

something incredibly wonderful happens

Frank Oppenheimer and the World He Made Up

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(chapter 8):

## **A DECENT RESPECT FOR TASTE**

"I cannot really say that I have noticed any difference in the way visitors to the Exploratorium behave on sunny and cloudy days. But for the staff and especially for me, and my feeling for you when you come to visit, whether the sun is turned on or not makes an incredible difference. This is because of the Sun Painting. I think it crucially important to have an exhibit of such scale and beauty . . . The exhibit demonstrates light scattering, prisms and mirrors and color, and sunlight. It is a brilliant abstract painting that shimmers and changes as people move in the light path and brush against the Mylar mirrors behind the frosted screen. We have other exhibits of beauty, and without them the museum would be sterile and incomplete; but none are so fine as the Sun Painting."

To Frank, it would have been all but pointless to build a science museum that didn't include art in a serious way. In his eyes, the two were inseparable: "One Cannot truly understand nature without also discovering the ways in which it is related to human experience and feeling," he said, "and one cannot appreciate human experiences without learning that they are imbedded in a broad concept of nature."

It was, in fact, impossible to discriminate between art and science at the Exploratorium. When Buckminster Fuller stopped by for a visit, a woman accompanying Fuller sniffed, "I thought this was an art museum. Where's the art?" Fuller waved his arm expansively, saying, "It's all around you."

Early on, I remember experiencing the same confusion myself. I asked Bill Parker - whose "Lightning Balls" have since become standard toys available in many science museums-whether he considered his plasma discharge sculptures art or science. "Neither," he said. "It's nature."

I was also taken aback at first when Frank described particle accelerators as modern analogues of Gothic cathedrals - but of course, he was right. Both are stupendous creations of human minds designed to reach out to the unknown and ask the most profound questions. And as much as scientists create art, artists do science - often adopting forefront technologies or new understandings of visual perception. Artists make intellectual decisions and scientists make aesthetic ones.

So almost immediately after the museum opened its doors, artists started bringing their works to the Exploratorium. The word got out that "anything goes," as Bob Miller remembers it. Bob was living in a dingy apartment in North Beach, experimenting with a rack of prisms and small slivers of mirror, when he heard from an artist friend about a strange scientist who was building some kind of new place at the Palace of Fine Arts. Bob invited

Frank over to look at his work. Frank hired Bob on the spot, asking, "How soon can you come over and play?"

The experiment with prisms and mirrors turned into the "Sun Painting," in which a palette of pure color extracted from sunlight creates three-dimensional otherworldly landscapes - a swirling wash of color that spread over the Exploratorium's entrance as webs of pure gold and green and blue and red; wandering through the light felt like swimming in an underwater rainbow.

In keeping with the Exploratorium's philosophy of total honesty, the "Sun Painting" shows its colors only when the light from our local star does. Waiting for the sun to break through the San Francisco fog and bring the sculpture to life could be an endless purgatory of tried patience - and on gloomy days, it didn't come on at all. The experience felt, as Muriel Rukeyser put it in her poem "The Sun Painter," "a good deal like real life."

Many of the earliest exhibits at the Exploratorium were creations of artists. A typical piece was "Bathroom Window Optics," ghostly geometrical light forms that seemed almost alive, transforming in shape and size as one approached. On closer inspection, it turned out that the shapes were made by ordinary Christmas tree lights filtered through textured glass of the type used to diffuse light in bathroom windows and shower stalls. It was so simple, and yet it produced such fantastical effects.

One pivotal piece of (dare I say) serendipity was the donation of the "Cybernetic Serendipity" exhibition from the Corcoran Gallery in Washington, D.C. One piece turned sound into ever-changing images on a television screen. Some people talked or screamed into it, but a pure voice or the sound of a flute could produce quite beautiful forms. One day, a deaf child stayed at the exhibit for nearly an hour, making sounds and watching the patterns. The child was entranced to see that what he was doing with his mouth and throat was having such a singular effect. He stayed there so long he got hoarse.

The show had been put together originally by the Institute of Contemporary Art in London before moving to the Corcoran Annex in Washington. Frank talked the Corcoran into lending it to his nascent museum. When it turned out to be too expensive to ship, the Corcoran's staff rented a van and drove it across the Country themselves, and then helped set it up. The exhibit convinced Frank that art could have a major role at the Exploratorium.

The artist August Coppola (brother of Francis, the film director) came by and decided he wanted to build something that had to do with "touch and tactile" senses. So he got a little money from the National Endowment for the Arts and brought in dozens of students, who worked all summer without pay; he persuaded an engineer and an architect to lend their expertise. The "Tactile Gallery," as it became known, is a pitch-dark multistory rabbit hole where people feel their way through a maze of artistically rendered "chutes and ladders" (the metaphor is mixed, but apt) and wind up in a . . . well, that would be like giving away the end of a mystery story.

Tad Bridenthal brought in his “Limbic System,” a crawl-into sculpture of infinitely reflecting colored lights, which became the cover art for my article in the Saturday Review. (Alas, people tell me that the artist later either accidentally dropped or deliberately threw the sculpture off the back of his truck.)

The physicist Jan Pusina remembers being a “poor struggling artist” when he walked into the Exploratorium and met Frank. He built a “Multiplied Glockenspiel,” and Frank was delighted to discover it created “artificial harmonics.”

An Englishman stopped by on his way to Australia and left his “Light Form,” a ghostly impressionist sculpture created by light reflecting off rapidly revolving brushed-metal plates. A student at San Francisco State University brought in a “Polaroid Projector,” which created shifting, brightly colored patterns out of plain white light using only two plastic Polaroid filters, cellophane tape, and an overhead projector.

Jackie Oppenheimer discovered Ben Hazard’s “Pinball Machine” -- a mesmerizing installation that exploited polarization to create an ever-changing landscape of colored forms -- in the Oakland Museum. Doug Hollis created an Aeolian harp that perched on the roof over the entrance like a spindly singing insect, long threads attached to speakers, greeting visitors with a low drone, as if the building were humming to itself - rather like Frank himself.

This infusion of art wasn’t restricted to physical stuff. The Exploratorium was a three-dimensional blank slate, a magnet for all kinds of innovators. The publisher Stewart Brand had parties there to raise money for the Whole Earth Catalog. Artists and musicians used it as a venue for sometimes wild experiments.

One musician, in preparation for a concert, spent the afternoon in the shop cutting up tiny Strips of mirrors. He clamped them onto a frame, put transducers on selected ones, and stuck them on the glass. Then he hooked them up to a sound mixer and installed an amplifier with humongous speakers. As the concert began, he shined lights on the mirrors. He hit the mirrors with a tiny mallet to make them vibrate, sending out screeching tones. Finally, he turned up the volume as high as it would go and hit the mirrors harder and harder until they started breaking. By the end of the performance, nothing remained but shattered glass.

Another group of musicians put choirs at opposite ends of the huge cavern; they wanted to experiment with the two-second delay created as the sound waves made their way from either end of the building, but since the choirs couldn’t see each other, it was very hard to conduct.

“The place was almost empty,” Frank said. “There was just this thousand-foot-long space. The music was just incredible. One person, Dinwitty, wrote a special composition just for the space. Then there was Carlos Carvajal, he had a small dance group here. Holden had a concert. That just kept up.”

(Of course, being Frank's place, the Exploratorium had its fair share of unplanned events. Someone brought in a nineteenth-century projector, with hand-painted slides and a kerosene lamp inside. One day it caught fire. "There were great flames," Frank recalled. "All the public visitors stood around and looked at it, waiting to see what was going to happen, assuming it was just another exhibit." Frank ran to grab a fire extinguisher. "But for the visitors, it was just a normal thing happening in the Exploratorium.")

By 1976 there were short films on weekends, a program put together by Liz Keim (and still going strong, with Liz as curator). Liz came to the Exploratorium as a weekend receptionist and Quietly became part of Frank's family. Frank hardly ever missed a screening. "He would see a film and tell me why it really worked in terms of the rhythms of the music and the image," Liz said. "And if anybody ever laid music over a film that wasn't intrinsic, it would infuriate him."

Frank invited poets to read, painters to paint. In the San Francisco Bay area, the Exploratorium became known as one of the major arenas for new music, new film, new art. He asked his friend Muriel Rukeyser to come and help with writing explanations: "How does one explain lateral inhibition in the retina of the eye, or the way in which light waves can cancel each other to produce darkness from light?" he asked. "How does one imagine electricity?" He thought a poet could come to his rescue. But it wasn't so easy – and was much more interesting. "It turns out that the communications of the poet do not necessarily pop out automatically to the uninitiated any more readily than do those of the physicist," Frank said. "Muriel could help, but she frequently had to start from scratch along with the rest of us."

What usually happened was that people asked Muriel to read. And so Frank and Muriel put on a series of "Readings on the Forefront of Science and Poetry." Writers would read their poems, and scientists would read whatever they had written, and then people would talk about the similarities and differences between the ways scientists and poets use imagery, how they perceive meaning, how they describe newly discovered phenomena. "At the leading edge of experience in philosophy, science and feeling," Frank mused, "there is inevitably a groping for language to translate the insecure novelty of noticing and understanding into a precision of meaning and imagery."

Frank attended most of the sessions. He noted that when science was young, before jargon had become standardized, scientific writing was not so "dehumanized" as it is today. And while he tried to find differences in the ways physicists and poets communicated, he could not. "Both could evoke expressions of caring, of imagination, and of passion. Both could be either starkly descriptive or intensely polemic."

During a discussion after one of the readings, Frank complained that many of the young physicists he encountered didn't seem to really care about the answers to the questions they raised in their research. One of the poets was surprised at his comment. Like most people, she thought scientists weren't supposed to

care. "What a strange misconception has been taught to people," Frank said. "They have been taught that one cannot be disciplined enough to discover the truth unless one is indifferent to it. Actually there is no point in looking for the truth unless what it is makes a difference."

### **A Decent Respect for Taste**

"Why do we admire children when they build a pattern of objects with great symmetry, but then refuse to understand that when they 'ruin' it with a misplaced object, they, in fact, have made an aesthetic decision?"

Art and music had always been central to Frank's life. His flute went with him everywhere, whether he was in the mountains, on a boat, or in the office. You'd be in the midst of a conversation and suddenly Frank would be gone; you'd be answered with a sweet snatch of Bach or Purcell. He encouraged the staff to play as well, putting on "talent shows" where staff members would play the piano or display their photography or paintings. He encouraged my early efforts at the flute, and later - awful as I was - we'd play together while his second wife, Milly, accompanied us on piano. I remember telling Frank (only partly in jest) that if I could learn physics and the flute, then surely I could learn just about anything. Perhaps I would try my hand at painting. Frank shook his head. "Painting is hard," he said.

When I visited Frank at his home in Sausalito, I bumped into art everywhere, from the Picasso drawing in Frank's office to the silly wooden quacking duck hanging from the ceiling. By the time I met him, most of his art collection had been sold - some to support the family during their years of exile - so that only some Picassos remained. Still, few people walked into Frank's house without being stunned by the Blue Period Mother and Child hanging without fanfare in the living room. When Frank was teaching in Colorado, a graduate student went to visit him at home. "That's the best Picasso imitation I've ever seen," he said. He was shocked when Frank responded matter-of-factly, "It's not an imitation."

In Frank's mind, aesthetics had a place in the most mundane things. He railed at objects that didn't "feel nice" - usually if something was frustrating or aggravating in some way. Vacuum cleaners were high on his list. "They are hard to steer and they make that awful noise. It's because nobody cares what it is like to use one."

He hated buying batteries in a plastic package that you had to cut open with a knife. "It makes that awful crinkly noise." Batteries should be sold loose, he insisted. "And frankfurters too! I don't like them packaged. They are all sort of shrunk that way." One of the few museums he didn't like was the Guggenheim in New York, because you could walk only one way, and even if you went against the stream, you had to go in a particular order.

At the same time, he took great aesthetic pleasure in things others might find decidedly distasteful. When Frank visited my home in Port Washington, New York, during an oppressively muggy

summer, he immediately pronounced, "What a glorious day!" At his insistence, we took a leaky rowboat out to our ancient O'Day Mariner, Frank in his business suit, water up to his ankles, humming as he bailed water. He stood on the bow of our boat with his suit coat open to catch the nonexistent wind. Reveling in it all.

Frank's often peculiar "aesthetic" once played a role in an uncomfortably close encounter between Orestes and me. It happened one weekend when Frank and Jackie and I drove to Bodega Bay, on the northern California coast, to look at some property they'd bought. Orestes came along as always, taking up most of the back seat of Jackie's broken-down Plymouth Barracuda, while I squeezed myself into the other corner. (*I don't hate dogs, really; I have a big black Lab myself; Orestes was an entirely different matter.*) Orestes smelled bad even in the best of times, but then Frank and Jackie thought he should get out for a run, so we stopped the car, and the dog ran out and disappeared. A half hour later, he returned, encrusted in cow dung, and resumed his sprawl on the back seat. I was disgusted beyond words; Frank found the episode funny – a broad comedy of the "city girl meets country dog" variety.

He later wrote an essay about the subject of smell in which he admitted liking all manner of odors, including acetone, ether, manure, dirty socks, even a "whiff of skunk." He found it remarkable that every part of the human body - ears, mouth, underarms, feet - had its own strong smell. And he was disturbed that advertisements implied that smells like sweat were offensive. It was part of a "concerted attempt to sterilize human experience," he wrote, "part of the set of rules that say we are not to raise our voices, not to argue about religion, not to revolutionize politics, not to be awake when we should be asleep or drowsy when we should be awake or ever miserable or mischievous.

"We can now be odorless when we smell. But have you ever cringed as you rushed to your car in the rain? I have! Then with a flash of insight I say to myself, 'What the hell?' and I walk slowly with my face skyward, letting it be washed by the rain."

He concluded the essay in a way that almost suggested a connection between the use of deodorant and the mindset that led to the use of the atomic bomb: "We might know each other better and more humanly if we ignored the deodorants that are foisted on us and stuck to plain soap. It is silly to scoff at inventions, but it is equally foolish to let them carry us where we do not want to go. We do not need all the different kinds of umbrellas that we have invented. They get out of hand and instead of protecting us from nature, they isolate us from it and so from each other."

For a man who almost always wore a suit and tie, whose tastes were so refined and whose manners were so gentle, this disdain for coverings and filterings of all kinds was oddly out of kilter. But it was consistent with his insistently inconsistent character. He was both cultured and crude, airy-fairy idealistic and intensely practical, on a cloud and down-to-earth, smooth and elegant and rough-and-tumble. Somewhere along the line, the filters had fallen off, the internal Caution signs we all carry around ceased to work - or perhaps, given what he'd been through, they no longer seemed to

matter. Either way, the result was that his sense of aesthetics could be all over the map.

Frank's aesthetic pervaded every aspect of the Exploratorium, right down to the doorknobs. "It may actually be better to make a doorknob square, but those big heavy round doorknobs feel nicer," he said. "They're really lovely. So we use them." He even made an exhibit out of an enormous ball bearing, which he simply put out on the floor with a sign that read "Some machinery feels nice."

The fact that children could run around the museum at will was part of Frank's aesthetic too. And years later, when the Exploratorium was forced to charge admission, he came up with the idea that each entry ticket should buy a six-month pass. Though he didn't want to charge admission at all, this solution, he said, "felt nice." In fact, most of the decisions he made about the Exploratorium, he later concluded, were based on "things that I'd like to happen to me."

For aesthetics to become deeply ingrained, Frank thought, a "decent respect for taste" should be inculcated in the very young even when the choices might upset their parents or teachers. He believed, for example, that children should be allowed to choose their own clothes from the earliest ages, no matter how outlandish the outfits. One day at lunch, in a rather fancy restaurant, he encouraged my then four-year-old son to play with the silverware and - hey, why not? - the food. Frank thought children weren't even encouraged to believe they could convey something important in the paintings they did in school.

"We need to look at children with new eyes," he wrote. "Why do we self-righteously ignore (and even berate) children's intense discrimination among textures and tastes of food, or object to their enjoyment of the feel of food on their hands and faces? Why does a group of adults invariably laugh at children when, As two-year-olds, they begin to move in response to music? Why do we refuse to recognize that knocking down a just built, Teetery structure of blocks is a fine example of an order-disorder transition?"

As an example of such early aesthetic sensibilities, he often told the story of a four-year-old girl he watched uttering "a shriek of delight after watching a rather spectacular disorder-to-order transition." A boatman at a lake in Golden Gate Park was preparing to move the public rowboats from the docks to a shed in the middle of the lake, where they were stored at night. "He started by untying them from the dock and tying them together in an impossible looking, random mess of every which way boats," Frank wrote. "The four-year-old looked on with increasing anxiety. Finally, the boatman attached his putt-putt to one of the boats And took off. The fifty or so boats broke out of their tangled web And followed him in two lines that formed a beautifully curved symmetric 'V.' It was at that point that the four-year-old burst forth with her shriek of aesthetic delight."

As for the toys children were normally expected to play with,

Frank thought they were “an abomination,” because “they do not feel nice.” Frank thought that toy stores should stock their shelves with “commercial, industrial and military surplus items.” He himself vividly remembered the pleasure of being five years old and “sinking submarines” by hurling “a large, marvelously built and balanced screwdriver” at tin cans.

He also remembered with delight a multiwire egg slicer he discovered in a kitchen drawer. “Such slicers still exist, but they were stronger and tougher in my day,” he wrote. “They made wonderful music as one twanged the five or six strings that were each somehow under slightly different tension. I still twang egg slicers whenever I find one, but I am usually disappointed. They do not feel or sound as nice as the one in our kitchen used to feel and sound.”

It was the aesthetic of such toys, he believed, that helps children develop taste - helps them recognize what is nice, what is beautiful, what is humanly desirable. He wondered whether toys were an introduction to art. “Toys that are well conceived and not just junk may be the prime movers that induce people to strive for a nicer and nicer world in which to live,” he said.

Frank himself loved to give people toys - not surprisingly, very nice ones. He gave my son a stopwatch and a microscope-spyglass combination before he was six years old. He gave the perception researcher Richard Gregory a variable prism. “He loved ingenious gadgets,” Gregory remembered. Many of these toys he made himself - a necklace of ball bearings, a pendulum toy. I treasure the brass top he turned for me on a lathe: Frank designed it to “sleep,” as he put it. Normally, a top precesses as it spins, tilting tipsily as it swirls, but Frank’s top spins perfectly upright until it runs out of steam and falls over flat. He also made me an “earthquake-proof” flute stand with a huge hunk of lead worked into the wooden base.

One of the reasons Frank valued play so highly is that it is one of the few activities that explicitly encourages people to rely on their sense of aesthetics. In play, you try something because you like it. You do things that are pleasing, that seem “right” in one way or another, that reward the senses. This “aesthetic feel,” he believed, was a critically important human quality. Taste was an intellectual tool as valuable as logic, empathy, or common sense.

### **A Matter of Urgency**

“It’s through familiarity with the arts that I think we will make the kinds of changes that make life stay human.”

A respect for aesthetics, Frank thought, should be a central part of sound decision-making. He didn’t think it would be out of place - though he admitted it would be impractical - if Congress, unable to decide on a difficult matter, took a recess to visit the National Gallery for guidance. “Art,” he liked to say, “is not valid merely to decorate our surroundings with statues in the plazas of skyscrapers, any more than science is valid because it provides the conveniences of electric shavers.”



When people said, "We need more art," Frank complained, they tended to say it in the same tone of voice they used to say, "We need more trees." True, both art and trees make our surroundings more pleasant, but artists also make discoveries about nature and human nature that are on the same level as the discoveries scientists make. And in the same way that we can make better decisions about global warming if we know what scientists have discovered about the earth's changing climate, so we can make better decisions about human affairs and environments if we pay better attention to what artists have learned.

Frank worried a lot that the arts were undervalued, and that aesthetic considerations were largely ignored whether people were designing schools, supermarkets, bridges, or "topless dance joints, nuclear weapons, and homes for the aged." If money was tight, aesthetics was the first thing to go.

"We're in terrible trouble because of that," he said. Historically, places that respected the arts and based decisions on aesthetics were also places where "better things happen," he argued. If art were considered more important, he wrote to David Rockefeller, "many of the things that now shock or degrade people's sensitivities would not be tolerated."

Of course, as a physicist Frank had learned to trust aesthetics. Scientists often try things because they "smell right." They believe in theories because the mathematics behind them are "beautiful," even when they contradict evidence. Like artists, scientists develop an eye (and ear) for nature, a sense of what is true and what is not. Laypeople, too, should be encouraged to rely on their aesthetic sense to guide their decisions, Frank thought; if a certain course of action or behavior struck them as "ugly," then it probably was.

Artists and scientists, Frank liked to say, are the official "noticers" of society - those who help us pay attention to things we've either never learned to see or have learned to ignore. Artists of all ages and in all lands have traditionally sensitized people to nature through their poetry and painting, sculpture and drama, and, less obviously, through their music. Without art, "one even ignores what people's faces are like," Frank said, "but by seeing paintings of people's faces you begin to look at them again, and I think that the same thing is true of science. You look at the sky and you see the stars, and it is just an amorphous mass; but suddenly somebody talks to you about it and you see that some stars move with respect to other stars."

He gave artists credit for teaching us great human truths. Without art we might not have recognized the universality of the feeling between mother and child, he said, or the emotion between man and woman.

"If you don't know how to notice, you can't do anything well," Frank said. "You can't even relate to people well." You can't tell if someone is angry or amused or hurt, or if the weather is about to change and maybe you should get an umbrella. You'll miss that guy lurking in the shadows, and Saturn shining overhead.

Frank wondered why urban planners didn't look at paintings in order to learn how to design cities; why architects didn't look at Cézannes to design cafes; why people didn't look at portraits to find meaning and wonder in the transformations that occur in aging faces and bodies. Why didn't people realize that paintings enable us to find pattern and structure in scenes that would otherwise seem shapeless, amorphous, and emotionless?

So above all else, the Exploratorium was a place that encouraged the kind of everyday noticing that helped people develop an eye and ear and feel for the social and physical universe around them – an almost artistic sensibility.

Visitors to the Exploratorium certainly build up intuitive feelings for physical phenomena as much from artistic works as from "science" exhibits - whether the subject is wave mechanics or the nature of light or fluid dynamics or the quantum properties of matter. To this day, when I imagine stars being born from swirling interstellar clouds, I think of Ned Kahn's "Whirlpool"; when I think of exotic bits of matter coming into being seemingly out of nothing, I see his "Visible Effects of the Invisible." Most of my intuitive feel for light and color and shadow and reflection comes from Bob Miller, and there is a lot of the spinning black hole in Doug Hollis's "Vortex."

Even in terms of process, Frank pointed out, artists and scientists work in similar ways. They both start by noticing patterns in space and time, trying to make sense of them, rearranging them, and then linking patterns together in ways no one had thought to do before. They make sketches with equations or charcoal. They elaborate and synthesize. "They end up with a composition which means more than what they started with," Frank wrote – melodies and theories. In essence, they make patterns of patterns that reveal new insights. Their compositions, theories, and other works separate relevancies from trivialities; provide a framework for memory; reassure by creating order out of confusion.

Of course, all people spend much of their time perceiving and making sense of patterns; even animals do it (the dog knows exactly what follows the fetching of the leash). Frank once told me that when he can't see a pattern, he gets "miserable." But artists and scientists spend their whole lives looking for patterns in nature, and so perhaps learn to see more than the rest of us.

To Frank, artists were people who looked at human experience in the same way astronomers looked at the sky through telescopes. Just as astronomers collect, codify, interpret, and communicate what is known about the stars, so artists collect, codify, interpret, and communicate what we know about human feelings.

The reason we need this knowledge so much, he argued, is the rapid pace of change. If things didn't change, then perhaps education could simply be a matter of learning to conduct business and follow directions. But everything in nature changes. People inevitably change the world in which they live. They change themselves. And as people(s) change, at some level there's always a worry that we might lose some of that indefinable and

extraordinary specialness that makes people human. And who can define that essential nature of humanity we so want to preserve? Who can tell us (or remind us) what is fine, what is beautiful, what is important, in humankind? Frank claimed that was the role of artists.

Decisions about how to adapt to inevitable changes are based, by necessity, on what we believe is possible. Science tells us what is possible in the physical realm, and in doing so, gives us a basis for action. If we don't know that it's possible to make antibiotics, for example, we won't learn how to protect ourselves against disease. In the same way, Frank thought, art tells us what is possible in human experience. What's more, it tells us how we feel about the various possibilities - or at least how an individual artist feels, and therefore one way it is possible to feel. "If you don't know those things, you are not going to make good decisions," he said.

And just as technological inventions help us cope with changes in the external environment, we need "heightened social and emotional awareness and invention," Frank said, to cope with changes in the human environment.

### **Alien Territory**

"There are two things that people [are surrounded by and] avoid trying to understand. One is music, and the other is electricity."

If science seems unfamiliar territory - a realm where strange characters do obscure things with complicated machinery - at least it is territory that is socially acceptable to steer clear of. Art is another matter. Because art is "culture," it is a realm where everyone (everyone who is not a barbarian) is expected to be at home.

Yet museums and art galleries can seem less than welcoming to outsiders. Some are musty and mausoleum-like, places of reverence where you can almost smell the incense and holy water, final resting places for artifacts of long-dead worlds - as remote and untouchable figuratively as physically. Others are antiseptic and sterile - dead in a different way (they often seem to maintain this aura even when the artworks themselves are playful). The appropriate emotion in either case is awe. One treads silently and cautiously, avoiding at all costs public displays of ignorance or confusion or emotion. (And oh, the stares you'll get at the symphony should you commit the faux pas of applauding between movements!)

For most people, museums fall into the same category as church or school - places to be revered more than really enjoyed, places to learn and appreciate rather than to play, places of silence and solemnity. In a very real sense, museums are preserves that keep precious objects safe from people.

So for me, nothing was quite so unorthodox as Frank's take on museums, which he loved in the same passionate, meddling way he did everything else. For one thing, art, according to Frank, was an absolutely appropriate venue for play, and also for breaking rules. Going to museums with him turned my long-held notions

upside down, changing museums from repositories of things to adventure parks. You should race around, talk loudly, laugh, and touch just about anything when the guard isn't looking.

On one occasion when Frank was visiting New York, we went to see an exhibit at the Whitney Museum of Duane Hanson's un-cannily lifelike sculptures of ordinary people: the woman laden with shopping bags, the camera-toting tourists, the janitor. Suddenly I noticed that Frank wasn't there. It took me a few moments before I realized that he'd hidden himself by freezing into the backdrop of the art, posing as a Hanson sculpture. He wanted to see if anyone would poke him to find out if he was real. He got the idea because he himself had just poked a very still, but very alive, security guard - thinking the guard might be a statue. He was so amused, he wanted to try the same experiment on himself.

Frank well understood that for many people, art was every bit as intimidating as science. And not only was art itself alien territory: artists - like scientists - were often seen as strange characters who do unpredictable, outrageous, sometimes dangerous things. If scientists were logical robots, artists were creative freaks whose work had nothing to do with our daily lives.

One of the reasons for this attitude, Frank thought, was the fact that the work of both artists and scientists was increasingly inaccessible to the general public, increasingly removed from ordinary experience. Neither the public nor students were expected to understand the latest discoveries in physics. And yet people were expected to understand contemporary art even if they had no background in the arts whatsoever-and that made them feel confused, stupid, and distrustful. In school, children were often exposed to "modern" art divorced from context or history - given no tools to help them "read" a poem or a painting or really listen to a piece of music. Art was too often taught as science is - as a "nonexperiential and hollow mimicry of what artists (or scientists) are publishing at the forefront of the field."

Artists shared some of the blame for this situation, just as many scientists shared some of the blame for the impenetrability (to the general public) of much of science. "Contemporary artists," Frank wrote, "tend to either sneer at people who cannot extract meaning from their works or, alternately, deny that their works have meaning, insisting that they should be appreciated as meaningless aesthetic experiences."

So Frank hoped the Exploratorium might do for art what it did for science-make people comfortable and involved enough to participate in the process, to ask themselves questions like "What if?" What if I tuned the frequency as high as it could go? How would changing a single element in a painting alter its impact?

One quasi-didactic attempt to make people ask questions of art and one of my personal favorites - was an installation exploring the use of balance in Saul Steinberg's drawings. The drawings were enlarged and mounted, but an element would be deliberately taken out and instead put on a plastic overlay, which the visitor

could add or remove to see how balance was achieved - not just through composition, but also through meaning.

This was dramatically illustrated by a sculpture that towered over the exhibit entrance. A long horizontal platform was perched on the top of a thin, pointy pyramid, rather like a seesaw. On the left side were the enormous figures  $5\frac{1}{4} + 2\frac{3}{4}$ ; on the right was a tiny numeral 8. Although the numbers as objects were grossly out of balance, and should have tipped the seesaw in a crashing tumble to the floor, the intellectual balance was perfect - effectively and completely counterbalancing (so to speak) the visual effect.

Frank also tried to bring a certain comfort level to the arts through programming. One of the earliest series of events was initiated by the flutist Leni Isaacs, now the public affairs director for the Los Angeles Philharmonic. "Speaking of Music," as Leni called it, presented all kinds of music, from classical to avant-garde, in an informal setting that encouraged people to ask questions about anything from the subtle intricacies of harmony to the reason a violin was shaped like an 8.

It wasn't long before art became seamlessly incorporated into just about every aspect of the Exploratorium. Thomas Humphrey (an artist as well as a physicist) was already working closely with the San Francisco Art Institute (one of the works he created for it mimicked Marcel Duchamp's iconic *Nude Descending a Staircase*, using a strobe light). He was soon asked to design a course, which he called "Perception in Art and Science." When Thomas left temporarily in 1978, Frank and Rob Semper, another physicist, took over the class. Frank would dream up demonstrations that were "incredibly simple and incredibly insightful," Semper said "It was the most fun I had with Frank." Artists became involved in the school at the Exploratorium almost from the start.

And artists in residence became a regular presence at the museum. One of the first of the invited artists, and the one who gave direction to the program, was Pete Richards, the neighbor of the Oppenheims who grew up in Blanco Basin. Pete was just getting out of graduate school with a degree in sculpture when Frank asked him to help create the Exploratorium. In his art school, "all of the work we were doing was totally introverted," Pete said. "It was all about Who am I? What am I trying to do? And the work we made had to look like 'art.' Then I walk into this place and here's these gizmos made out of two-by-fours and gaffer's tape and surplus motors, stuff that looked like it should fall apart at any moment, yet it communicated some really interesting ideas . . . My art changed drastically after coming to the Exploratorium . . . It was all about noticing things and trying things out and developing a real interest in the way people interact and respond in public situations. I was experimenting more like a scientist."

Richards started experimenting with tides, an exploration that culminated in his "Wave Organ," which sits at the end of a jetty in San Francisco Bay, not far from the Palace of Fine Arts. Pipes leading into the water create a panorama of sound that encircles you, a symphony conducted by the bay itself as it swells or sinks or chops or calms in response to the waves and tides and weather.

"I like the way it's got a direct link with the Cosmos," Richards said. "The way it behaves is directly related to the position of the moon to the earth and the earth and moon to the sun, and what you hear is really the result of that relationship."

### **Hardening of the Categories**

"It has something to do with physics."

The sensibilities of several artists were so in sync with Frank's aesthetic that they played a major role in shaping the Exploratorium. One of these was Bob Miller. Impossibly tall (about six foot seven), eccentric, and uncannily creative, Bob complemented Frank perfectly, and together they made a wonderful team, eternally playing in the intersections of physics, perception, reality. One of Bob's sculptures, for example, is an optical illusion in which a concave object appears to pop out and follow you as you walk by. The sculpture is made up of an inside corner of a box that appears to turn into a cube, and so Bob calls it his "Far Out Corner." At one point, Frank encouraged him to patent it. They were both amused when the U.S. Patent and Trademark Office maintained that he couldn't patent an effect that existed only in someone's mind. As if there's a work of art or science that doesn't! The office finally relented, and Bob got his patent.

Another of Bob's pieces came to the museum from an art fair. It was a box of silver Christmas tree balls stacked together in a way that made for curious optics; infinitely reflecting light actually made the edges of the balls look black. Bob stuck the box on a stick and put it in a planter for the show. Later, he noticed a mother and child stopping to look at it. When the child asked what it was, the mother dragged the boy away, grumbling, "It has something to do with physics."

The insight behind many of Bob's creations - and the lesson that lodges in your head after spending time with them - is that no one ever sees anything but light, and then only as it emerges from whatever surface it last scattered from or traveled through. Everything else is imagination and projection. As far as your brain knows, light has no history; even if it's been bent and spun around several times over, your brain assumes it's coming at you in a straight line. So you "see" the image behind the mirror even though you know full well there's nothing there. Your brain places the image exactly where it would be if there were an object behind a window instead. Because we believe that reflections are real (and why not? all we're ever seeing is light), it's no stretch, in Bob's "Floating Symmetry," to stitch together one-half of a person plus the person's reflection and "see" that person fly.

Like Frank, Bob was an acute noticer, so if you sat with him in a restaurant, for example, the table became a big toy box of things to experiment with - glasses and silverware and white cloth and colored lights and shadows. People would stare at the goings-on at our "kids' table" and, more often than not, come by to see what was going on. The one sad part about such outings - or at least those without Frank present, especially after Frank got sick with leukemia and then lung cancer - was that we often drifted into

discussions about what would happen to the Exploratorium when Frank died. What we were really worrying about was what would happen to us when Frank died.

Another artist whose work is deeply entwined with both Frank and the Exploratorium is Ned Kahn, whose tornados and clouds and wind sculptures have earned him a worldwide reputation (and a MacArthur Foundation “genius” award). Ned specializes in making the invisible visible, creating sculptures that capture the complexity of the nonlinear dynamics behind the way water droplets organize themselves into clouds, stars into galaxies, birds into flocks, neurons into thoughts, motions of rocks into avalanches, electrical impulses into heart attacks. His work draws people into what he calls “cloud time” - the internal life of fog - and alters their perceptions so they begin to see kinetic sculptures in wind-blown trees or in bits of garbage that twirl into tornadoes in the corners of buildings.

Ned came to the Exploratorium right out of college as a shop apprentice, and for the first six months he had almost no contact with Frank. Then one day the head of the shop came to him sheepishly and announced, “Well, Ned, we had a meeting, and I’m really sorry, but we sold you to Frank.” Frank was already pretty sick at that point, and he needed an assistant. “And they were all kind of expecting me to freak out,” Ned remembered. “But I was just so excited, because I hadn’t really had any connection with Frank.”

Ned and Frank started spending several hours together almost every day. Ned would wander into Frank’s office, where the two would go through the drawers in a metal rollaway cabinet. “It was full of weird little Frank things, strange artifacts he had collected over the years, all kinds of bizarre optics and irises and crystals,” Ned remembered. “It was a box of wonders. I’d say, ‘What’s this, Frank?’ and he’d say, ‘Oh, that’s from . . .’ and it was like pieces of some atomic physics thing. Everything had a story.”

They’d fool around with half-baked ideas Frank had for exhibits - most of them made out of string or cardboard. He’d tell Ned what he found interesting about whatever it was, and suggest that he make an exhibit out of it. “We were amazingly prolific, the two of us,” Ned said. “We just cranked stuff out. It was a great collaboration. But the best part of it for me was that I got to spend all this time with him.

“I was full of all these burning questions about the physical universe,” Ned said. “And a lot of these questions were on really basic things. Like I remember asking him what electricity was, like when you turn on a light bulb, what was actually running through that wire? And he’d spend hours and hours trying to give me an inkling. I kept asking him, ‘But what is actually going through that wire?’ And at a certain point he said, ‘Well, nobody knows. We know how to do stuff with it, and we know the effects that it has, but what is actually going through the wire, no one really knows.’

“That was an earth-shaking thing for me. The whole time I was in college, my whole life up until then, I thought I didn’t know what was going through a wire or all these other basic questions because I hadn’t taken the next class. So hearing that from someone like Frank, who was the smartest human I had talked to up until that point, was mind-blowing for me.

“And that was a major influence on me,” Ned said, “because I got interested in the edges of what’s knowable . . . those phenomena that are so complicated and intricate that they’re physically unpredictable.”

Frank also learned science from artists. One example he talked about a lot was Doug Hollis’s “Vortex,” a large, clear glass cylinder filled with water that swirls into a sinuous aqueous tornado. Watching it, Frank noticed that the tornado doesn’t go all the way to the bottom but has “a little fine fuzz”; that things twirl around at different speeds in a way that can’t be entirely explained by conservation of angular momentum; that complex ripples embellish the undulating form in unexpected ways. He talked about being inspired to try to calculate some of these effects.

“I mean, you begin to think things out just by watching a thing like that, whereas I’ve never thought of watching a bathtub or thinking about a tornado,” Frank said. “So [there were] all these things I’d never thought of until I saw that exhibit, and it was done by an artist.”

### **Aesthetics and the Right Answer**

“I just don’t like the idea that there’s no right or wrong in art.” One reason Frank thought that people didn’t take aesthetics seriously was because they didn’t think art had right answers in the same way that science did. If physics was seen as a tyranny of right answers, art seemed to have no right answers at all.

Physics students spend most of their time solving problems for the “right answer,” Frank noted. Most textbooks listed the answers for, say, the even-numbered problems; students who can’t find the answers for the odd-numbered ones feel guilty and stupid. Physics is taught as a “right answer” subject, while its metaphysical implications are ignored “along with the creative nature of scientific activity.” Art students, on the other hand, are rarely told that “right answers” are also important to artists. “In the popular view,” Frank said, “no one looks to art to provide any answers at all.”

But Frank thought there was every bit as much validity – and as many “right answers” - in art as there was in science. Just because artists deal with more complicated subject matter, such as human feelings and emotions, it doesn’t mean that you can change a line on a Picasso and not ruin it. The works of artists were valid, Frank thought, because just like theories in physics, they led to the discovery of things that existed in nature but that no one had yet perceived.

During one long tape-recorded conversation about validity in



art, Frank and I argued at length about the idea that art could be judged valid under much the same circumstances science is – that is, if a work of art somehow predicts the existence of phenomena that might be found in nature but have never been seen before. This could be anything from the colors in faces to abstract shapes in a painting that also appear in the shadows of buildings or hills.

And what of the performing arts? I asked. What about the ballet? Frank thought perhaps the corresponding natural phenomenon might be “the wonderful sense of freedom from earthliness” that is often reproduced in dreams. So even if the art doesn’t correspond to a real human experience, to be valid it ought to correspond to a plausible human experience. “I think that’s at least something we can speculate about,” he said. “How to test that, I haven’t the slightest idea.”

Not having the slightest idea didn’t stop him at all. Frank was always poking at art the same way he poked at people and other natural phenomena. In an introduction to the *Exploratorium* magazine on the subject of color, he digresses from discussing the physics and physiology of perception to the “experiential, emotional, and aesthetic components of color. Why do we say we are ‘feeling blue’? Whence the term ‘mood indigo’? Why Royal Purple? Artists talk of warm and cool colors or those of foreground and distance. Colors can be bright and gay or soft and soothing. In fact, many contemporary artists are experimenting with color divorced from a context of form. They create large juxtaposed canvases each with a single uniform color, or alternatively, canvases with precise narrow stripes of contiguous brilliant color which seem to send conflicting sensations to the brain.”

When you think about it, it’s something of a wonder that we don’t all ask such questions constantly. By all rights, we should naturally be wide-eyed noticers: stopping to sniff things up close; staring and turning things over to see the hidden side; snuggling up to experience and nature and art and poking at them for all they’re worth. Was the problem all those years of being told what we were supposed to see and how to get the right answers? What if we don’t even know the questions? Then we can’t help feeling a little squeamish and uncomfortable - like sitting at a formal dinner table and not having a clue which fork to pick up for the salad.

Frank’s *Exploratorium* brought to art the same sense of comfort he brought to science. The result was a decidedly un-museum-like museum. And yet, of all the awards Frank eventually received, none meant as much to him as the Distinguished Service Award from the American Association of Museums, which he won in 1982. “When I started developing a science museum,” he said, “there was no organization whatsoever that thought of science centers as part of the museum world.”