



Too Big, Too Small, Too Slow, Too Abstract: Exhibiting Modern Science

by Eric Siegel,
with case studies by Gretchen Baker and Tim Martin

Eric Siegel is Director and Chief Content Officer at the New York Hall of Science. He may be reached at esiegel@nyscience.org.

Gretchen Baker is Exhibition Development Manager at The Field Museum. She may be reached at gbaker@fieldmuseum.org.

Tim Martin is Principal of Tim Martin Design in Los Angeles. He may be reached at tim@timmartindesign.com.

Since the inception of science and natural history museums, exhibitions have focused upon the resolutely material: machinery, specimens, and phenomena that occur within the range of human perception. As the technology and processes of science have evolved, the properties and phenomena under study range to the extremes of scale, from subatomic to universal. Considerable public interest surrounds these invisible phenomena, even extending to concepts that are fundamentally abstract such as contemporary speculation on multi-dimensional, multi-universal models of reality.

So, in discussing how to exhibit the unexhibitable, we confront the question of how to create experiences that communicate essential aspects of phenomena that are too big, too small, too slow, or too abstract for normal sensory comprehension. This article will address examples of exhibitions that attempt this feat, and inquire of their creators and designers how they confronted these fundamental challenges.

For this discussion, we are considering things that are far outside the range of human perception. For the merely microscopic, we have very effective tools such as Wentzscopes™. For the speedy, we have Videospinners™ or Edgerton-like strobe photography; for the distant, we have telescopes, and for the slow, we have time-lapse photography. But the scales that are really challenging, and the subject of this article, are so far out of the range of human perception that there are no tools to image or capture them physically.

Too Big

The traveling exhibition *Cosmic Questions:*

Our Place in Space and Time was designed by Jeff Kennedy Associates for the Harvard Smithsonian Center for Astrophysics. The description of the exhibition on the ASTC web site highlights the breadth and scale of the exhibition's subjects.

What is beyond our galaxy? When did time begin? Questions like these are at the heart of Cosmic Questions: Our Place in Space and Time. The exhibition invites visitors to explore the mysteries of the universe, discovering what it's like to be an astronomer using the latest technologies to uncover clues hidden in distant galaxies.

According to Greg Sprick of Jeff Kennedy Associates, the exhibition team decided during formative evaluation not to try specifically to relate the 10⁶ light year scale to scales that would be familiar to visitors. Rather, they decided to use these vast distances to “bump up against the limits of people’s understanding.” Rather than walk visitors through a size chart leading from planet to star to galaxy to universe, the designers created a gallery of mysteries. In this gallery, the visitor explores some of the great questions of cosmology: dark matter and energy, the behavior of black holes, the possibilities for life elsewhere. This gallery ends with an innovative space for contemplation, in which visitors quietly reflect on the vast incomprehensibility of space.

While the exhibition is rich in science fact and process, with interactives about colliding galaxies; the relationship of cosmology to human life; and telescoping; summative evaluation demonstrated that it is the wonder and incomprehensibility of the scale of space and time, and the unfamiliarity of phenomena

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In the "Infinity Crystal" visitors immerse themselves in a crystal's repeating patterns of atoms. From the exhibition **Too Small to See**. Courtesy of Cornell University Sciencenter.

such as black holes, that left the greatest impression on the visitors. Greg summarized visitor reactions saying that visitors left the exhibition understanding that the universe is bigger and weirder than they had imagined.

The title of the exhibition emphasizes the "questions" at the heart of the science of cosmology. It strikes me that this is an effective approach for dealing with scientific research at the extremes of scale, as it engages visitors with the scientific method, as well as the sense of mystery that energizes scientific research.

Too Small

For the past three years, the Nanoscale Informal Science Network (NISE) has been grappling with the challenges of engaging visitors with the characteristics of the unimaginably tiny world of the nanoscale. While this has not resulted yet in a coordinated suite of exhibits, designers at the Museum of Science in Boston, the Science Museum of Minnesota, the Exploratorium, the New York Hall of Science, the Oregon Museum of Science and Industry, and Sciencenter in Ithaca, New York worked on prototype exhibits and programs for the NISE exhibition. These represent a range of approaches that shed light on the difficulty of engaging visitors with nanoscale phenomena.

A front end meta-study conducted by Barbara Flagg for NISE (unpublished) documented a disconcerting combination of lack of comprehension and awareness of nanoscience and technology, along with a very low level of interest or affective response to the subject. Recent actions to regulate nanomanufacturing processes have created increased public awareness about social choices related to nanoscience.

The NISE exhibition developers therefore decided to focus principally on the applications of nanoscale science and engineering. A small scale nano fabrication lab and interactives related to the use of nanoscience for drug and other medical delivery were tested with audiences to modest success. Some NISE exhibits attempted to use digital technologies to zoom into the nanoscale world to show the fundamental science of nanotechnology. These were generally not very successful in communicating to visitors the qualities of matter and interaction at very small sizes. While the NISE network is still evolving, it seems likely that programs such as forums and "nano-days" will play a more prominent role than stand-alone exhibitions.

The NSF-funded exhibition **Too Small to See** was created through a partnership with Cornell University, Sciencenter in Ithaca, and the exhibition design firm Painted Universe. One of the exhibition's key ideas was: "all things are made of atoms; atoms bond together to form molecules; atoms and molecules are always moving; there are one billion nanometers in a meter." The exhibits used a carefully controlled vocabulary to describe nanoscale phenomena, and referred to the main ideas repeatedly from different perspectives. As a result of this focus and well-designed interactive experiences, summative evaluations did demonstrate significant content knowledge change as a result of the exhibition. For example, if a visitor had named a macro (grain of sand) or micro (bacteria) scale object as the smallest thing they could think of before they visited the exhibition, they were likely to name a much smaller object such as a molecule or an atom after the visit.

Technology and nature are connected in the "Game of Life" interactive, part of the **Connections** exhibition. Courtesy of the New York Hall of Science.



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Too Slow

Over the past several years, there have been a number of major exhibitions about evolution. To understand the emergence of different species, one must grapple with time spans of millions and hundreds of millions of years. How museums choose to confront this time span depends on their exhibition learning goals, interpretive strategies, and target audiences.

Life Changes, an NSF-funded program currently underway at the New York Hall of Science, combines University of Michigan developmental psychologist E. Margaret Evans' research with the work of an interpretive team led by Martin Weiss of the Hall of Science. This project undertakes the substantial challenge of engaging young visitors, ages 6-10, with a developmentally appropriate understanding of the science of evolution.

Dr Evans' research shows young children naturally have a fabulist explanation of why there are different species..."they were just made that way," or explanations like those found in Kipling's "Just So Stories." In order to build on this affinity for storytelling, the *Life Changes* team is prototyping a storytelling approach, but with science replacing fabulist explanations. In this approach, the tremendous span of time involved in speciation is simply encapsulated in a short familiar phrase, such as "long, long ago" or "many years went by."

Another approach to exhibiting evolution, undertaken at The Field Museum of Natural History, is outlined in the case study that accompanies this article.

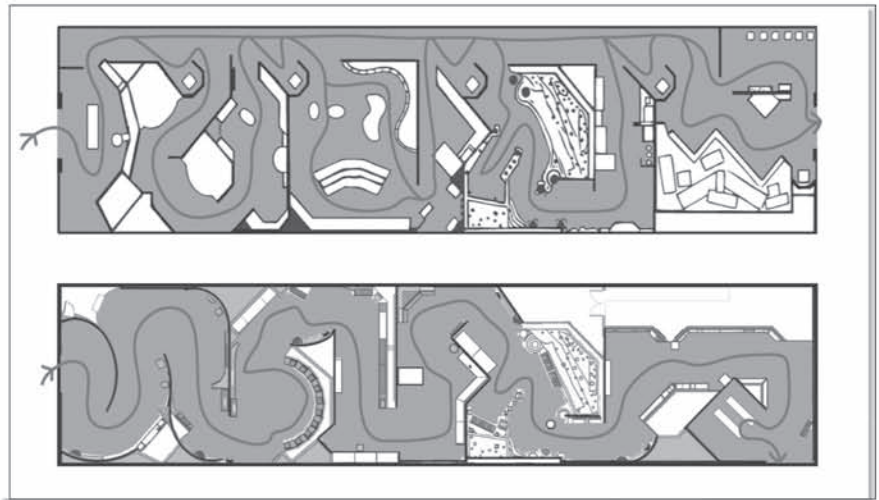
Too Abstract

One of the persistent challenges of science

exhibitions and programs is communicating abstract concepts. For example, in an exhibition at the New York Hall of Science called *Connections: the Nature of Networks* the development team, led by this author, attempted to communicate underlying principals of networks that are common to natural phenomena such as ant colonies and technologies such as the World Wide Web. In the same exhibition, live spiders and their webs are displayed with interactives such as an arm-wrestling game over the Internet. As the exhibition evolved, it became clear that the unitary "big question" approach was not going to cohere through the entire exhibition, but rather that we would be providing a range of examples through which the visitor would be encouraged to construct a common theme. Our hope was that each of the individual experiences would be sufficiently compelling to engage visitors in addressing the common theme.

In the target age range for this exhibition, 8-14 year olds, our success in this endeavor was mixed. Using images and storytelling techniques, our evaluators discerned that a significant number of young people would respond with relevant imagery and phrases, for example, that "everything is connected." Older visitors and visitors with a background in technology proved extremely capable of discerning the underlying concepts.

The circulation route, in the first hall of **Life Over Time** (top) compared to new **Evolving Planet** (bottom). Courtesy of The Field Museum.



The Einstein Exhibition developed at the American Museum of Natural History faced the challenge of presenting the legendarily difficult concept of Einstein’s theories of relativity. Their approach is outlined in the accompanying case study.

Conclusion

These summaries of different approaches reveal the tension between intellectually ambitious content and the strategies that are effective in reaching the extraordinarily diverse audiences and environments of museums. Eight year olds need an entirely different approach to the concept of deep time than 20-or even 12-year-olds. The range of outcomes for exhibitions that grapple with the super and sub-sensory world also is diverse. In undertaking exhibitions on these and similar topics, developers and designers need to clarify whether they are satisfied with an impressionistic understanding of the topic at hand (the universe is immense beyond our imagining) or whether a more factual outcome is desired (the universe is 15 billion years old.) My personal sense is that exhibitions are more effective in creating curiosity and wonder than in imparting facts, so I am impressed by those exhibitions that can introduce visitors to the very idea that there are worlds beyond their senses and kindle a new interest.

Case Study 1: Developing *Evolving Planet* at The Field Museum

by Gretchen Baker

In March 2006, The Field Museum opened *Evolving Planet*, a 27,000-square-foot permanent exhibition exploring the history of life on Earth. This story—spanning billions of years and involving millions of species—is

dramatic, but can also be daunting to visitors. To convey clearly the concepts of deep time, and the timeless principles of evolutionary science, our exhibition team used a suite of design and interpretive strategies. Here, in a few paragraphs, is what we did over a few years. *Evolving Planet* was conceived as a wholesale renovation of *Life Over Time*, a popular but scientifically outdated exhibition. We also knew it suffered from poor navigation tools, and failed to communicate key messages:

1) the history of life on Earth is vast and 2) its diversity is connected through, and the result of, the process of evolution. To strengthen these messages in *Evolving Planet*, we defined two “backbones” that form the exhibition’s framework. The first backbone, which gives the exhibition its structure and orchestrates the visitor’s experience, is *time*: the four-billion-year journey through the planet’s history, and the changes to life and to the planet as evidenced in the fossil record. The second is *evolutionary science*: how the process of evolution works, how we know it works, and who are our scientists who study it.

Deep Time

Among several big moves, we redesigned the footprint of each gallery to reinforce the two thematic backbones. For example, we changed



Repeated elements in *Evolving Planet* that reinforce life on an ancient, changing planet: (left) one of eight “Period Previews” with environmental illustration and geologic timeline; one of eleven “Date dots” on the floor; (right) one of six towering, interactive “Mass Extinction” stops. Courtesy of The Field Museum.

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the circulation pattern in the first third of the exhibition from multiple pathways into one. A 2001-2002 assessment concluded that the open circulation of *Life Over Time* contributed to an uncertainty about wayfinding, and to a poor understanding of geologic time and the length of time *Life Over Time* covered. New repeated elements reinforce the passage of time, including towering timelines, illustrated wayfinding maps, a floor trail of “date dots,” and information on every specimen label. To further accentuate the visitor’s walk through different time periods on a dynamic planet, exhibition designers employed a color palette that changed from gallery to gallery.

Evolutionary Science

Evolution operates through processes that are timeless—they have been going on since life evolved and continue today. In *Life Over Time*, displays on how and why evolution functions as it does or how we know were treated in galleries separate from the fossil evidence. Based on a summative evaluation of *Life Over Time* conducted by People, Places and Design Research in 1996-97, few people stopped at or recalled the “hows;” they remembered the “whats.” According to a 2001-02 assessment by Field Museum researchers, these separate galleries created a disjointed experience. In *Evolving Planet* we integrated the “hows” with the “whats” by means of two repeated video series: “Evolution Essentials” and “Scientist Stops.”

“Evolution Essentials” are animations that focus on key processes or principles such as natural selection or phylogeny. Animation allows for the collapse of millions of years, many generations, or numerous stages of action into one concise narrative. The whimsical, hand-drawn cartoons also provide a humorous

and visually appealing access point to the difficult material. This series received a 2006 MUSE Award from AAM’s Media and Technology Committee.

“Scientist Stops” are videos featuring Field Museum scientists discussing their research. These are part of our ongoing efforts to broadcast that evolutionary science is active, relevant, cross-disciplinary, and takes place right under The Field Museum’s roof. “Evolution Essentials” and “Scientist Stops” are strategically integrated within a fossil display that is relevant to the particular principle or research area.

The summative evaluation of *Evolving Planet* indicates that visitors are grasping its two key messages. For example, visitors are 2.5 times more likely to have an accurate understanding of how much time *Evolving Planet* covers than those surveyed upon leaving *Life Over Time*; nearly 70% answered correctly when life originated; 70% recalled the correct number of mass extinctions; 80% reported that trilobites and Triceratops did not live at the same time; and more than 75% gave a good definition of evolution, as compared to our target definition.

Case Study 2: Exhibiting the Abstract in Einstein

by Tim Martin

Einstein is synonymous with genius, pacifism, pop icons and, of course, revolutionary physics made breathtakingly clear. The American Museum of Natural History was privileged in 2002 to exhibit documents on loan from the Israel Museum in Jerusalem, and set out to create an ambitious and comprehensive exhibition capturing the scientist’s life and work.

Einstein's letters and manuscripts—wonderful objects in themselves—deftly describe a life crowded with events, romance and status. But what about his science? Despite initial concerns that an institution traditionally catering to 'natural history' audiences might cross a fine line into 'science center,' Einstein's story seemed incomplete without somehow exhibiting the basis of his theories. To understand the man's influence, one needed to appreciate his science. The reverse was also true: an understanding of his science leads to an understanding of his character, his philosophies, and, feasibly, the way he lived his life.

How was our team of designers to bring the abstract—complex theories, mathematical equations and groundbreaking physics—to life?

First: we thought outside the exhibition box.

We turned to Einstein himself and his singular character. Our approach was to attempt to describe the world through his eyes: his imagination, his passion for humanity and his curiosity about how the world works.

Second: we aimed at keeping it direct.

We parceled the messages in simple concepts where Einstein's theories could be presented logically and naturally. Thus, the science sections were worded simply: Light, Time, Energy, Gravity.

Third: it was critical that we interweave his life and science, and this resulted in the exhibition's principal organization.

We commenced with Einstein's humble beginnings—revealing the grains of genius—and progressed by interconnecting additional life stories with his theories. The life and the science necessitated a dialogue with each other.



Interactive media provokes exploration of concepts of space-time. Courtesy of the American Museum of Natural History.

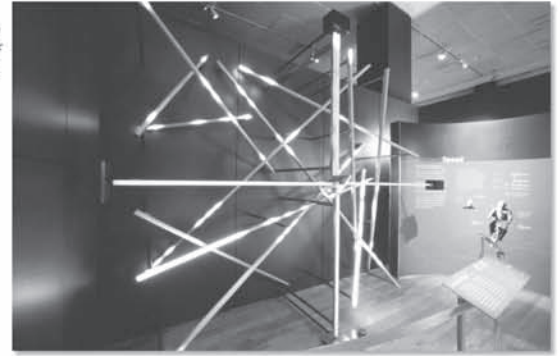
Fourth: Einstein's work resulted from imaginative thinking, creativity and dreaming, and this was the essential connection we needed to make with the visitor.

The Museum's media department designers created unique media-based installations that posed questions, physically involved the visitor and presented Einstein's theories in surprising ways. Intriguing objects in themselves, the installations moved, interacted and played with the visitor, sparking a creative response rather than a didactic one. In this way we hoped they would stay with the visitors long after their visits and perhaps help trigger the memory of the underlying theoretical concepts. In addition we utilized specialist docents, text-minimal interactives, large-scale graphic displays, and suspended models to enliven Einstein's abstract world.

Fifth: it was essential to demonstrate that Einstein is relevant today and to bring the science to life. Einstein's legacy is undoubtedly enormous: he laid the foundation for continuing examination into the evolution of the universe. Much modern technology has resulted from his theories. We needed to be clear with the message that his science is as significant to today's view of the world as when he was alive, and that it continues into the future.

The exhibition architecture aimed at being contemporary and highly graphic—curved forms, clean lines and exposed acrylics and

Exhibition architecture closely joined with text inspires visitors to engage with fundamental aspects of Einstein's theories. Courtesy of the American Museum of Natural History.



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metals. Exhibits were planned in a spirited spatial arrangement that aimed to reflect his passionate personality and the various stages of his life. Striking support graphics lined the gallery walls and incorporated color demarcations for each section with pithy, minimal text. The exhibition concluded with a visitor "Learning Lab"—an informal museum laboratory where visitors were encouraged to test a variety of experiments that linked Einstein's work to the latest scientific research and technology.

Every abstract idea is able to be exhibited—even the immense imagining behind the Theory of Special Relativity. The trick may be to reveal the abstract as a result of human inspiration, and connect it with the visitor's imagination. There are always text, images and mathematical equations, but perhaps the more engaging way is to approach it with imaginative exhibition methodology. Innovative and unique art, media and technology, graphics and exhibit architecture all played a role in describing Einstein's complex theoretical world with the collective aim to engage, and evoke appreciation and surprise. ✨

images that captivate

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Tel: 407.472.7595 fax: 407.839.2055
Email: information@electrosonic.com
www.electrosonic.com

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