

**Evaluation of the
BIOMEDICAL TECHNOLOGY PROJECT
for
The Great Lakes Science Center**

**Mini-Report :
Formative Evaluation of the Microarray Interactive**

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EXHIBIT NAME: MICROARRAY INTERACTIVE

Authors, version, date: Eric D. Gyllenhaal and Katherine Ziff, version 3, January 2007

See Appendix A for a description of the prototype exhibit and its goals, messages, and intended engagements.

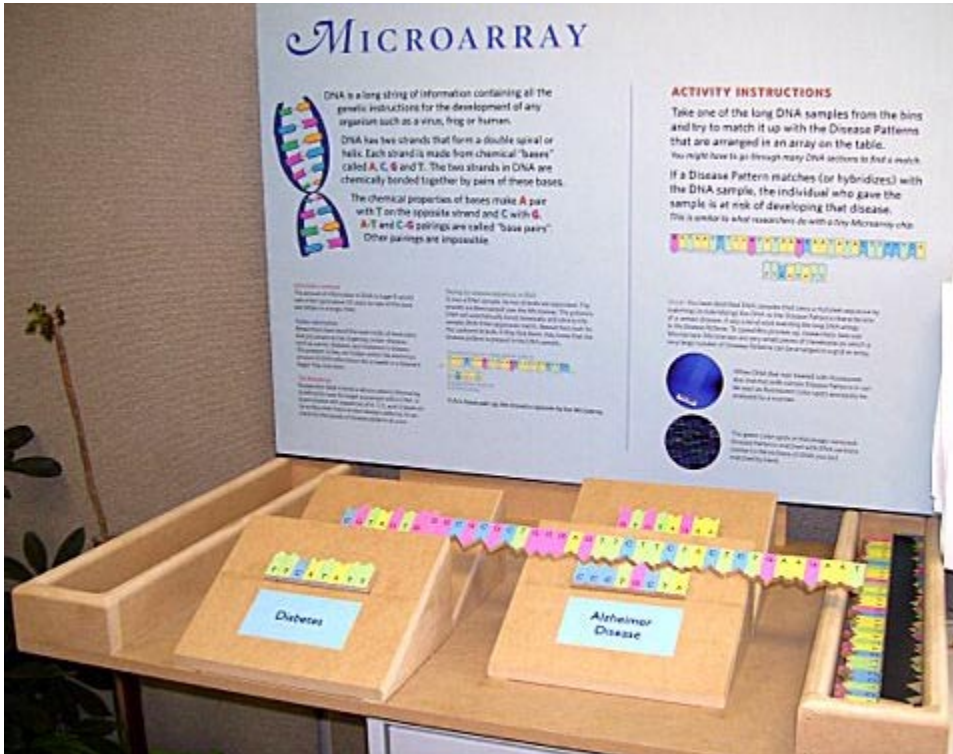


Fig. 1A. Original version of the Microarray interactive. Overview.



Fig. 1B. Original version of the Microarray interactive. Close-up of a match. Note that puzzle shape, letter combinations, and color combinations are all clues to a match.



Fig 2A. Closer-to-final version of the Microarray interactive after several rounds of revision. Note reduced text on back label panel, addition of a flap over an answer key (blue tab), labels on DNA bins, shorter Patient's DNA segments, and addition of instructions on the interactive (lower right).



Fig 2B. Additional “label panel” with example of a real Microarray and text moved from the original back panel. During testing, this was placed on a table to the right of the interactive.

SUMMARY

The authors iteratively developed a series of revisions to this interactive, which they tested with a total of 24 visitors in eleven groups. Respondents had quite a bit of difficulty with the amount of information on earlier versions of the panel, to the extent that they had trouble figuring out what they were supposed to do, and why. The revised interactive was fairly effective at achieving its overall goal, although it will require additional label panels to satisfy visitors' new-found curiosity about what microarrays are capable of doing and the personal implications of widely available DNA testing for diseases. The recommendations include retaining the many revisions developed during iterative testing, incorporating a few additional revisions, and adding additional panels to discuss and illustrate concepts related to what microarrays can do and their implications for personal health.

VISITOR ENGAGEMENTS WITH THE PROTOTYPE EXHIBIT

In what ways and to what extent did the observed engagements match (and differ from) the intended engagements?

Physical	<ul style="list-style-type: none">• All respondents read at least some of the label, but they initially had trouble finding the text and graphics that explained how to use the interactive.• Most respondents picked up pieces of DNA and tried to find matches.
Emotional	<ul style="list-style-type: none">• Respondents worked hard to find matches—they really wanted to succeed, and they often seemed disappointed that some pieces did not match.• Respondents were initially frustrated because the long pieces of DNA were difficult to match. Once the DNA pieces were shortened, most respondents found matches within a minute or two.• Because some DNA pieces did not match, some respondents felt a lack of closure—until they read the results table and learned some pieces had no matches, and that having no matches was a good thing for the patient. Some wanted to find a match for each piece of DNA before checking their answers under the flap.• Respondents who read the appropriate label seemed to enjoy pondering whether they personally would want to have their DNA tested in this way. (There was more emphasis on personal decisions than on empathy for other people facing tests.)• A few respondents said they were reminded of creepy-feeling science fiction scenarios that involved testing for DNA (e.g., the film, <i>Gattaca</i>).

<p>Social</p>	<ul style="list-style-type: none"> • Some respondents read or summarized the text for companions. • Some respondents worked together to find matches, although members of the same group often used different cues to find a match (e.g., letter, color, or puzzle shape) • Some respondents talked about personal experiences with inherited disease. • Some respondents shared their feelings about whether they would or would not have a DNA test done.
<p>Intellectual</p>	<ul style="list-style-type: none"> • Respondents recognized that the interactive had them matching DNA. • Most respondents eventually recognized when there was a match, although they often had to work for a minute or so to figure out what a match looked like. • A few respondents celebrated a match without realizing that it meant the patient had a higher risk of getting that disease. However, most respondents either read or figured out on their own that a match was a bad thing. • Most respondents recognized that doctors had ways to test for flawed DNA. Some respondents did not understand that the interactive was a model of an actual biomedical technology, called a microarray. • Many respondents understood that the flawed DNA put patients at <u>risk</u> for a disease. However, in keeping with the common public perception that “DNA is destiny,” others said that the flawed DNA meant the patient had the disease. • Most respondents thought the DNA pieces came from several patients. Although we tried to counteract this tendency through label revisions, we have not yet been successful

WHAT CHANGES WERE MADE DURING PROTOTYPING, AND WHY?

How well did they work?

	<p>The following changes accumulated during several rounds of revisions:</p> <ul style="list-style-type: none"> • Retitled the interactive the “New tool finds flawed DNA.” Respondents had never heard of a microarray, but most understood the idea that DNA could be “flawed.” • Clarified the text and used a larger font for the instructions. Also placed an additional copy of these instructions on the interactive. Respondents initially had trouble finding and
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understanding the instructions. We clarified the instructions by reducing the amount of detail. Also, because it seemed useful to many respondents, we added the puzzle analogy up front in the instructions: “Like a puzzle, C only fits with G, while A only fits with T.” [The revised wording was based on a visitor’s misreading that “C only fits with G and A”]

- **Created a new, colored graphic that showed what a match looked like.** This showed what visitors needed to know to recognize when they had a match. We placed this matching graphic and the interactive instructions adjacent to each other.
- **Removed all of the text and the illustration explaining how DNA works.** Given its size and original placement, this text made the exhibit seem to be about DNA, rather than microarrays. Also, visitors didn’t need to understand details about how DNA works to be successful with the interactive or understand the purpose of a microarray.
- **Reduced the explanation about how microarrays work,** moving some of it to a separate label panel (Fig. 2B, see below).
- **Reduced the remaining text to just the most critical points.** We removed the second subtitle, so as to combine the first two paragraphs into one, and then vastly simplified that text. Also removed two blocks of text, the sections “Information Overload” and “Imagine trying to match ...” text, which we decided should become part of the label for a display of real microarrays.
- **Reduced the length of individual DNA samples and the number of samples.** This reduction helped most respondents achieve their initial success within a minute or two and feel that the overall task was not too overwhelming.
- **Labeled the DNA bins and the patient DNA (on the back).** Respondents initially had a hard time recognizing the patient’s DNA.
- **Added “DNA pattern” under the disease names.** That’s so visitors would have some idea what they are matching even if they don’t read much of the main label
- **Added a key that incorporated the idea that “A Match is Bad News.”** This seemed to satisfy visitors’ need for confirmation (i.e., make them feel safe) and reinforce the purpose of the interactive. After some experimentation, we reorganized the results into a table to use fewer words. We developed a sample vs. disease grid,

identifying matches with the word “match.” We also covered the results table with a flap, which (paradoxically) called visitors’ attention to it. (Respondents knew it was there, but avoided lifting the flap until they were satisfied with their results.)

- **We experimented with several versions of “hints.”** In the end, the most useful hint was, “Hint: some DNA does not match,” placed on the flap over the results table.
- **We included a bench** that adults could sit on (and younger children could stand on). That’s because many respondents spend four or five minutes making certain they had found all possible matches. Before we added the bench, several visitors knelt in front of the prototype as they worked.
- **We developed an additional label panel (Fig. 2B) that both showed a real microarray and brought back the “Would you want to be tested?” paragraph** (which we had removed from the original label panel). When this text was originally placed on the large backboard panel, the sheer amount of text interfered with visitors’ ability to find the key information that they needed to complete the activity. Once the exhibit had been revised, visitors were much more interested in learning about Microarrays and thinking about the issues they raised.

COMMUNICATING EXHIBIT MESSAGES

In what ways, and to what extent, did the prototype exhibit communicate (or fail to communicate) its intended messages? What features of the prototype best communicated its messages? What features inhibited its success?

<p>Message 1: People with flawed sequences of DNA are at higher risk for certain diseases.</p>	<ul style="list-style-type: none"> • Many respondents understood that the flawed DNA put patients at risk for a disease.
<p>Message 2: Microarrays are an important new tool that allows doctors to test patients’ DNA for many inherited diseases at once.</p>	<ul style="list-style-type: none"> • Most respondents understood that there are tools that allow doctors to test for flawed DNA. Many respondents also understood that this tool was called a “microarray,” although they did not understand <u>how</u> it works (unless they read the additional panel that we added late in testing).
<p>Message 3: <i>The microarray works because split DNA only fuses together with an exact match.</i></p>	<ul style="list-style-type: none"> • <i>We dropped the text and graphic that communicated this message.</i>

Message 4: If doctors know that patients have flawed DNA sequences, then they can take action to help them, depending on the disease.

- Some respondents read and thought enough to realize that this was the case.
- This was best understood by those respondents who read and discussed the “Would you want to be tested?” paragraph (which was eventually placed on the additional, separate label panel).

ACHIEVING EXHIBIT GOAL

In what ways, and to what extent, did the prototype exhibit achieve (or fail to achieve) its goals? What features of the prototype provided support for the goals? What features inhibited its success?

Goal 1: Visitors will understand how the microarray, a new biomedical technology, allows doctors to test whether their patients have flawed DNA sequences that put them at risk for certain diseases.

- The revised interactive came very close to achieving this goal. Most respondents understood that there are tools that allow doctors to test for flawed DNA, and many also understood that this tool was called a “microarray.” Also, many respondents understood that the flawed DNA put patients at risk for a disease (rather than guaranteeing that they would get it).

RECOMMENDATIONS FOR THE FINAL EXHIBIT

- **Continue to develop this interactive for use in the exhibition.** It provides a much-needed level of hands-on physical engagement that will be lacking in most other exhibits.
- **Retain all the changes outlined in the [What Changes Were made During Prototyping, and Why?](#) section of this report.**
- **In addition, incorporate the following changes:**
 - **Move the “A Match is Bad News” paragraph out from under the flap.** Since they did not lift the flap until they were done, some respondents spent their whole time thinking that a match was a good thing (e.g., a cure for a disease). Also, consider ways to alter other text to emphasize the “match is bad”

concept.

- **Illustrate what a match looks like with real puzzle pieces attached to the vertical backboard.** That's because some respondents had trouble finding and interpreting the graphic.
- **Use only one bin for patient DNA.** That's to reinforce that it only comes from one patient.
- **Use the term "microarray" under the flap, too.** Maybe: "Doctors can use real microarrays to find flaws in patients DNA..."
- **Make the area of the interactive larger, so several visitors can work simultaneously.**
- **Help visitors feel like it is okay to stop even though they have not matched all of the pieces of DNA**
- **Find a way to call more attention to the real microarray.** Some visitors did not recognize that it was part of the prototype

OTHER LESSONS LEARNED

- **When an exhibit panel tries to communicate too many complex messages, it decreases the exhibit's ability to communicate any message effectively.** We needed to drop several messages to make an effective interactive. Once the interactive was effective, respondents became interested in learning more about the messages we dropped (so we added them to a separate panel).
- **Persistence pays off.** Although this is a conceptually difficult interactive, with enough work it became a positive experience that raised visitors' interest in microarrays and related issues.

APPENDIX A: STATEMENT OF EXHIBIT GOALS, MESSAGES, AND INTENDED ENGAGEMENTS

Great Lakes Science Center *Biomedical Technology Project* Formative Evaluation

Exhibit Unit Intentions for Microarray Interactive

November 4, 2006
Version 03

Name of prototype exhibit: Microarray interactive

Brief description of prototype exhibit: This prototype was developed a part of a larger exhibit about genomics. A graphic panel providing background on microarrays was posted above a tabletop with a touchable model of a microarray for four diseases and test sequences of patient DNA. The labels explained why doctors need to test patient's DNA for flawed sequences and how a microarray allows them to do that quickly. Activity instructions told visitors to look for "matches" between patient DNA and flawed sequences associated with four diseases, explained what a match is (and is not), and explained that a match means bad news for the patient, but alerts their doctor to the need to take appropriate steps to help them.

Goals *are those things you want this exhibit unit to achieve. Goals always start with "Visitors will...." Goals tend to be pretty big statements about developing appreciation for or greater understanding of something.*

- Visitors will understand how the microarray, a new biomedical technology, allows doctors to test whether their patients have flawed DNA sequences that put them at risk for certain diseases.

Messages *are the content of the exhibit. They are comprised of Big Ideas and educational messages. The Big Idea for this exhibition is, "Rapidly advancing biomedical technologies give doctors new tools to improve personal and public health." The educational messages are a description of the main ideas you want visitors to walk away from the exhibit with.*

- People with flawed sequences of DNA are at higher risk for certain diseases.
- Microarrays are an important new tool that allow doctors to test patients' DNA for many inherited diseases at once.
- The microarray works because split DNA only fuses together with an exact match.
- If doctors know that patients have flawed DNA sequences, then they can take action to help them, depending on the disease.

Physical engagements are all the physical things visitors do at an exhibit, for example, sitting, standing, looking, reading, pointing, touching, and manipulating dials. It also includes how long visitors are expected to spend with the exhibit.

- Read the label
- Manipulate the model sequences of patient DNA to find a match.

Intellectual engagements are all the ways in which visitors engage cognitively with an exhibit, including thinking about, processing, and making meaning of their experiences.

- Visitors understand that the physical interactive represents DNA and a microarray.
- Visitors recognize when there is a match, and when there is not.
- Visitors realize that finding a match means that the patient has a higher risk of getting that disease.
- Visitors ponder whether they personally would want to have their DNA tested in this way.

Social engagements are all the ways in which visitors engage with each other within the context of the exhibit, including verbal exchanges as well as body language. This could include directing attention, asking a question, coming up with an explanation together, reading a label out loud.

- Visitors read (or summarize) the text for companions who cannot read it independently.
- Visitors work together to find matches.
- Visitors talk about personal experiences with inherited disease.
- Visitors discuss advantages and disadvantages of having this kind of test done, and under what circumstances it might be appropriate.

Emotional engagements are all the ways that visitors engage emotionally with the exhibit; examples include surprise, delight, awe, satisfaction, feelings of competence, intimidation, and frustration.

- Visitors want to find matches.
- Visitors feel challenged as they try to find matches, but the task is not so difficult that they feel frustrated or resentful.
- Visitors do not celebrate a match without realizing that it means that the patient has a higher risk of getting that disease.
- Visitors empathize with people who face the decision of whether or not to have a test.

RESPONDENT DATA SHEET
BMT2 Formative for Microarray Interactive

Date	#	Exhibit unit	DC	Group Composition					Ethnicity				Racial Categories								Other notes	Time (min)
				Total	AF	AM	CF ages	CM ages	H/L-F	H/L-M	N-F	N-M	A-F	A-M	B-F	B-M	W-F	W-M	AI-F	AI-M		
1104	1	Microarray	KZ	1	1						1					1					Staff	~ 5
1104	2	Microarray	EG	1		1						1					1				PO	~ 8
1104	3	Microarray	KZ	2	1	1					1	1				1	1					~ 5
1104	4	Microarray	KZ	2	1	1					1	1	1				1					
1104	5	Microarray	KZ	2	1	1					1	1				1					PO	~5
1104	6	Microarray	EG	1	1						1					1						~2
1104	7	Microarray	KZ	3	1	1	14				2	1				2	1					~4
1105	1	Microarray	KZ	4	2	2					2	2				2	2					~4
1105	2	Microarray	KZ	4	2	1	4				3	1				3	1					~8
1105	6	Microarray	KZ	2	1	1					1	1			1	1						~5
1105	7	Microarray	KZ	2	1	1					1	1				1	1					~3.5

KEY:

Date = MM/DD

= Interview number

Exhibit unit = Prototype tested

DC = Date collector Initials

Group Composition:

Total = Total number in group

AF = Number of adult females in group

AM = Number of adult males in group

CF = AGES of female children in group

CM = AGES of male children in group

Ethnic Category:

H/L-F = Hispanic or Latino female

H/L-M = Hispanic or Latino male

N-F = Not Hispanic or Latino female

N-M = Not Hispanic or Latino male

Racial Categories:

A-F = Asian female

A-M = Asian male

B-F = Black or African American female

B-M = Black or African American male

W-F = White female

W-M = White male

AI-F = American Indian or Alaskan Native female

AI-M = American Indian or Alaskan Native male

Other notes = Note if respondents are in a wheelchair, show other evidence of having a disability; also note other relevant observations about the group.

Time = Approx. time at the prototype (prior to the interview), in minutes