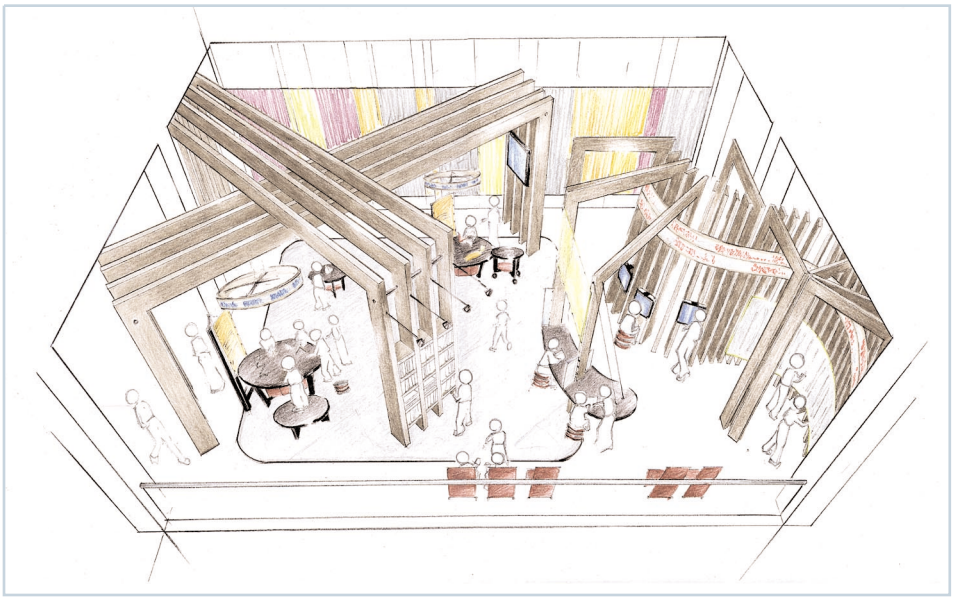
# Breakthroughs

## the leading edge of science & technology



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liberty science center

*Liberty Science Center is an innovative learning resource for lifelong exploration of nature, humanity and technology, supporting the growth of our diverse region and promoting informed stewardship of the world.*

- Liberty Science Center Mission Statement

*"...the consequences of scientific illiteracy are far more dangerous in our time than in any that has come before. It's perilous and foolhardy for the average citizen to remain ignorant about global warming, say, or ozone depletion, air pollution, toxic and radioactive wastes, acid rain, topsoil erosion, tropical deforestation, exponential population growth. Jobs and wages depend on science and technology. If our nation can't manufacture, at high quality and low price, products people want to buy, then industries will continue to drift away and transfer a little more prosperity to other parts of the world. Consider the social ramifications of fission and fusion power, supercomputers, data "highways," abortion, radon, massive reductions in strategic weapons, addiction, government eavesdropping on the lives of its citizens, high-resolution TV, airline and airport safety, fetal tissue transplants, health costs, food additives, drugs to ameliorate mania or depression or schizophrenia, animal rights, superconductivity, morning-after pills, alleged hereditary antisocial predispositions, space stations, going to Mars, finding cures for AIDS and cancer.*

*How can we affect national policy - or even make intelligent decisions in our own lives - if we don't grasp the underlying issues?"*

- Carl Sagan, *The Demon-Haunted World*, 1996

**Rationale**

The Breakthroughs project is being developed and designed to be an interactive, multimedia space in which we will present exhibits and programs that address the current topics, issues and events that result from or pivot on current science and technology.

A defining feature of human history is our ability to share experiences in order to reshape how we interact with the world around us. Much of what is called research and development in modern science and engineering is a complex process of shared experiment, publication and verification.

In contemporary society, the technical community is more specialized than ever before and, partly because of that specialization, more isolated from large segments of society than even one or two generations ago.

At the same time, the need for society-at-large to be aware of and understand the work and results of technical specialists grows almost as quickly as that research is applied to the daily lives of "the rest of us."

The impact of science and technology on the rest of society can be as subtle as a sequence of binary digits or as obvious as a viral epidemic. Not only do we need to understand our world; we need to train the next generation to recognize this.

Three of the most significant areas where science, technology and society interconnect are the three themes that Liberty Science Center has as its focus: Invention, Human Health and the Environment.

Accounts of the research being conducted in these areas fill scores of peer-reviewed journals every week. Public and private research departments and the laboratories working in these fields around the world number in the hundreds. And the resources devoted to this work equate to millions of person-hours annually.

Against this backdrop, there is pressing importance for our audiences - students, adults and family groups - to be aware of and understand the principles and opportunities of these scientific and technological breakthroughs.

Our responsibilities have been summarized in our Mission Statement:

> *Liberty Science Center is an innovative learning resource for lifelong exploration of nature, humanity and technology, supporting the growth of our diverse region and promoting informed stewardship of the world.*

As a major forum for information about breakthroughs in science and engineering, *Breakthroughs* will foster public understanding, dialogue and debate about the social and ethical issues posed by new discoveries.

Just as importantly, the *Breakthroughs* gallery will alert and inspire our audience, especially our student audience, to new and exciting fields of inquiry, discovery and innovation. Acting as an information conduit for research and development in the region, we can help our guests contribute to the success of the area through informed involvement, as well as through career and educational choices.

Liberty Science Center is uniquely positioned to fulfill this vision.

Our neighbors include leading universities, such as Princeton, Columbia and New York University, New Jersey Institute of Technology, Stevens Institute of Technology and Rutgers, all of whose faculty and staff includes leaders in scientific research.

With more high-tech firms than Silicon Valley and a significant number of technology incubators, the business sector of our metropolitan area is home to corporate leaders in innovation as well.

Finally, the New York metro area is the *locus standi* of print, broadcast and other electronic media in this country, with impact internationally.

The *Breakthroughs* gallery and public programming will be key components of the Center's expansion and renewal, dedicated to monitoring and presenting the scientific and technological pulse of our region and the world.

**Audience**

*Breakthroughs* experiences and interpretation will be developed to include real objects, self-guided experiments, well-organized and visually stimulating graphics, a dynamic space design and staff-assisted or mediated activities and programs. Stand-alone Interpretive information and experiences will be presented through a cascade of layers, organized to provide a sufficiently complete explanation of the major themes of the exhibition in an experientially rich gallery space.

The project team envisions that *Breakthroughs* communicates with four specific teaching/learning audience segments, recognizing differences in experiences, cognitive abilities and learning styles. These groups are key segments of the Center's primary and secondary audiences; children aged 5 through 8, students aged 9 through 13, adolescents aged 14 through 16, and parents, teachers or other adults.

Our layered approach is patterned after the cognitive cycle of experience summarized as rational thinking about the concept or process that in turn influences further experience leading to more advanced thinking. This approach will be applied to all aspects of the exhibition project.

In order to increase accessibility to our diverse region, all interpretive text will be presented in English and Spanish languages.

The gallery space and the modular experiences will be fully accessible to audiences with special perceptual (e.g. hearing and sight) or mobility requirements or limitations. All designs will be reviewed for conformance to American National Standards Institute (ANSI) ergonomics specification 117.1 and the Americans with Disabilities Act requirements defined as Title 1 and Title 3.

**Front-end Evaluation**

As a front-end evaluation for this project, Randi Korn & Associates (RK&A) was commissioned to conduct a survey of audience attitudes and understandings of current science and scientific research. Two data collection strategies were employed: face-to-face questionnaire interviews and open-ended, in-depth interviews.

Project staff and RK&A developed a four-page standardized questionnaire with a variety of question formats. Specially-trained interviewers conducted face-to-face interviews with visitors using the questionnaire. Using a systematic sampling method, survey administrators intercepted visitors 14 years old or older and asked them to participate. Those who agreed were interviewed.

A total of 411 visitors were interviewed at the Liberty Science Center and the Franklin Institute in Philadelphia, PA. Interviewers spoke to visitors at two different locations to gather data from science museum visitors in a larger geographical region. Data were collected in July 2002.

The questionnaire interviews revealed important information about audience attitudes and understandings about the social function of science and scientific research.

A large majority of respondents agreed with the statement "I usually wonder how (science) findings apply to me."

Seventy-five percent of respondents agreed or strongly agreed with the statement "most scientists do their research to increase their own understanding of the world."

Sixty-five percent agreed or strongly agreed with the statement that "most scientific research is more beneficial than harmful," and eighty-five percent disagreed or strongly disagreed that "most scientific research being done today is not important."

At the same time, sixty percent agreed or strongly agreed that "research reflects the bias of the scientist," and fifty percent agreed or strongly agreed that "most research findings are manipulated to support a particular viewpoint."

When asked what a science center can provide that other information sources cannot, respondents' most frequent response was hands-on or interactive experiences.

The Executive Summary of the RK&A report is included as Appendix A of this document.

**Prototype Work**

As a key component of the development process for this project, the project team is creating and testing proto-typical self-guided exhibit elements and mediated activities that might be used for regular programming of the *Breakthroughs* gallery. We are also experimenting with types of display furniture and interior architectural elements that may be used as part of the larger gallery space.

During the Autumn of 2002, the project team simulated a typical short-term presentation about global warming and the collapse of the Larson B ice shelf in Antarctica.

This prototype was planned and created within a two-week window, as a test of process, and included a series of interpretive graphics, a display of everyday items/activities that contribute to greenhouse gas emissions, a model that demonstrated the greenhouse effect, a video interview with a climatologist, and demonstrations about alternative energy. These displays and programs were presented on the Environment floor beginning in October 2002.

The prototyping process is enabling the project team to study exhibit and program effectiveness with audience, exhibit and program development as joint staff process, communication design methods and interior or space design problems that may be recurring.

Exhibit staff conducted a standard timing and tracking study of visitor behavior with the global warming prototype. For this study, 169 visitors were observed at the prototype exhibit. Approximately half of these were pre-teen children, approximately 13% were teenage youth, approximately 36% were adults.

Considering the self-guided display elements, the greenhouse model, the display of everyday items and the video interview were used by more visitors than the interpretive graphics. The video interview, the display objects, and one of the graphic panels ("Is this a long-term problem?") elicited the longest attention times from those visitors who used the space.

A summary of this study is included as Appendix B of this document.

Going forward, the project team is designing a dedicated prototyping space for *Breakthroughs* to be sited on the lower level, below and north of the Hoberman Sphere. We will use this area to conduct further formative and summative visitor studies.

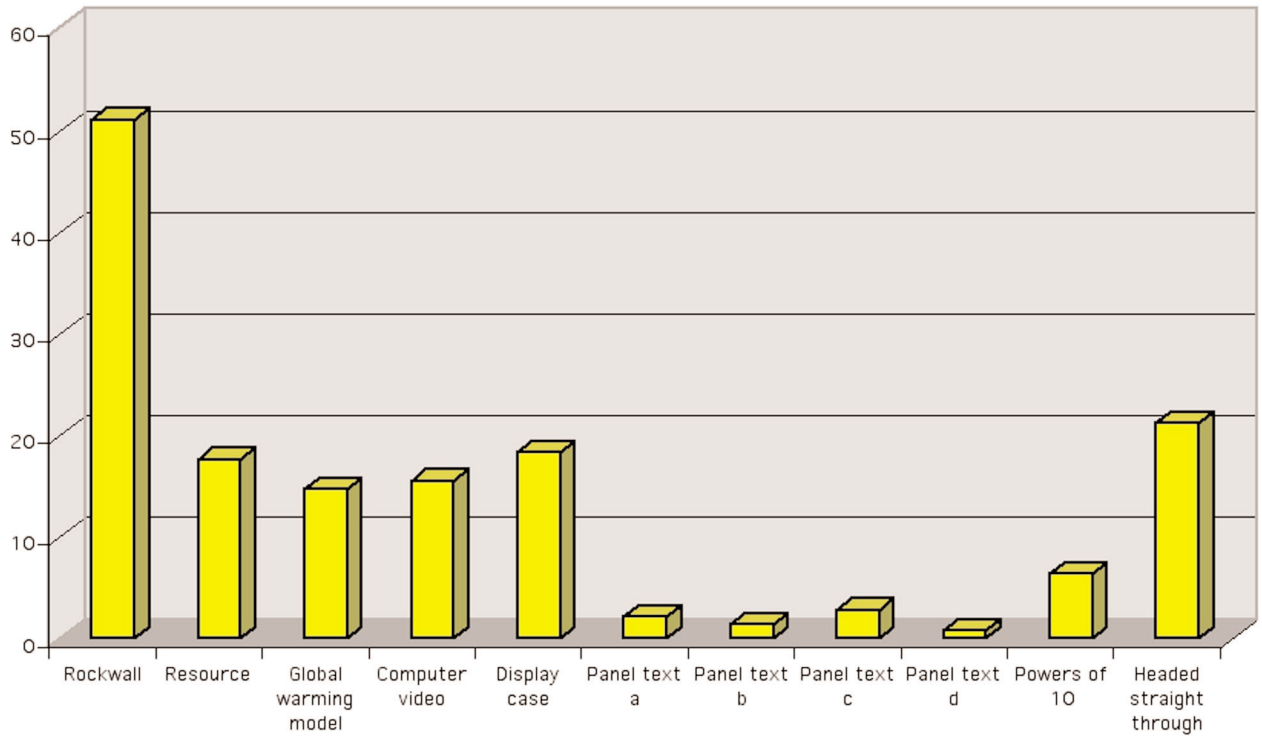



*Exhibit use by percentage of guests tracked in climate change prototype study.*


*Demonstration about alternative energy in Breakthroughs prototype on climate change.*

## Excerpt of Prototype Interpretive Copy

### Our Life in a Hot House

Scientists from 100 countries are collecting data that shows that global climate has warmed over the last century. And they think it's because of the way we live.

The earth's surface temperature has risen by about 1° F since the 1890s, largely because of growing emissions of greenhouse gases. This increase has already affected glaciers, ice caps, and sea level. Countries across the globe have contended with unexpected floods and drought.

Even the poles are vulnerable. In the single most dramatic event in thirty years, an area of the Larsen B ice shelf in Antarctica, that dwarfs Rhode Island in size, shattered and separated from the continent. In the Arctic, the ice cap is shrinking, threatening the ecology of the region.

### What is the greenhouse effect?

The greenhouse effect is actually a natural feature of Earth's atmosphere that makes the planet habitable.

Many atmospheric gases function like the glass in a greenhouse that lets in light but traps heat.

Energy from the sun passes through the atmosphere as short wave solar radiation. This solar energy warms the earth's surface, which in turn radiates energy back out to space.

The out-going radiation has a longer wavelength. Atmospheric greenhouse gases absorb some of this long wave radiation. The trapped radiation warms the lower part of the Earth's atmosphere and radiates energy back to the earth's surface.

Without these gases at all, heat would escape back into space and the Earth's average temperature would be about 60° F colder.

The problem is that if you add more greenhouse gases into the system, the earth warms up more and more.

### What are greenhouse gases?

Some greenhouse gases occur naturally in the atmosphere, including water vapor, carbon dioxide, methane, nitrous oxide, and ozone.

Cars, power plants, buildings and agriculture add to the levels of these naturally occurring gases, altering the chemical composition of the atmosphere.

Each greenhouse gas differs in how it absorbs heat in the atmosphere. While carbon dioxide is the most problematic because there is a larger quantity of it, each molecule of methane traps 21 times more heat than carbon dioxide and nitrous oxide is 270 times more heat absorbent.

Decomposition of waste in landfills, cattle raising and more intensive rice growing are thought to be responsible for the dramatic 145% increase in atmospheric methane over the past 100 years.

Hydrofluorocarbons are man-made industrial products that do not occur naturally. They are mainly used as coolants in refrigerators and air conditioners. And they are the most powerful heat absorbers.

### Is this a long-term problem?

Even if greenhouse emissions were to stop immediately, the effects of past emissions would persist for centuries because greenhouse gases stay in the atmosphere for a long time.

Climate researchers don't look into crystal balls to predict what is going to happen. They use math and computer models to calculate the effects of adding greenhouse gases to the atmosphere.

Most model simulations that take into account greenhouse gas emissions and sulphate aerosols (which have a cooling effect) match real observations of the global climate taken over the last 50 years.

The forecast is that temperatures are set to rise another 2-6° F by the year 2100.

### What can I do?

Choices we make do count. How we use natural resources - for food, manufacturing, and energy production - affects a range of greenhouse gas emissions. Lower emissions mean lower global temperature rises.

You can do your bit by using more public transport or by car-pooling.

Use less electricity. Don't simply rely on the standby button on your electrical equipment, turn it off when you are done.

Recycle cans, bottles, plastic bags and newspapers. By sending less trash to the landfill you help save natural resources.

Write and encourage governments and corporations to pursue environmentally sustainable policies.

And finally...

As a society, we can opt to use clean energy sources. At Liberty Science Center we have a wind turbine that uses wind power and solar-electric cells that use sunlight to create some of our electricity.

Visit the E-Quest gallery for more information on alternate sources of energy

**Prototype Elements**

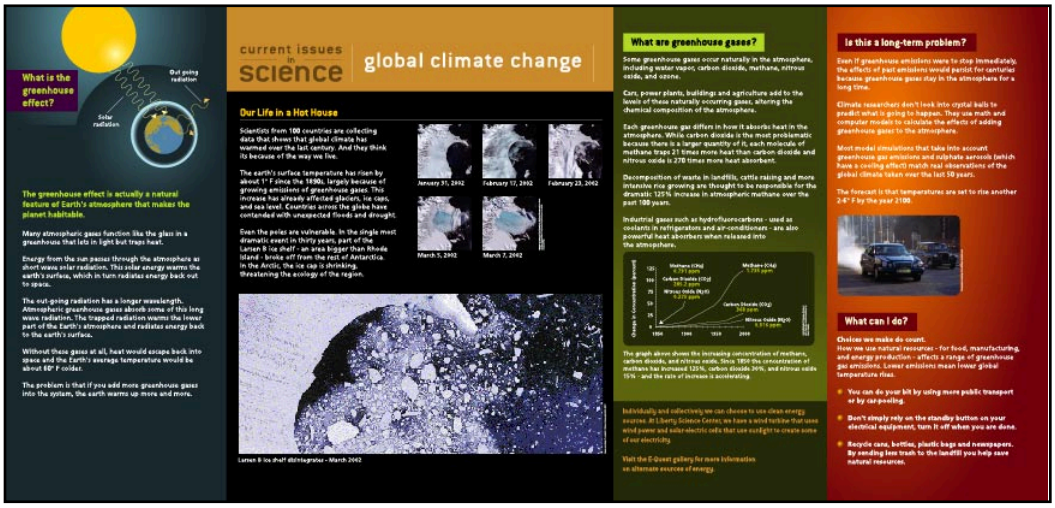
current issues in science

*Typography treatment*

*Screenshot of computer interactive*

*Everyday objects*

*Greenhouse effect model*




*Global climate change interpretive panel (3.5' x 7.8')*

**Gallery Concept**

The *Breakthroughs* Gallery will occupy approximately 4,000 square feet on the third and fourth floors of the science center in the area between the tower and the atrium. The gallery will also engage the atrium space with suspended video screens for electronic media presentations.

The third floor space will be used to present daily news items and announcements, bi-weekly exhibits and mediated programs, a print/electronic information resource area (for self-guided study), and present a large graphical wall presentation about the experimental method.

Daily information will be conveyed using overhead LED displays at the west entrance to the gallery, a bulletin board display of newspaper and magazine clippings or other graphic displays, and via Internet-enabled computer displays. Some or all of this info will be recorded to a database to be accessed through http://www.lsc.org.

Bi-weekly exhibits and programming will focus on key events or topics and will combine displays of artifacts and models, interpretive graphics and images, descriptive copy, web components, and a convertible staging area for scripted demonstrations.

The reading resource area will include reading tables, Internet enabled computer terminals, book and magazine shelves, and comfortable seating apart from the chairs at reading or computer tables.

The south wall of this space will feature a large montage or mural that depicts the experimental method, verification process and other activities that are exemplary of scientific discovery. As part of this display, menu selected electronic media displays will feature interviews with specific scientists and engineers, recounting specific insights or processes that led to the insight, as well as profiles of specific career paths in the sciences.

The fourth floor space will be used to present longer-term exhibits and programs about topics on a three month schedule. These quarterly presentations will include artifacts, models, interpretive graphics, interactive multimedia presentations, web components, scripted demonstrations, pre- and post-visit information for school groups and electronic field trip programs.

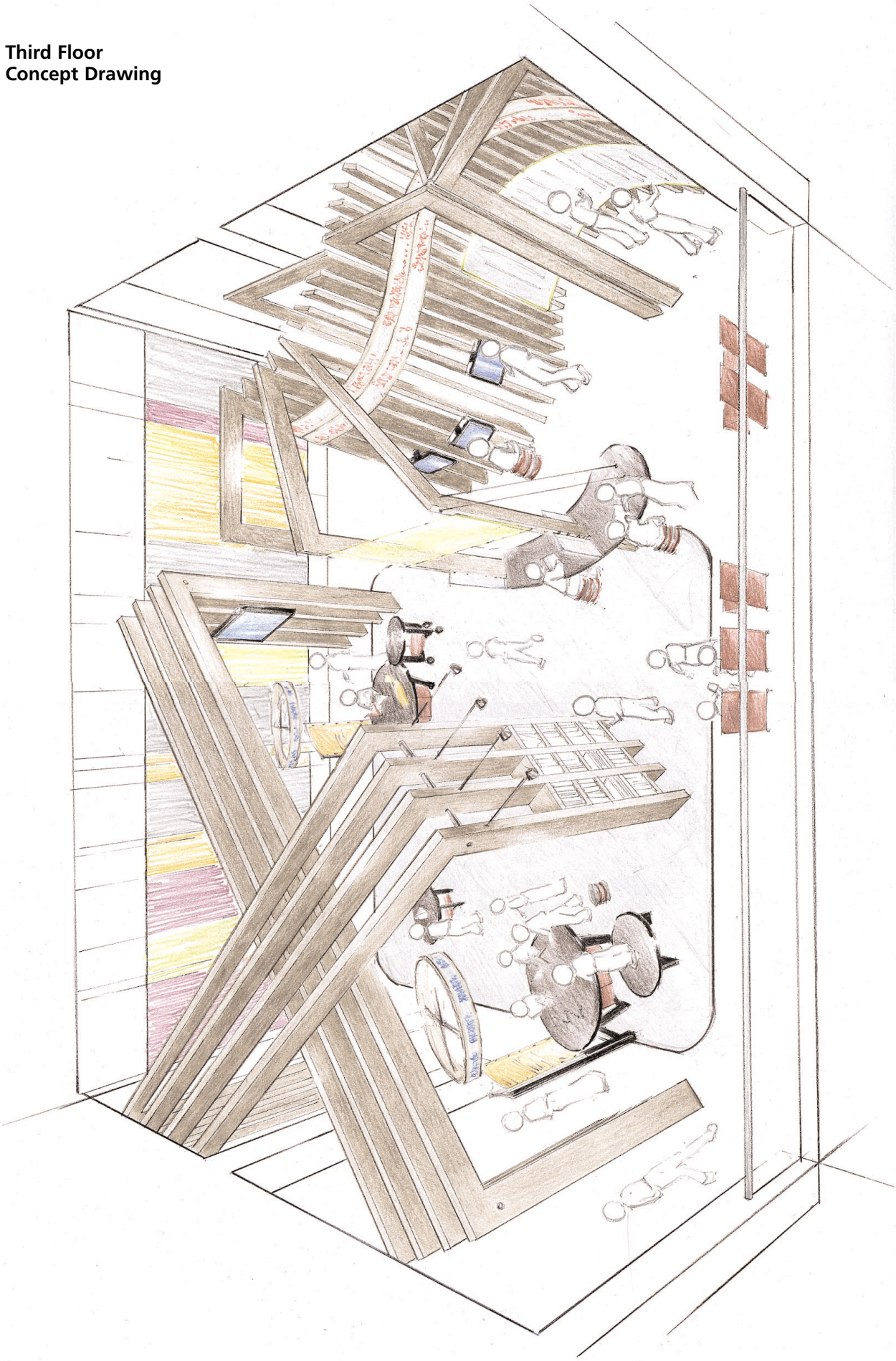
Modular furnishing will be used throughout. Several large diameter tables will be used to display objects, provide demonstration space, locate individual or small-group self-guided experiments, and for multimedia presentations specific to the topic. Smaller diameter tables will be used to display manipulative models and artifacts. Three-sided graphic display kiosks will present interpretive graphics, adjacent to 3-D elements or as stand-alone presentations.

Overhead banners and LED displays situated above furniture clusters will identify – literally and through physical association – the specific bi-weekly or quarterly topic being presented.

A series of linear elements are overhead beams above parts of both galleries will reinforce the sense of space for exhibits and programs. The beams provide a superstructure for supporting lighting and hanging graphics or other visual elements as well as sound reinforcement and acoustic control. On the fourth floor, these beams are important to create a more human-scaled perception of ceiling height.

In the adjacent existing atrium, the currently planned staircase between the two floors would be sited east-to-west and feature a series of translucent panels that step up the atrium-side face of the staircase. These panels will serve as projection surfaces for lighting or video images that provide a sense of context and visual interest.

**Third Floor**
**Concept Drawing**



## Concept Model

*View into third floor space, looking south.*

*View across existing atrium of both gallery spaces, showing proposed staircase, looking south.*

## Concept Model

*View down onto fourth floor gallery space.*

*View of fourth floor gallery space, looking north.*

**Operational Process**

The key to presenting information about new and significant developments in science and technology is timely content development. In order to meet that commitment a team of researchers, writers and producers will be assembled to evaluate possible stories, conceptualize presentations about those topics and write/design/produce self-guided or mediated visitor experiences based on that new information.

This team will include content developers who are familiar with the the Center themes of Health, the Environment and Invention, and with the literature produced in those fields of research and application. Working under the auspices of Theme Directors and in collaboration with Student Experience staff and outside experts, staff content developers will identify topics for presentation, research the stories for those presentations, determine the media best suited to the story and produce a completed experience that may include object displays, video or software components, hands-on demonstrations and teaching guides.

The project team will also include other visualization and design experts who will use this content research as starting points for creating self-guided and informal learning experiences. These experiences will include video and audio narratives about the topic; 3-D and 2-D interpretive displays using object examples; interactive models and hands-on demonstrations; docent- or educator-mediated experiences and training materials and learning guides for use online or in the classroom.

During a normal year of operation, the *Breakthroughs* team will produce a mix of short subject and feature presentations. We have modeled two operational scenarios, one implmenting bi-weekly and quarterly presentations and the second implementing monthly and trimesterly presentations.

Daily bulletins presented on video or computer displays will be used to communicate breaking news or special events in science and technology, relying on real-time video feeds from NASA or other research and news organizations.

Bi-weekly (or monthly) productions will follow a “news wire” format, consisting of some combination of live demos by floor staff, small-scale object displays, and/or electronic media - video, audio or software - on site and via the Center web server.

A computer database system will manage the *Breakthroughs* text and image archives. Content developers will interface with the database to publish content directly to computer stations in the galleries and the website. Users will be able to search the database onsite and online for further exploration of current science and technology topics.

Periodically (quarterly or timesterly) through the year, larger, topic-in-depth presentations will utilize a broader spectrum of tools for learning in an informal setting. In addition to “news wire” information about a topic, more complete stories about the efforts leading to the new development and possible applications of the new development will be examined. The learning experience in the science center will include electronic media, object displays, mechanically interactive displays, formal demonstrations, teacher training guides, distance-learning activities and other components that require more lead-time than would be available for a weekly presentation.

A method for soliciting feedback from visitors, on-line readers, and other sections of the science center public will be developed to monitor opinions and to correlate *Breakthroughs* subject matter to existing viewpoints on science and technology.

The expected schedule to be followed by project staff is as follows.

*Daily presentations*

One hour each morning to scan a selected number of newspapers and cut them out - mount into scrap book or whatever the medium of display is. Load LED display with information

*Bi-weekly or Monthly presentations*

Each of these presentations on the third floor would have an on-the-floor life-span of four weeks. Each presentation would have a two-week development and production schedule. This would allow for development work on quarterly/trimesterly presentations to alternate with work on bi-weekly/monthly exhibits.

In order to meet this rapid schedule, the team will cultivate a number of sources of current science information to draw upon.

a. press releases from colleges, institutions.
b. early information from technical journals
c. direct contact with researchers in the field.
d. calendar of scientific events that should be programed in the gallery or that impact programming in the gallery, such as World AIDS Day or the 50th anniversary of Watson and Crick's announcement of the structure DNA.

Topic selection will require a two week lead time. The team will hold an editorial meeting each Friday to select topics and distribute tasks. The working schedule begins the following Monday.

| | |
|---|---|
| Day 1 | Story line, image, and activity research takes place. |
| Day 2 | Morning, continue to research. Afternoon, copy writing begins, activity and image research continues |
| Day 3 | Copy writing continues, image and activity research continues. Afternoon copy submitted for editing. |
| Day 4 | Final edit for copy, final image selection, activity copy to be written. Afternoon, copy sign off. |
| Day 5 | Graphic layout. If there are objects, developer to work with technicians and 3D designer to create cases and floor plan layout. |
| Day 6 | Graphic layout, content researcher perhaps is working on acquiring objects or conducting interviews or other computer software related activities. |
| Day 7 | Graphic sign off, production of activities, any further work to be completed in-house by content developer. Graphics sent to printer. |
| Day 8 | Production day, and in house production - graphic designer may be creating case labels, activity labels or other daily presentation business |
| Day 9 | Production and final refinements. |
| Day 10 | Morning breakdown of old and installation on new exhibit. |

*Quarterly or Trimesterly Presentations*

Development and design of quarterly/trimesterly exhibits and programs will be scheduled to alternate with the more frequent schedule outlined above. The project team also envisions that many bi-weekly/monthly presentations may be expanded into longer-lived displays. The tasks required to produce these exhibits are otherwise the same as those to develop a bi-weekly/monthly presentation.

**Staff Requirements**

In order to meet the objective of regular and frequent presentations, the *Breakthroughs* project will require specific skilled staff who are focused on this work.

**Scenario A**
**Bi-weekly & Quarterly**

• Content Developer (3 FTE) - Analogous to the role of any other exhibit developer, the content developer's work will be an amalgam of feature news writer, copy editor and documentary video producer. The developer will be very familiar with activities in the fields to be covered and will follow the peer-reviewed literature in those fields.

• Electronic Media Producer (.5 FTE) - This producer will supervise video or sound production used for *Breakthroughs* presentations. This may involve creating new video or audio segments, researching and collecting stock media assets and all post-production work required for a project. This person will be expert in film/video production and with non-linear video editing tools and techniques.

• Exhibit Designer (1 FTE) - Like other designers, this role will focus on the visualization and actualization of 3-D interpreted, self-guided experiences. The designer will develop presentations of specimens and objects, models, interactive components and the overall physical presence of a specific presentation. The designer will also supervise all work related to executing this design.

• Graphic Designer (1 FTE) - The 2-D interpretive materials created as part of or in conjunction with a *Breakthroughs* topic will include interpretive graphics in the display gallery, interface elements and typography for electronic media, print materials for education guides and other graphic design items such as posters and banners.

• Demonstrations Coordinator (1 FTE) - This role will focus on developing and coordinating in-house demonstrations incorporating the subjects presented in the 2-D and 3-D displays, and will coordinate in-house or electronic live presentations by outside scientists or other experts relating to specific Breakthrough topics.

• Part-time Demonstrators (3 FTE) - These staff will conduct the mediated demonstrations created as part of bi-weekly and quarterly presentations.

• Interpretive Associates (3 FTE) - These staff will conduct small-group mediated activities and assist visitors using the galleries.

• School Programs Coordinator (.5 FTE) - This position will develop teacher-training materials and programming to support pre- and post-visit connections to school curricula and standards, and advocate for in-school connections as parts of *Breakthroughs* programming.

**Scenario B**
**Monthly & Trimesterly**

• Content Developer (2 FTE) - Analogous to the role of any other exhibit developer, the content developer's work will be an amalgam of feature news writer, copy editor and documentary video producer. The developer will be very familiar with activities in the fields to be covered and will follow the peer-reviewed literature in those fields.

• Electronic Media Producer (.5 FTE) - This producer will supervise video or sound production used for *Breakthroughs* presentations. This may involve creating new video or audio segments, researching and collecting stock media assets and all post-production work required for a project. This person will be expert in film/video production and with non-linear video editing tools and techniques.

• Exhibit Designer (.5 FTE) - Like other designers, this role will focus on the visualization and actualization of 3-D interpreted, self-guided experiences. The designer will develop presentations of specimens and objects, models, interactive components and the overall physical presence of a specific presentation. The designer will also supervise all work related to executing this design.

• Graphic Designer (1 FTE) - The 2-D interpretive materials created as part of or in conjunction with a *Breakthroughs* topic will include interpretive graphics in the display gallery, interface elements and typography for electronic media, print materials for education guides and other graphic design items such as posters and banners.

• Demonstrations Coordinator (1 FTE) - This role will focus on developing and coordinating in-house demonstrations incorporating the subjects presented in the 2-D and 3-D displays, and will coordinate in-house or electronic live presentations by outside scientists or other experts relating to specific Breakthrough topics.

• Part-time Demonstrators (1.5 FTE) - These staff will conduct the mediated demonstrations created as part of bi-weekly and quarterly presentations.

• Interpretive Associates (1 FTE) - These staff will conduct small-group mediated activities and assist visitors using the galleries.

In  either scenario, as with the current project team, the *Breakthroughs* operating group will be a cross-divisional team drawn from the mission core divisions.

**External Advisors**

In order to follow and present reliable information about current topics in science and technology, a network of experts and specialist collaborators is required.

This network should include scientists and engineers from academia, government research labs and commercial R&D facilities. It should also include non-scientists, such as journalists, public policy advocates, ethicists, and other concerned citizens and regional residents with interest in and an informed opinion about current topics and issues in science.

Through this network content developers will be alerted to new issues, alternate perspectives on topics and have access to expert reviewers for the overall Breaktrhoughs project.

The key criteria for *Breakthrough* advisors, in addition to their willingness to participate in the Center, is their activity in their field as bench scientists, engineers, or other working professionals in science or technology disciplines.

Participation in a *Breakthroughs* advisory group may enable the Center to maintain working relationships developed through other experience renewal projects, to involve additional experts in the scientific life of the Center, to strengthen working relationships with key academic, public and private R&D organizations, and to provide cascading opportunities in areas adjacent to or beyond informal science learning.

**Budget**

The creation and operation of this type of experience is different from other exhibition experiences. This is due to several factors:

1. The need to create and maintain modular, re-usable, and multi-purpose furnishings and equipment required by the presentation types and schedule.

2. The need for supplies and materials to continually update the exhibition. Although electronic forms of presentation will help in this area, the physical nature of technological developments will require the creation of some new elements more frequently than other exhibitions.

3. In order to stay abreast of developments, perform the required research, design new displays and implement them, dedicated personnel resources are required.

Using these factors, the following summarizes the budgetary resources required to create and operate *Breakthroughs*.

**Development** and Implementation of *Breakthroughs* up to and including the first featured presentations

| | |
|---|---|
| Staff | $260,000 |
| Exhibit Fabrication | $1,815,000 |
| *Total* | *$2,075,000* |

**Operating Scenraio A** yearly operating costs for staff, equipment and implementation, as outlined earlier in this report.

| | |
|---|---|
| Staff | $501,000 |
| Fixed Assets (start-up equipment) | $114,000 |
| Materials & Services | $152,000 |
| *First out-year total* | *$767,000* |
| Five Year operating cost estimate | $3,265,000 |

**Operating Scenraio B** yearly operating costs for staff, equipment and implementation, as outlined earlier in this report.

| | |
|---|---|
| Staff | $339,488 |
| Fixed Assets (start-up equipment) | $114,000 |
| Materials & Services | $83,500 |
| *First out-year total* | *$536,988* |
| Five Year operating cost estimate | $2,114,940 |

Operational funding opportunities with private foundations and public agencies may be enhanced especially because of the topical focus of this project.

In November 2002, the Center applied for and received a $100,000 grant from the New Jersey Commission on Science and Technology to support current prototyping work for *Breakthroughs*.

**Fabrication Breakout**

Our preliminary estimate for costs associated with building and installation of the two *Breakthroughs* galleries is as follows.

| | |
|---|---|
| Computer and AV Hardware | 505,000 |
| Exhibit Furniture | 270,000 |
| Interior Construction | 335,000 |
| Atrium AV Display | 200,000 |
| Media & Experience Archive | 300,000 |
| Graphic Treatments | 75,000 |
| Lighting | 130,000 |
| *Total* | *1,815,000* |

**Appendix A**

## *Breakthroughs* Exhibition Front-End Evaluation

Report by Randi Korn & Associates

October 2002

### EXECUTIVE SUMMARY

Only the most salient findings of the evaluation are included in this summary. Readers are urged to read the body of the report, as there are many details about the Breakthroughs evaluation that the exhibition development team will find both interesting and insightful.

### INTRODUCTION

This report presents the findings from an evaluation conducted by Randi Korn & Associates, Inc. (RK&A), for the Liberty Science Center in preparation for an upcoming exhibition tentatively titled *Breakthroughs: the Leading Edge of Science and Technology*. This study provides the exhibition development team with information about the Liberty Science Center audience and potential audience, and visitors' understanding and perception of concepts associated with the proposed exhibition. To understand visitors' understandings and opinions, two data collection strategies were employed: face-to-face questionnaire interviews and open-ended, in-depth interviews.

### PRINCIPAL FINDINGS: QUESTIONNAIRE INTERVIEWS

A total of 411 questionnaire interviews were conducted with visitors: 205 at the Liberty Science Center (LSC), and 206 at the Franklin Institute.

*Demographic Characteristics*

- The sample included a fairly even proportion of males (53 percent) and females (47 percent).
- Respondents' median age was 28 years. Almost one-half of respondents were under 25 years old (44 percent).
- Forty-two percent of respondents have a college degree, while 20 percent hold a graduate degree.
- The sample surveyed at LSC is similar to LSC samples surveyed in previous studies with the following exceptions: respondents in this sample were somewhat younger and held lower levels of completed education.
- The majority of respondents visited in groups of adults and children (72 percent).

*Psychographic Characteristics*

- The majority of respondents said they use the Internet as a source for current science research (55 percent).
- Thirty-eight percent of respondents hear or read about current science research five or more times a month.
- Nineteen percent of respondents actively seek current science research findings five or more times a month.

*Opinions About Current Science Research*

- When asked to rate different science topics as "important to society" and "important to me," respondents' ratings of topics as "important to me" were slightly lower than their ratings of topics as "important to society."
- Respondents rated highest "new discoveries in fighting disease" and "renewable energy sources and fuel-efficient cars."

- Respondents rated lowest "animal cloning and genetic engineering" and "how nature influences the design of robots."
- Older visitors rated three of the science topics higher as "important to society" and three of the topics higher as "important to me" compared with younger visitors.
- Respondents were asked their opinions about how science research is conducted and their level of trust regarding the research they encounter. Respondents gave the highest ratings to these two statements: "I usually understand what is being reported" and "I usually wonder how the findings apply to me."
- Respondents are not likely to question the accuracy of science research findings and even less likely to question the source or impetus of the research.
- 75 percent agreed or strongly agreed with the statement "most scientists do their research to increase their own understanding of the world."
- 65 percent agreed or strongly agreed with the statement, "most scientific research is more beneficial than harmful," and 85 percent disagreed or strongly disagreed with the statement, "most of the science research being done today is not important."
- 58 percent agreed or strongly agreed with the statement "most of the work that scientists do will improve my life."
- 60 percent agreed or strongly agreed with the statement "research reflects the bias of the scientist," and 50 percent agreed or strongly agreed with the statement "most research findings are manipulated to support a particular viewpoint."
- When asked to think of a science, technology, or medical topic that interested them, respondents' most frequent response was cancer/cancer research.
- When asked why they were curious about the above topic, respondents' most frequently said school research or discussing the subject with a friend or family member prompted their interest.
- When asked what a science center can provide that other information sources cannot, respondents' most frequent response was hands-on or interactive experiences.

PRINCIPAL FINDINGS: IN-DEPTH INTERVIEWS

Thirty in-depth interviews were conducted with visitors. The sample included 14 females and 16 males ranging in age from 21 to 78. Most of the interviewees were visiting with children under 18 years old.

- While a few interviewees could not recall hearing about science news recently, the majority named a variety of science topics they had heard about, including technology news (such as computer, space, or medical technology), health issues, space or anthropological discoveries, and advancements in genetics research.
- The majority of interviewees cited the Internet as a source they would use for information about current science research.
- Approximately one-half of interviewees said they could not remember the last time they sought current science research.
- Among five science topic titles interviewees read on a list (Animal Cloning, Dark Energy, Botox, Global Climate Change, and Robots), "Animal Cloning: Science Fiction Comes to Life" and "Dark Energy: Cosmic Forces Found by the Hubble Space Telescope" were selected as most interesting.
- Among five science topics presented graphically, "Robots: Design Inspired by Nature" and "Animal Cloning: Science Fiction Comes to Life" were selected

as most compelling. Overall, interviewees found the robots and Botox topics more compelling in panel presentations than by the topic titles alone, and the Hubble Telescope, animal cloning, and global climate change less compelling in their panel presentations than by the topics title alone.

- The robots and their potential uses intrigued interviewees, and many indicated information about robots was new to them.
- While some interviewees mentioned they had previously heard about animal cloning in the news, they said they would like to know more about the cloning process, and a few were interested in discussing the ethics and necessity of cloning.
- Some interviewees were surprised by the characterization of Botox as poison and interested in learning more about the implications of using Botox for cosmetic purposes and the beneficial uses of toxic substances.
- Interviewees described global climate change as relevant for all of Earth's inhabitants and expressed interest in learning more about the current state of the planet and actions that could or should be taken to preserve it.
- Some interviewees said space research was important and compelling, but this topic was discussed least frequently of the five topics presented.
- Overall, interviewees seemed moderately to very interested in talking about the different topics and no interviewee was uninterested in discussing the topics.
- More than one-half of interviewees said that science centers and museums can provide visitors with interactive experiences, including hands-on activities and immersive environments. Some interviewees said that science centers provide clearer, more in-depth information, including balanced presentations of difficult topics. A few interviewees said that science centers can use different presentation methods, including IMAX movies. Finally, a few interviewees stated that science centers expose visitors, particularly children, to topics they might not be exposed to otherwise.
- Interviewees said that science centers have a responsibility to present current science research in a truthful, unbiased manner, provide clear and detailed presentations, provide up-to-date and understandable information, and help foster an interest in science among children and adults.

## DISCUSSION

The goals of this evaluation were to better understand visitors' experiences with current science research, determine their interest in science research topics, ask their opinions about scientists and scientific research, gauge their reactions to science research presentations, and uncover their expectations for science centers' presentations of current science research.

### *Experiences With Current Science Research*

Both questionnaire respondents and in-depth interview respondents cited the Internet most frequently as a source they would use for current science research, although when asked to name specific web sites they visit, few could do so. Respondents also named other media sources providing scientific research, including newspapers, magazines, and television. In general, while respondents are passively exposed to current science research fairly frequently (watching, listening to, or reading the news) they are less likely to actively seek out research findings. Respondents who recalled seeking out information on a particular science topic generally did so because of a personal interest in the topic, often because of their own or a loved one's personal health problem. Some respondents also seek out current science research for school, either for themselves or for a child. Overall, respondents' interests in researching science topics came from an outside need or impetus, rather than an existing interest in the topic.

*Interests In Science Research Topics*

Among a list of 12 science research topics, questionnaire respondents rated the topics with the clearest connection to their health (new discoveries in fighting disease) and daily life (renewable energy sources and fuel-efficient cars) as most important to society and most important to them. Though we did not measure respondents' familiarity with the topics they were rating, one's familiarity with an idea could influence whether a respondent thinks a topic is important, as evidenced by the in-depth interviews that were conducted. Interviewees were shown a list of five topics, from which they were to select the one most interesting to them. Then they were asked to look at five panel presentations of those same ideas, and select the most compelling one. Interestingly, when interviewees read the list of topics, "Robots: Design Inspired by Nature" was selected least often as interesting, but when they were shown the panel presentations, it was selected most often as compelling. Interviewees explained their reversal by saying that when they read the list of topics, they did not know anything about "Robots: Design Inspired by Nature," but when they learned a little about them from the panel, their interest was piqued. Responses to the panel presentations are more fully discussed in a subsequent section.

Ratings of four of the twelve science topics (on the questionnaire) were significantly related to respondents' age. In all cases, older respondents rated a topic's importance to society and/or to themselves higher than did younger respondents. Visitors' initial interest in a topic may be lower if they are unfamiliar with the topic or cannot easily see the topic's relevance to their own life, and older visitors, because of their accumulated life experiences, are more likely to be familiar with a topic and understand how the topic is relevant to them. When presenting science research topics, the topic's significance needs to be clearly stated in the exhibit's introduction, thus encouraging visitors who may be unfamiliar with the topic, to invest time in exploring the topic further.

*Opinions About Scientists and Scientific Research*

Survey respondents were asked their opinions about current science research, including their general attitudes towards scientific research, how they evaluate the information they receive, and their attitudes towards scientists and their research. Overall, respondents have positive attitudes toward science research, agreeing that most of the science research conducted is important and generally beneficial to society. The National Science Foundation's survey research report of public attitudes and understanding of science supports this finding, concluding that, "Americans consistently believe that the benefits of science research outweigh any harmful results" (NSF, 2000). However, the LSC study also shows that respondents are less likely to wonder how the findings apply to them, to see how science research benefits them personally, or to seek more information about science research. Superficially, respondents see the benefits of science research, but have some difficulty seeing the relationship between science research and their own lives, as evidenced by their consistently lower ratings of science topics on the "important to me" scale compared to the "important to society" scale.

Respondents are also less likely to think critically about research findings, particularly about the research's funding source and the scientists who conduct research. While respondents may think about the accuracy and bias of the findings, they are less likely to consider the source of the findings, including scientists' reasons for conducting the research. While some respondents agreed that research reflects the scientist's bias, they disagreed that scientists do research for their own economic gain. Thus, while visitors may see research as flawed (reflecting the bias of the scientist), they believe scientists' do research to increase their own and other people's understanding of the world.

*Reactions to Science Research Presentations*

In-depth interview participants were shown a list of five exhibition topics and asked which topics were most interesting, and then were shown graphic presentations of the same topics and asked which were most compelling. As noted earlier, when reading from the list of topics interviewees infrequently selected "Robots: Design Inspired by Nature" as interesting, but when they were shown the panel presentations of the topics, interviewees frequently selected it as compelling. Interviewees who became more interested in the topic after seeing the presentation explained that the subject intrigued them once they knew more about it, including how scientists imitate insects to construct the robots and robots' many uses. While interviewees initially appeared uninterested in the topic, they were actually unfamiliar with it, and subsequently stated their interest after reading the story and learning a little about the subject.

To accentuate this point, the topic of Dark Energy was frequently selected as interesting to interviewees, but few selected the graphic presentation of this topic as compelling. Interviewees may have selected the topic as interesting because they were familiar with the Hubble Space Telescope, which was included in the topic's title. Visitors who lost interest in this topic after seeing the graphic presentation cited the uninteresting images as the reason. However, the few visitors who discussed this topic with the interviewer generally did so in some depth, discussing the theory of dark energy and how it contradicts what scientists previously believed to be occurring among galaxies in the universe. The subject and presentation may have intimidated others, as Dark Energy did have more text than the other panels and one had to read the text thoroughly to understand the content and comment on it. Thus interviewees' lack of interest in the story on the panel may be due to the density of the content and visitors' inability to understand the subject, as well as the length of the label and visitors' unwillingness to devote the time to read it.

Interviewees selected animal cloning as interesting and as having a compelling graphic presentation. Interviewees said they heard about this topic in the news more than any of the other topics presented, and many also discussed the controversy surrounding the topic as the reason for their interest or disinterest in the subject. Some interviewees specifically said that although they had heard about animal cloning, they were confused about how animal cloning is done. While they may have had a cursory understanding of animal cloning, they lacked knowledge about animal cloning and were interested in learning more about it or discussing the ethical controversy surrounding it.

As illustrated by the above examples, regardless of whether visitors express a superficial interest in a subject simply because they are familiar with the topic, an exhibition that presents the story and visuals in a compelling and understandable manner will successfully draw visitors' attention.

*Current Science Research and Science Centers*

Questionnaire respondents and in-depth interviewees were asked what they felt a science center could provide that other sources of science information could not. In-depth interviewees indicated that visiting a science center exposes them to different subjects that they would not know about otherwise. More than one-third of questionnaire respondents and more than one-half of interviewees said that science centers provide them with interactive experiences, including hands-on activities and immersive environments. Interviewees said that interactive experiences increase both adults' and children's appreciation and understanding of scientific concepts. Questionnaire respondents rated "interacting with or manipulating things on display" highest among seven methods of presentation, while they rated "accessing science information via computers" the lowest. Visitors may acknowledge the Internet as the most

useful tool for gathering current science research information in their daily lives, but they visit science centers because they prefer an interactive experience.

While visitors who participated in this LSC study express their interest in science (or in exposing others to science) by visiting a science center, they do not consider themselves knowledgeable about breakthrough scientific research. The National Science Foundation confirms the existence of this gap between the public's moderate to high interest, but moderate to low self-assessed knowledge, in science and technological issues (NSF, 2000). Respondents in this LSC study rely on science centers to engage them in subjects that they neither encounter in-depth, nor seek out, as part of their daily lives.

Interviewees stated the importance of clarity and depth in science centers' presentations. Visitors see science centers as providing a wealth of information in one place, where they can spend as much time with a subject as they wish. They also see science centers as providing balanced presentations. While visitors may not think critically about all science research findings they encounter, they perceive the media as biased. On the other hand, most respondents indicated they believe that science centers are not biased in their presentation. In fact, in an American Association of Museums commissioned study that measured the trust the public has in a range of institutions, museums ranked the highest.

## REFERENCES

The National Science Foundation. (2000). "Science and Technology Policy: Past and Prologue - A Companion to Science and Engineering Indicators 2000." NSB 00-87. The National Science Board.

**Appendix B**

**Summary of the timing and tracking study**
**Global climate change prototype**

Prepared by Su-yen Thornhill
March 19, 2003

*Summary of prototype*

During the fall of 2002, the Breakthroughs team took the opportunity to prototype a 'Current issues in Science and Technology' exhibit based on the topic of global climate change. The team created a number of elements for the exhibit that simulated what would be considered a bi-weekly presentation. The exhibit was displayed on the Environment floor of the Science Center.

The team felt that global climate change was a relevant topic to be considered for a presentation on current issues in science and technology. This was because earlier that year an area of the Larsen B ice shelf in Antarctica, that dwarfs Rhode Island in size, shattered and separated from the continent. Also the world summit held in Johannesburg was also held late summer last year.

The exhibit included:

Graphic panel - A large graphic panel broken up into four sections that contained text and imagery:

| | |
|---|---|
| Section a | What is the greenhouse effect? |
| Section b | Global Climate Change: our life in a hot house |
| Section c | What are greenhouse gases? |
| Section d | Is this a long-term problem? What can I do? |

Display case - A Perspex case containing items that are available from the supermarket that we often take for granted but carry an ecological footprint. Items included a bottle water that was imported from France, out of season fruit that has to be imported from abroad, and meat whose demand is so high that more land is being converted into farmland.

Talking head video - Su-yen Thornhill met with Professor Dick Wetherald a climatologist based at Princeton University who explained his work and what in his expert opinion was the current thinking on global climate change. The interview was filmed, edited and produced into short QuickTime movie clips that were played on a loop on a computer monitor. Guests were able to pause, fast forward or rewind each clip.

Greenhouse gas model - The team created a mock up of a greenhouse using a Perspex case that contained a digital thermometer that registered the temperature in side the case and outside. When a light was shone onto the case, the temperature inside the box became warmer, just as in a greenhouse. An accompanying graphic asked guests to if they noticed a difference in temperature and likened it to the effect of the greenhouse gases in the atmosphere.

Demonstration - A demonstration cart was also placed into the area that allowed for mediated activities to take place about renewable fuels. This element was not included in the timing and tracking study.

*Location*

The prototype exhibition was placed on the Environment floor of the science

center in an area opposite the Resource Area of Global Viewpoints adjacent to the Rock Wall, a particularly popular exhibit. The team decided that the timing and tracking study should take the surrounding exhibits into consideration. These included the aforementioned Rock Wall and Resource Area, and Powers of Ten.

*Method*

Two imaginary lines were drawn on the Environment floor plan diagram just before the Powers of 10 exhibition and just before the Rock Wall from the other side.

Every fifth visitor to cross either line was timed and tracked in the area. A stopwatch was used at all times.

The following questions were taken into consideration during the study:

In general:

- What did the guest look at and in what order?
- How much time they spend at each?
- Were they discussing the item with anybody?
- What behaviors were observed?

Graphic panel:

- What areas of the panel is the guest looking at and how long do they spend doing it?
- Do they point to anything?

Greenhouse model:

- What is the guest doing at the model?

Computer interview:

- What is the guest doing at the computer?
- Do they watch entire clips?
- Do they watch more than one clip?
- Do they navigate between the clips?

Display case:

- Does the guest look at the display case?

*Findings*

Owing to the inclusion of the Rock wall and the surrounding exhibits, a fewer number of guests moving into the climate change area were tracked.

A total of 169 guests were tracked. The study was carried out between December and January during office hours, once during the weekend and a couple of days over the Christmas vacation period. This was to ensure that the majority of Liberty Science Center's audience was captured. Of this sample, 27 individuals were not tracked according to the standard protocol. These results are presented with this in mind.

Of the 142, children made up 50% of the visitors and teenagers 13%. Adults and senior citizens made up the rest, with the latter being the smallest in number.

Since the Rock Wall was included, it proved to be the most popular attraction in the area under study. Of the 142 visitors that came into the space, 48 (34%) went only to the Rock Wall. Time on task was also the highest for this attraction.

Of the 142 guests tracked using the two imaginary lines, 15 (11%) went to climate change only.

*Visitor demographics*

The ratio of male to female guests tracked was approximately 50:50 out of a total of 142

When the Rock Wall was included in the study, it was by far the most popular choice of exhibit in the area, with just over 50% of guests spending time on it. The least attractive component was the graphic panel, and of the guests, who did look at it, all were all adults. 21% of the guests simply used the space as a thoroughfare to get to another exhibition.

And being the most popular attraction, guests spent the most time at the Rock Wall, often spending many minutes in line waiting their turn. However, although the video, computer and display case were the most popular, panel d registered as the longest time on task, however only 2 people visited it.

The average time spent at exhibits did not alter significantly when the group that had been tracked only at climate change was included into the study.

All three permanent exhibits, the Rock Wall, the Resource Area and Powers of 10 attracted longer visits. However, in looking through the timing and tracking raw sheets, visitors at Powers of 10 often sat facing the opposite direction or were undertaking other tasks such as baby feeding, hence the benches may be being used for other purposes. This however was an observation only.

11 of the 25 guests who visited the resource area also looked at the computer interview with Dick Wetherald.

8 Guests spent time at all three tabletop interactives (the model, the video and the display case).

18 of the 42 guests, who went to the climate change exhibit looked at both the greenhouse model and the computer video, these were adjacent to one another.

One behavior noted at the greenhouse model was that a few guests breathed into the temperature sensor, which was encased in a perforated Perspex cover.

If an adult was accompanying a child, they mostly interacted at the model, where the adult read the back panel to the child or at the display case where the adult read the labels to the children.

The display case generated most interactions between guests.

*Conclusion*

The timing and tracking of the climate change exhibit should not have included the adjacent exhibits. Many guests who did visit climate change were not tracked because of the competition with guests coming into the space for the Rock wall.

The display case, model and computer tabletop displays were the most popular of the climate change components.

The panels were only attractive to adults and even then to very few.

In order to prototype for *Breakthroughs* in the future, qualitative interviews will have to be conducted to understand better what it was that attracted guests, what captured their attention and how to improve any written graphical presentations. These findings will inform how prototyping will proceed on the Invention floor of the science center.