult visitors have a career in science and 17% said they have some special experience with robots.

	Adult Entrance (n=142)	Adult Exit (n=161)	Parent/Child Exit (n=169)	
<u>Familiarity with Museum</u>				
first-time visitors	34%	40%	n/a	
repeat visitors	66%	60%		
<u>Familiarity with Robots Exhibit:</u>				
never seen	82%	78%	69%	
seen before	18%	22%	31%	
<u>Residence</u>				
Mpls-St. Paul	31%	22%	n/a	
other MN	56%	50%		
out-of-state	13%	27%		
<u>Group composition</u>				
adults only	35%	30%		
family with children	65%	67%	100%	
school/tour group	0	3%		
<u>Ages of kids in family group</u>				
includes ANY preschoolers	18%	23%		
ages 6-17 ONLY	47%	47%		
<u>Gender of person interviewed</u>				
male	47%	40%	57%	Parent 29%
female	53%	60%	43%	71%

Sample characteristics (continued)

	<u>Adult Entrance</u>	<u>Adult Exit</u>	<u>Parent/Child Exit</u>
<u>Age of person interviewed</u>			
:			38%
			62%
			<u>Parent</u>
	18-24	14%	11%
	25-34	23%	20%
	35-44	31%	39%
	45-54	16%	19%
	55-64	10%	8%
	65+	6%	3%
			7%
			12%
			53%
			20%
			2%
			6%
<u>Education of adult</u>			
	high school	8%	10%
	some college	35%	26%
	college graduate	33%	43%
	graduate school	24%	21%
			25%
<u>Occupation of adult</u>			
	science career	20%	20%
	some science courses	39%	34%
	interest, no training	23%	35%
	not really interested	19%	11%
			20%
			28%
			41%
			11%
<u>Special experience with robots?</u>			
	yes		17%
	no		83%