

Exploratorium influences science museums new and old

About 40 million people are thought to visit science museums in the United States each year, and judging from the number and quality of new museums and exhibits being installed in the United States and overseas, the public appeal of science appears to be growing stronger all the time.

Everywhere the influence of the late Frank Oppenheimer is apparent. Whether it is the science city at La Villette in Paris or the science center in San Diego, the Technology Center in San Jose or the Hall of Science in New York, the emphasis is on what we might dub the three I's of Oppenheimer's approach to science exhibiting—innovation, interaction and involvement.

Working first on his ranch in Colorado during the 1950s, then as an elementary and high school teacher, and finally as the founder and director of the San Francisco Exploratorium from 1969 to his death in 1985, Oppenheimer developed an impressive array of interactive devices. Departing from the style of famous older museums such as the Franklin Institute in Philadelphia, the Museum of Science and Industry in Chicago and the Deutsches Museum in Munich, which tended to be dominated by industry-inspired exhibits of technological wonders, Oppenheimer designed toylike exhibits that engaged curiosity and intellect as well as eye and emotion.

The older museums were among the first to be affected by the new style, in which Oppenheimer was the main but far from the only influence. At the Franklin Institute it was decided in 1970 to eliminate industry-donated exhibits entirely. All four floors have been renovated during the last five years, and a \$40 million wing has been added. Called the Futures Center, it houses a film theater and new exhibits on space exploration, planet Earth, computers, automation and robotics, and health and life sciences.

At Chicago's Museum of Science and Industry, similarly, the industry-sponsored exhibit came under reexamina-



'The Curiosity Place,' an exhibit area for preschoolers, opened with NSF support at the Museum of Science and Industry in Chicago three years ago. In the photo the children are beating domes attached to drumheads. The domes enclose beads or droplets of water on the drumheads that jump about, providing the children with a visual representation of the motion associated with sound.

tion about ten years ago, when the staff began to worry, as Education Director Ted Ansbacher puts it, about "the conflict between promotional and educational values." The museum started to raise money to produce exhibits of its own and reduce the proportion of industry-built displays.

About six years ago the museum opened a science balcony with exhibits on the universe and the process of scientific research. Three years ago it opened "Technology: Chance or choice," which contains material on the pros and cons of various innovations. Two years ago it opened an exhibit for preschoolers that, Ansbacher says, owes a lot to the Exploratorium.

Exploratorium style. Oppenheimer did not invent the interactive exhibit and

his was not the only style of designing manipulable displays. At the time he set up shop in San Francisco, scientists and designers at the Ontario Science Center in Toronto were developing a more polished kind of interactive exhibit that some museum experts consider more appropriate for the general public than Oppenheimer's relatively crude devices, in which the gears show and the parts often are the kinds of things one finds in a junk heap.

Robert Semper, deputy director of the Exploratorium and an unabashed disciple of Oppenheimer, likes exhibits to be straightforward and homey. "Often ... exhibits that are simply built [out of things you can pick up at your local hardware store] are quite attractive because they are not off-putting—

they're not too slick, not too chrome and plastic," Semper said at the recent APS-AAPT meeting in San Francisco. Semper also stressed, speaking at the same meeting, that exhibits should "have a good aesthetic."

David Hawkins of the University of Colorado has observed that "one basic mark of the Exploratorium's style is the shop where exhibits are first put together crudely, then tested, revised and tested again" (PHYSICS TODAY, November 1985, page 122). "The shop is a highly visible part of the museum and visitors contribute to the museum's design as well because their reactions are observed and recorded."

At the refurbished New York Hall of Science, the new museum most obviously influenced by the Exploratorium, the visitor sees the shop immediately upon entry to the round ground-floor room. Carpenters build exhibits behind windows at the left of the room, while others scurry about the main floor checking devices and making repairs. A library containing science literature and computer guides to the literature is at the right.

Sheila Grinell, the associate director of the New York Hall, and Michael Oppenheimer, the exhibits director, were codirectors of exhibits at the Exploratorium in its early years. Michael Oppenheimer is a published poet and veteran exhibit designer who also happens to be a son of Frank Oppenheimer; Grinell was executive director of the Association of Science-Technology Centers in Washington before joining the New York Hall. Alan Friedman, director of the New York Hall of Science, formerly was responsible for physics and astronomy at the Lawrence Hall of Science, which is across the bay from the Exploratorium in San Francisco.

New York Hall. One of the most appealing things about the New York Hall is its compactness—virtually every part of the exhibit space on the ground floor and mezzanine can be seen from virtually any other spot. The museum is located at the site of the 1964-65 World's Fair, a half hour by subway from Manhattan, but as a reviewer for *The New York Times* wrote after it opened last summer, "a traveler is amply rewarded for the inconvenience."

The mezzanine surrounding the ground floor displays a show commissioned by IBM and built by the Exploratorium called "Seeing the light," which consists of 83 exhibits involving light, color and visual perception, all duplicates of exhibits at the Exploratorium (PHYSICS TODAY, February 1986, page 67).

The ground floor of the New York

Hall houses two sets of exhibits, one on mechanical and electronic feedback mechanisms, and one on the quantum atom. The ambitious quantum atom exhibit includes some relatively simple items such as a microscope in which examples of Brownian motion can be observed and a selection of New York street lamps showing that each type combines a different spectrum. The most impressive item in the exhibit and the one that has been most difficult to design and build is a laser device that makes a three-dimensional dynamic image of a simulated hydrogen nucleus surrounded by a cloud of electrons. The device, now in the final stage of development, depicts oscillations among low energy states and excitations to higher states. Interactive controls demonstrate quantum leaps and the uncertainty principle.

School interaction. The New York Hall currently is attracting about 5000 visitors a week, many of them school students on tours, and it can handle about twice that number. The museum has raised more than \$300 000 from the National Science Foundation, the Carnegie Corporation of New York and a mix of other public and private sources to bring 19 teachers to the museum as associates to help part-time for two years with the preparation of educational materials.

Programs involving teachers are standard fare at many major science museums, including those in Boston, Philadelphia, Chicago and San Francisco. The Franklin Institute, for example, brought 400 elementary and high school teachers to the museum last fall for a two-day overnight visit.

The Pacific Science Center in Seattle, taking outreach several steps further, sends vans out to primary schools with exhibits that can be taken into classrooms. Starting in the early 1970s when the oil crunch made field trips more expensive, the Seattle science museum sent exhibits to the schools on themes such as astronomy, physiology, comets, water pollution, computers and robotics. Elementary school teachers are trained at the science center to travel with the exhibits and explain them in the schools.

The New York Hall of Science, emulating a practice developed at the Exploratorium and Lawrence Hall, pays students to work as "explainers" on the exhibit floors. About eight to ten minority college students are in the museum at any given time, ready to discuss exhibits with visitors. Friedman says that a remarkable number of the explainers are beginning to think seriously about careers in science teaching.

The life of the explainer is not always

easy, we learned on a recent visit to the Exploratorium. Watching a group of small boys and girls at a simulation of a tornado in which a funnel of vapor rises in an open cylinder, it became apparent that most of the boys wanted to play with the funnel, which ruined it, while most of the girls wanted them to leave it alone. Groups often come into conflict about how to interact with this kind of exhibit, explainer Remi Rubel said, so that a visit to the center can be an exercise in socialization as well as perception and understanding.

Parc de la Villette. Before coming to the New York Hall in 1985, Friedman worked for a year and a half as a consultant at the Cité des Sciences et de l'Industrie at La Villette in Paris, another new museum influenced by the Exploratorium.

The idea of building a huge complex of museums, theaters and exhibition halls in the Paris suburb La Villette was conceived ten years ago during the administration of Valéry Giscard d'Estaing, after a huge complex of slaughterhouses and meat markets closed despite efforts to revitalize it with modern buildings. Physicist Maurice Lévy prepared a plan for a museum of science, technology and industry in late 1977, and in 1980 the architect Adrien Fainsilber was chosen to prepare a design for conversion of the main meat market into a museum. Lévy was appointed director of the museum in 1983.

The Géode, a spherical stainless steel structure at the south entrance of the main building, opened in May 1985 as a film theater seating 354 visitors at a time. Its hemispheric screen, the largest in the world, has a diameter of 26 meters and a surface area of 1000 square meters. The theater is equipped with an Omnimax projection system developed in Canada, which runs 70-mm film horizontally through the projector at a rate of 24 images per second. Developed by IMAX Systems Corporation in Toronto, Omnimax is an outgrowth of IMAX, the large-screen projection system used in the National Air and Space Museum in Washington. At the end of 1986 there were 43 Omnimax and IMAX theaters in 13 countries, and by the end of this year there will be 57: 30 Omnimax and 27 IMAX. The key to the systems, the rolling-loop projector, was invented by an Australian named Ron Jones and was adapted to large formats by IMAX, which purchased his patents.

The Géode has been an enormous popular success and all its early performances were sold out, Friedman says. The main museum itself may be somewhat slower to win popularity and acclaim. French President François



The City of Science and Industry at La Villette, a Paris suburb, is shown here shortly before it opened to the public. The spherical stainless steel structure at the entrance, the *Géode*, is a theater in which Omnimax films are projected onto a huge hemispheric screen.

Mitterrand dedicated the museum on 13 March last year, as scheduled, and the next day, one day shy of the *ides*, it opened to the general public. Some initial visitors were disappointed, a French official said in an interview last June, that there was "so little there."

Lévy reports that "since opening, most of the exhibits have been completed so that at the beginning of 1987 it is now operating at virtually its full regime." The museum had three million visitors during its first nine months and it expects five million this year.

Grand scale. The building is an awesome four-floor structure supported by black and blue girders, with twin-column pipes at opposite ends of the main hall and sunken skylights in the roof. Overall, it is reminiscent of the Pompidou Center in downtown Paris and the US National Air and Space Museum, the most popular of all science-technology centers.

Like the Pompidou Center, which houses one of the finest modern art collections in the world, La Villette is not for the agoraphobic or acrophobic. The main exhibition area covers 320 000 square feet on three levels, connected by a complicated system of escalators, iron staircases and catwalks. The space is not surveyable at a glance, and even with the help of a map it is not always easy to find one's way from one exhibit area to another. When we visited the museum last June, we noticed that pupils visiting the museum often seemed disoriented and confused as they were hurried about

from area to area.

The La Villette science center was created at a cost of 4.45 billion francs (about \$685 million at current exchange rates), with about 60% going for construction and 40% for exhibits. The main exhibit areas are the *Explora*, which is devoted to the permanent science exhibits; the *Inventorium*, a kind of museum in miniature for smaller children; and the *Espace Diderot*, which will be devoted to temporary exhibits. The admission charges are 30 francs for the *Explora*, 15 francs for the *Inventorium* and 16 francs for *Espace Diderot*.

The special exhibit area will be enriched starting in May by a version of the *Exploratorium* show on light, which La Villette commissioned after getting news of IBM's plan to clone the show and exhibit it in Manhattan. The French version of the show is likely to be housed in a provincial museum after its tour at La Villette.

Smaller museums. Museums and exhibits need not be huge to be rewarding. Lewis Slack, director for educational programs at the American Institute of Physics, observes that exciting small museums can be found, among other places, in Ann Arbor, Michigan, where Cynthia Yao opened a museum in an old firehouse, and in San Diego, where a set of exhibits first was installed as a kind of sideshow and holding area when the country's first Omnimax theater was set up in 1973. Slack notes that most such museums have been much influenced by the

Exploratorium and its exhibit "cook-books." To date, the *Exploratorium* has published three such manuals on the design of interactive exhibits.

San Diego's Reuben H. Fleet Space Theater and Science Center went through a rebirth of sorts starting in 1982, when it was decided to expand and remodel the exhibit area with help from the Fleet Foundation. The museum brought in Elsa Feher, a professor of natural sciences at San Diego State University, as a consultant, and Feher proceeded to spend a month studying at the *Exploratorium*. The philosophy of the *Exploratorium*, as she sees it, is to build "exhibits that have parameters that can be explored." That is, an exhibit should be something more than a device that is simply activated when a button is pushed.

Elaborating on the modern science center philosophy in San Francisco this January, Feher said it was summed up by what she understood was an old Chinese proverb: "I see and I forget; I hear and I remember; I do and I understand."

San Diego's science center currently has about 65 exhibits about light and vision, sound and hearing, and human physiology. With approximately 15 000 square feet of exhibit space, it is about one-tenth the size of the *Exploratorium*.

Baltimore, an increasingly popular location for science conventions, also is the home of a science center that will appeal to those who like their science museums on a human scale. While the Maryland Science Center may not be quite in the same class as Baltimore's aquarium, which is one of the world's very best, it provides a worthy companion. The museum and the aquarium flank Baltimore's Harborplace complex of restaurants and boutiques, where the frigate USS *Constellation* is docked, and the complex as a whole provides enough edification and entertainment to satisfy a whole family for at least a couple of days.

In the making for the last ten years, the Maryland Science Center now includes a planetarium, a theater and classrooms. An IMAX theater will open in June. Permanent exhibits are housed mainly on the second floor and special exhibits on the third. The first floor has an excellent small aquarium providing a cross section of Chesapeake Bay ecology in miniature, and another permanent exhibit on the ground floor is devoted to Maryland.

The second floor exhibits include a show devoted to light and vision, which is similar to the *Exploratorium* show but smaller and simpler, an area devoted to computers and computer logic, and some exhibits on mechanics that

are doubly interactive: The visitor can manipulate things such as weights on swings while at the same time selecting and executing experiments with the help of a computer and video terminal. These kinds of exhibits, which were first developed by Eva Van Rennes at the Cranbrook Institute in Detroit, seem to be particularly appealing to both parents and children.

An exhibit area devoted to energy is perhaps less successful, in that it tends to present attitudes toward energy policy as though they were scientific conclusions whereas in fact they represent preferred answers to highly controversial questions.

Adjacent to the energy and mechanics exhibits is a special area that was occupied last fall by an IBM-sponsored exhibit on superconductivity, "The world of the supercold." That exhibit, which consists of diagrams and captions explaining temperature scales, the Joule-Thomson effect, Josephson junctions and squids, has left Baltimore in the meantime, going in February to the Naval Postgraduate School in Monterey, where it will stay until July.

The IBM show is unusual in that it makes no concession to the touch-and-manipulate style. The shows currently occupying Baltimore's special display space, an exhibit on holography and a selection of Harold E. Edgerton's strobe photographs, also are relatively traditional stylistically.

In yet another traditional kind of show, the work of Berenice Abbott, a contemporary of Edgerton who took physics photos with both aesthetic and scientific concerns in mind, currently is being exhibited at the New York Academy of Sciences. The Abbott exhibit is part of an ongoing series of shows on the place of modern physics in modern art, "Art at the Academy," which is run by Joelle Burrows and is sponsored by Novo Industri A/S of Denmark.

Alternative styles. The tenacity and vitality of traditional types of museums and museum concepts should not be underestimated. Nothing is more passive and less interactive than watching a film or a planetarium show, but planetariums continue to attract large crowds, and nothing is more successful than the IMAX or Omnimax film.

Zee Ann Mason of the Franklin Institute points out that many of the museum's most popular exhibits are historical artifacts such as the actual workshop of the Wright brothers or replicas of artifacts such as Galileo's telescopes. While the institute is absolutely not mainly a "glass case kind of place," Mason says, the historical objects often are very beautiful and the museum likes the interactive exhibits

to be more polished than is characteristic of the Exploratorium look. And by the way, she adds, the Franklin Institute already was interested in interactive exhibits before Frank Oppenheimer came along.

Eustace Mendis, a longtime staff member of the Ontario Science Center and another big name in science museum design, says they found at Toronto that many members of the public are turned off by exhibits done in the Exploratorium's most stripped-down style. "It seems to suggest complexity to them," Mendis says.

Everybody who has visited both the Exploratorium and the Ontario Science Center remarks on the strikingly different auras of the two museums, despite the similarity of the educational philosophies their designs reputedly are based on. While the Toronto center is open to the outside world, classy and relaxing, the Exploratorium resembles an airplane hangar in which children and adults dart about in a virtual frenzy to experience at least a fraction of the 600 exhibits. "The Exploratorium feels like a lab, Toronto like a corporate headquarters," Mendis says.

San Jose Technology Center. Mendis currently is working as the science director for the museum being planned for San Jose. Its focus is to be the science and technology associated with the electronics and biotechnology industries.

The Technology Center, which has been in planning for nearly a decade, is to have an exhibit area of about 200 000 square feet and is intended to be a hands-on learning center supported largely by the high-technology industries of Silicon Valley. Ricardo Legorreta, a noted Mexican architect, has been selected to do a site plan as well as designs for the center and an adjacent children's "discovery building." Peter Giles, a San Jose business consultant, has just joined the Technology Center as president.

The city of San Jose is expected to put up about \$30 million for construction of the museum and another \$5 million or so for site preparation. Backers of the museum hope to finalize an agreement with the city in the first half of this year. After that they will need to raise about \$36 million from private sources to support design and construction of exhibits. If all goes as hoped, ground could be broken for the center in 1989.

The Technology Center will be "similar to the older science museums in that we are unabashedly celebrating technology," Mendis says. "What is different is that the older museums all were done after the fact, after the first industrial revolution, while we are right in the middle of another technolo-

gical revolution. We don't know where we are going but we know the potentials."

The Technology Center will be concerned less with conveying what technology is than what it can do. "Gee, I didn't know this was possible, and wow, can you imagine what we will be able to do five years from now," is what the museum staff wants visitors to think and feel, Mendis says.

—WILLIAM SWEET

White takes up Oppenheimer's mantle at Exploratorium

Robert L. White of Stanford University has been named new director of the San Francisco Exploratorium, it was announced on 9 February. White will take office on 1 April as the successor to the late Frank Oppenheimer, who died in February 1985. Since Oppenheimer's death, Virginia Carolla Rubin has served as acting director and Robert Semper as deputy director.

White earned his BA in physics and mathematics and his MA and PhD in physics, all at Columbia University, in 1949, 1951 and 1954. After finishing his doctorate he joined Hughes Research Laboratories and eventually became associate head of the atomic physics department. In 1961 he became head of the magnetism department at GTE's Palo Alto Research Lab, where he participated in and directed research on magnetic materials, lasers and phosphors. He joined the faculty of Stanford University in 1963 and served as chairman of the department of electrical engineering from 1979 to 1986.

White also has been a Guggenheim Research Fellow at Oxford University and at the Eidgenössische Technische Hochschule in Zurich, a visiting professor at the University of Tokyo and Christensen Fellow at St. Catherine's College, Oxford.

White's most recent research has been on the development of an implantable electronic ear for the profoundly deaf, which has brought him into contact with work on perception and cognition. White says that he is "totally in agreement with and enthusiastic about the stated and traditional mission of the Exploratorium, which is to make science, art and perception comprehensible and fun for everyone. I hope to see the domains in which the Exploratorium has good exhibit coverage extended in the foreseeable future to include more mathematics—which is already in progress—chemistry, medicine and the life sciences, and to extend into the kinds of science that underpin our modern technology." □