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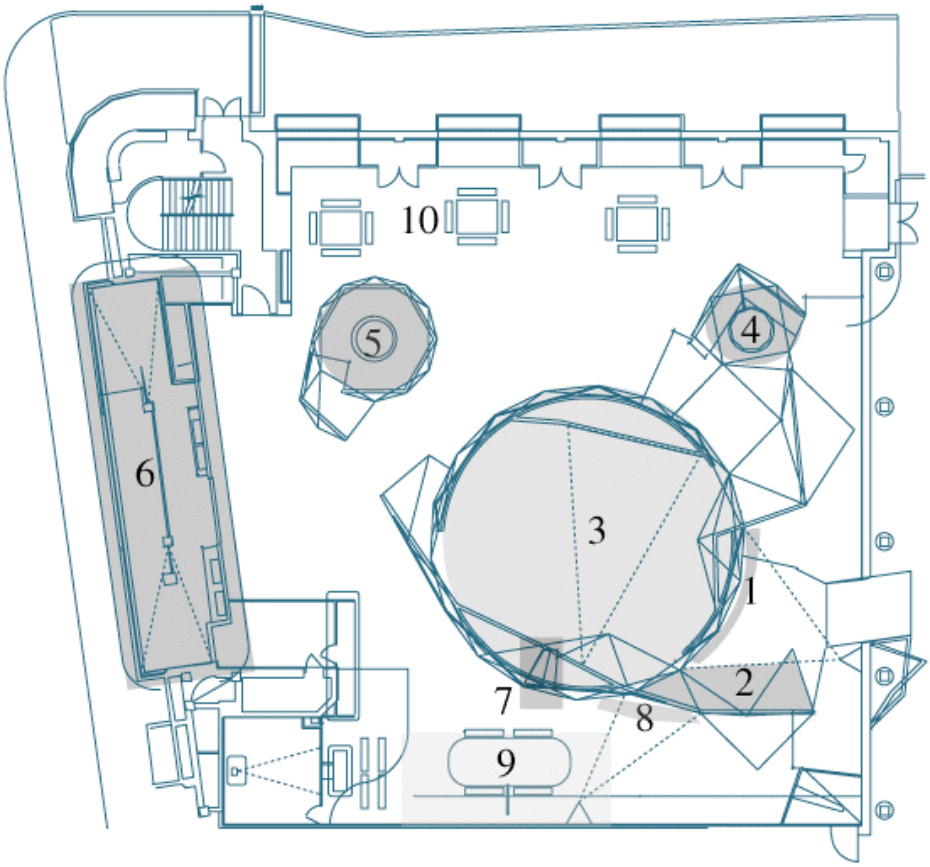
The invisible imaginary

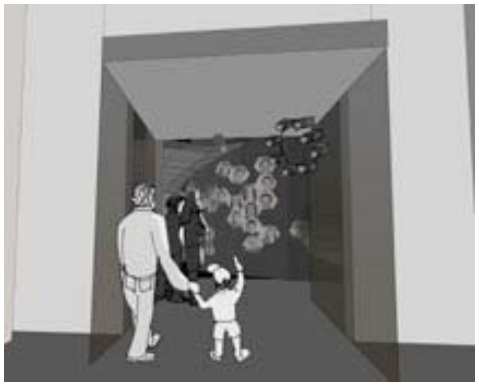
Museum Spaces, Hybrid Reality and Nanotechnology

Adriana de Souza e Silva[1]



***nano* floor plan**

1. Prelude to the Imaginary: Experiencing *nano*[2]

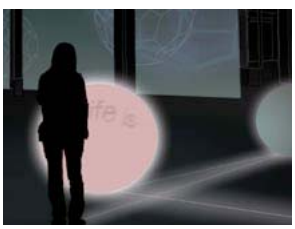
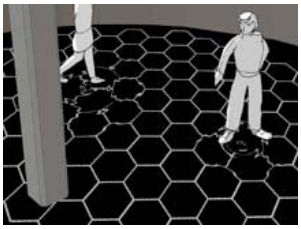


(1) Entrance.[3] As I walk into exhibition room, I see a "swarm" of cameras. One of them takes my picture, capturing my identity as soon as I enter *nano*. My face, as a product of this "unauthorized" surveillance, is then projected onto the wall in front of me, acquiring visibility among many of other pictures, forming a huge hive-like structure. Each face inhabits a hexagon, which is also part of the graphite molecule structure. Standing in front of this construction, I realize that the hive-like projection is a database of several faces from people who have been in the exhibition before me. Observing the movement of people entering the exhibition room and being captured by the camera, I occasionally notice humorous aberrations, since the camera not only captures the visitors' faces but also everything it understands as a face, such as faces stamped on a visitor's T-shirt, for example. Having my face captured right in the beginning of the show reminds me about surveillance mechanisms. "But isn't this an exhibition about nanotechnology?" I ask myself. Why are there surveillance cameras at the entrance? How could I forget that one of the anticipated developments of nanotech is the ability to invisibly monitor and identify elements of one's identity? Nano, among other things, is about surveillance.[4]

The projection is the first movement interpolating the participant inside the nanospace. The animation of these "molecules" reminds me of the self-assembly mechanisms that many researchers expect will be used in nanotechnology. In the projection, each hexagon attempts to align with or attach itself to others, and groups combine into larger (and slower) moving aggregations. The hexagonal "molecules" with faces in them, resembling graphite, begin to shrink as new molecules are formed with

other visitors' faces inside them. I feel as if my face is smaller than a protein. Nano is also about scale.

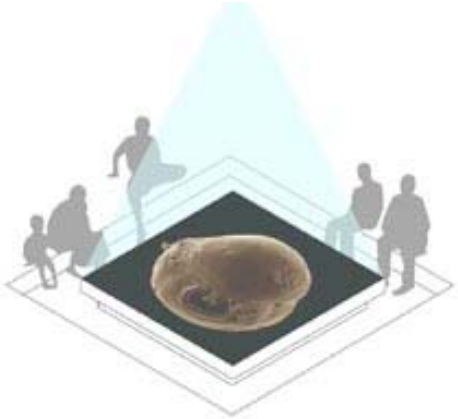
(2) Sense Space. Now I am crossing a dark tunnel. I can barely see, but rumbling sounds, echoing spoken words, and the walls' texture transforms the environment into a different kind of sensory space, in which I must use senses other than vision in order to perceive. Suddenly my idea of what is stable and physical is endangered, because I always thought the most accurate way of perceiving the world was by seeing. The dark atmosphere in the *Sense Space* reminds me of many imaginary nightmares commonly associated with nanotechnology, such as invisible nano-bots that invade the human body to destroy it, mind control through invisible mechanisms, and molecular structures imperceptibly injected into the brain to manipulate people's dreams. I wish to leave this space. Following the sounds and sensing the walls, I recall reading that the nanoworld cannot be viewed, only sensed with the tip of a scanning tunneling microscope (STM) that registers the topography of an atomic surface, an activity more like feeling than seeing. Then I think about how it would be if I were one of the atoms being probed by the STM, as the *Sense Space* flows into the *Inner Cell* of the exhibition.


(3) Inner Cell. Walking further through the tunneling *Sense Space*, I reach a circular cell. Cells are the cores of any living organisms,[5] and a cell space is also the core of *nano*. The rumbling sounds I heard before are coming from there. A projection can be viewed on the wall, and a different one on the floor; people are walking through the environment; and four big spheres are rolling across the space. While I walk slowly in order to sense the cell, I realize that I also affect the projected pattern on the floor. My steps have the power to deform a glowing hexagonal grid, similar to a pattern of graphite molecules. The deformation is a wave-like movement, transforming the static floor into a moving light pattern. The reactive floor also triggers bass frequencies while I walk, mimicking wave behavior on a molecular scale. It is as if I could hear the sound of an atom. Waves created by my movement over the floor merge with waves produced by other visitors walking around, as well as by deformations induced by the strange spheres. They are *robotic spheres*, automatically rolling over the floor apparently without the need of human aid. Spherical shapes allude to atomic forms. Being able to touch these 3-foot tall plastic spheres, rolling like giant atoms, makes me feel closer to the nanoworld. Then I think, for the first time, that the environment around me and also myself are not only constructed by what I am able to see with my bare eyes. The glowing grid is also projected on top of the robotic "atoms," creating a three-dimensional curved surface. Everything is connected in this environment, like a propagating wave influencing all nearby elements.

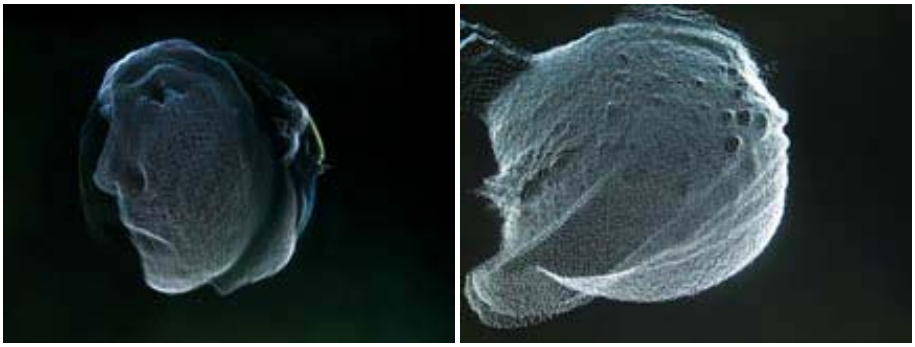
Raising my head, I perceive a huge projection of cellular-like structures resembling buckminsterfullerene carbon-60 molecules, or buckyballs.[6] Participants' shadows are projected onto the same wall, sharing the virtual nanospace with the buckyballs. From time to time a new molecule grows on the wall, while some stand still. I realize that my shadow is able to move and deform these structures. However, not every movement affects the system. Abrupt and fast gestures are helpless.

(4) Atomic Manipulation Space. I exit the *Inner Cell* via another *Sense Space* and realize that these spaces function to connect the *Inner Cell* to the outside environment. I reach the *Atomic Manipulation Space*, which consists of a nine-sided table with a projection on top and four track balls on its side. Getting closer, I perceive that the projection reproduces a bird's eye view of the same space I have been in before: the *robotic spheres* and visitors walking across the cell. Moving one of the track balls, I realize that they are interfaces used to control the *robotic spheres* in the *Inner Cell*, allowing me to be present in the former room, although not physically. If, as I thought earlier, the *robotic spheres* are atoms, my manipulation here resembles the manipulation of atoms through the STM.



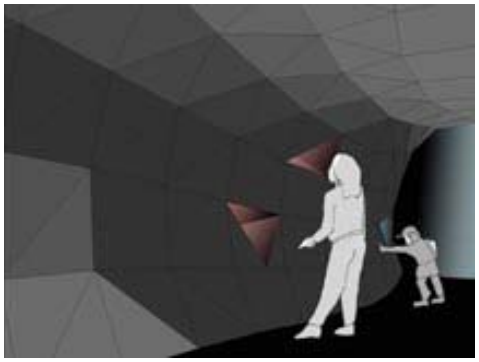
(5) Nanomandala. Exploring the space outside the cell, I find a dark room composed by a sand surface in the middle. Entering the space, I activate a projection over

the sand, which images sand over a wide range of different scales, from visible sand grains to the invisible atomic structure. The transformation from sand to atom is inspired in the sand mandala created by Tibetan Buddhist monks for the "Circle of Bliss" exhibit in LACMA East. I knew that the word mandala comes from Sanskrit and can be loosely translated as "circle," "whole," or "zero." A mandala can be regarded as a model for the organization structure of life itself, and there are many types of mandalas. The sand mandala exemplifies the impermanence of life and may take many days to be constructed. It is originally composed by colored sand made out of crushed semiprecious stones. These millions grains of sand are painstakingly placed on a flat platform and, after a period of days or weeks, are swept up into a jar and poured into a nearby water course to demonstrate the cycle of life. In dealing with atoms and cells, *nano* also deals with organization of living structures. The exhibition thus uses the *Nanomandala* to suggest a connection between two distinct processes of building the world from bottom up. While monks manipulate grains of sand as models for the organization structure of life, nanoscientists manipulate atoms, as the smaller known structures that construct the world.



(6) Quantum Tunneling. Walking farther, I enter a dark environment with a mirrored floor. A camera stands on the top of a long and flexible metal structure. Grabbing the camera, I see that the static image projected on the wall in front of me starts moving. My image, converted into "particle clouds," begins to be graphically disturbed and altered. Looking back, I see that the movement of children running across a white tunnel has influenced my image. The mirrored floor over which they run reflects the actual the environment, creating a double sense of space. I don't exactly understand what

is going on, but text on the wall outside explains that this part of the exhibit shows information being exchanged between two visitors standing at either end of the quantum tunnel, similar to electrons "tunneling" through an energy barrier because of quantum effects. I am curious about this phenomenon and decide to look for a more detailed explanation in the *Resource Room* (9) of the exhibition.



(7) Looking in from the outside. Going towards the *Resource Room*, I find two holes on the outside wall of the *Inner Cell*, a lower one and a higher one. I am compelled to look, as the orifices radiate colorful bright lights, and discover a giant kaleidoscopic structure embedded among the wall panels. Looking through the higher one, I see the *Inner Cell* in a kaleidoscopic view. Besides the fracturing view of multiple perspectives, I hear narratives that sound science-fictional: "He's always wanted to become quantum dust, transcending his body mass . . . live outside the given limits in a chip, on a disk, as data, in whirl, in radiant spin, a consciousness saved from the void." (DeLillo 206)

(8) Text. A black-and-white particles cloud is projected on the outside wall of the *Inner Cell* adjacent to the kaleidoscopes. Walking in front of the projection I see that my movement across the space has the power to destabilize the particles. After the perturbation ceases, they reassemble into a phrase related to nanotechnology. Every time a visitor comes, he or she disturbs the text on the wall, making the particles to rearrange into another different phrase. The dispersion of the image on the wall, like a swarm of particles, reminds me of Michael Crichton's passage in *Prey*: "A human body is actually a giant swarm. Or more precisely, it's a swarm of swarms, because each organ – blood,

liver, kidneys – is a separate swarm. What we refer to as a body is really the combination of all these organ swarms." (Crichton 260)

At this point I am adjacent to the *Resource Room* (9), where books and other research material can be found on the tables. From this perspective, I look back on the exhibition space and notice the flowing lines of the architectural structures. I glance at a pedestal on which sits a leaded glass triangular model created by Buckminster Fuller and realize the same forms are used on the walls of the cells and modules. The model represents Fuller's Dymaxion Map, the only flat map showing the entire Earth surface without distorting the shape of the land areas and without splitting the continents. The idea of connection among parts, turning them into one and only structure, is present in the *nano* architecture, suggested by the flow from one space to another. Now I understand they are all simulations of a nanoworld where boundaries are fluid and solid objects melt with molecular motion. I start appreciating that everything around me is in fact made out of atoms, including my own body and brain.

2. *nano* and LacmaLab: changing the concept of museum spaces

Metaphorically injecting visitors into the invisible nanospace, *nano* challenges the traditional concept of what a museum is through three interconnected actions: enlarging what is supposed to be invisible; mixing virtual and physical spaces; and exploring the borderland between the real and the imaginary. These challenges, implied by the main exhibition pieces as well as by the exhibition space itself, are consistent with the main goals of LACMALab's Director, Robert Sain. LACMALab focuses on creating a new museum space that appeals to people of all ages, commissioning artists to create exhibits and construct participatory spaces.

nano is the fourth long-term exhibition developed by LACMALab, a research development unit of the Los Angeles County Museum of Art (LACMA). According to Robert Sain, "LACMALab is a new initiative designed to develop, test, and apply experimental approaches to engage the public – particularly children, teens, college students, parents, and seniors – with the museum's permanent collection and exhibitions."[7] The first show, *Made in California: NOW* opened in September 2000 and

was up for ten months. Eleven California artists were commissioned to create interactive installations particularly to engage children and their families. The second exhibition, *Seeing*, lasted from November 2001 to September 2002. For this show, LACMALab commissioned nine Los Angeles-based artists with three broad challenging guidelines: works should explore the concept of "seeing;" they should incorporate at least one object from LACMA's permanent collection; and they should appeal equally to children and adults. *Making*, up from November 2002 to September 2003, was comprised of installations from five major art schools in Los Angeles: Art Center College of Design, California Institute of the Arts, Otis College of Art and Design, and the School of the Arts and Architecture at UCLA. Teams of student and faculty artists and designers were asked to create participatory pieces that investigate the process of making art.

For the first time, *nano* creates an overall concept for the whole space. The UCLA team, including media artists and nano-scientists led by media artist Victoria Vesna and nano-sicentist Jim Gimzewski, together with writers led by N. Katherine Hayles involved in the production of the text passages in the exhibition space and this book, created the exhibit with the goal of producing a unified artwork that would suggest the participation of everything, including visitors, in the nanoworld, the space where the world's composition becomes apparent. In order to inject visitors inside the nanospace, the installations filling the exhibition deal with concepts such as scale, surveillance, boundaries, identity, seeing by feeling, and mapping invisible spaces. The interconnections between science, technology, art, and the humanities are expressed through architecture and installations that merge virtual and physical spaces, transforming the exhibition environment into a hybrid space.

LACMALab's initiative reflects a general tendency among the arts and museum fields towards interactivity. It rethinks museum spaces in order to better integrate them with media arts (art mediated by technology). One approach is to transform traditional (impersonal, fixed, and neutral) museum spaces into participatory and interactive environments, thus promoting interaction between visitors and museum spaces, and among the visitors. In contrast to a conventional museum experience, it is no longer only the visitor who is changed by the space; the space is also modified by the visitor. *nano* is

representative of initiatives by museums to incorporate media arts into their spaces, thus changing the relationship between museum and audience.

3. The construction of museum spaces

3.1. The physical museum

We can better appreciate the hybridization of contemporary museum spaces by looking back at how traditional modern museums were organized. Modern European and North American museums can trace their origins back to the 17th century, with the opening of The *Ashmolean Museum* in Oxford in 1683. The concept of a traditional museum developed as a place that encompassed a collection of artifacts of several types. These collections had their origins in medieval and Renaissance collections of wonders and rare objects, which belonged to private collectors and later were donated to public museums. According to Foucault, traditional museum spaces can be regarded as heterotopias, since they are spaces that juxtapose in a single physical place several virtual (non-present, but existent) places. Therefore the concept of the virtual as it is analyzed in the following pages is already contained in the idea of a museum. Foucault defines heterotopias as opposed to utopias: while the latter are sites with no physical location, heterotopias are physical places enacted by virtual components. In this sense, heterotopias call forth virtual intensities that are not yet actualized but are on the threshold of actualization. “Places of this kind are outside of all places, even though it may be possible to indicate their location in reality,” argues Foucault.[8] Moreover, these places are absolutely different from the sites about which they reflect and speak. Similarly to libraries, which are collections of books from all places and times, museums are heterochronies or heterotopias of time. Consequently traditional museums, embedding within themselves their origins as a collection of objects from different times and places, include the seed of the virtual. Hybrid museums accentuate and develop this implication by positioning the virtual in a dynamic relationship to the actual rather than as something outside physical space.

Because their artifacts were supposed to be admired, museums developed as impersonal, neutral, and silent environments. The white cube was meant to create an isolated room disconnected from every aspect of outside physical space. The expectation

was that museum visitors would be able to appreciate the artwork in a pure way, without any influence from outside reality. Reality was to be created by each individual object, which was in turn related to other virtual places. Traditional paintings and art objects were supposed to inhabit their own reality, which were not mixed with any other outside context.

To achieve this state, a certain distance between the viewer and the viewed object was required: no touch, no photograph, no loud talking. Walking through museum galleries, visitors created their own narratives that were not generally shared with other visitors. Moreover, the white cube was unchangeable. Granted that the perception of the room may change depending on what size paintings were hung on the wall and how art objects are placed in the environment, there was nevertheless no direct interaction between visitors and museum rooms. There was also no connection between visitors' movement and the shape of galleries, that is, the museum space was unaffected by the presence of visitors.

3.2. The virtual museum

The emergence of the World Wide Web in the 1990s facilitated the utopian vision of creating an ideal museum: one that someone could visit without being physically present. The virtual museum represented constant access to artworks from any point with an Internet connection. The traditional unchanging museum space contributed to the easy transference of museums from physical to digital spaces. As the physical space was not part of the exhibition, why not eliminate it? This thought led to the great misconception of the past decade, when digital spaces were in some instances regarded as replacements for physical environments. Digital cities were designed in order to create new types of sociability on the web, enabling users to make avatars and develop new social connections. As a result, websites were viewed as remote places that could be instantly accessed from whatever server in the world. The user was therefore no longer required to dislocate through physical space in order to reach remote locations and access information. Why go to a specific place if one can have everything via the Web?

Michel Serres exemplifies this argument pointing to the passage from definite places, such as the *Louvre* Museum on the Richelieu Street in Paris, to a rich place *(Riche*

lieu). This '*Richelieu,*' equivalent to the planet, is comparable to the net of all nets in which data and places virtually accumulate. Because of the appearance of a global database that could potentially incorporate all data flows and information, digital spaces were frequently considered more important than physical places. "Why, then, a long street if it is enough to have a single place?" asks Serres (Serres 142). Virtual museums represented this possibility of an enormous database that could potentially contain all artworks.

According to William Mitchell, virtual museums have advantages over physical museums because "the exhibit material is kept on servers on a network, and viewers can be scattered at remote locations. It is not gallery capacity that matters, but server capability and network bandwidth" (Mitchell 59). Does accessing "information" about a museum replace the actual feeling of being inside a museum? Not really, for sure, but defenders of virtual museums also argued that they could offer far more choices for exploration than a large-scaled traditional museum. Although virtual museums would never mean the extinction of traditional museums, according to Mitchell, "as virtual museums develop, the role of actual museums will shift; they will increasingly be seen as places for going back to the originals." (Mitchell 60). As a result, one would see the work of art online, but one would go to a museum to see the original piece. Following the argument of Walter Benjamin's "The Work of Art in the Age of Mechanical Reproduction" (Benjamin 1990), the physical museum would be the place in which works would still have the aura of the original, and that is why they would remain significant.

If museums are there merely to display the original object and if many visitors did not care whether they saw the collection personally, changing viewing practices might arise that implicitly regarded an art object as representing only a specific amount of information. In this case, it would not matter which support was used to access the information: a web browser or a wood canvas. According to Claude Shannon's definition (Hayles 1999, 54), information is an immaterial entity that remains independent of the material substrate used to carry it. Considering that the concept of cyberspace has been based on the development of an information space, virtual museums have sometimes been viewed simply as information databases that can accumulate much more than the

physical museum. In practice, however, a brief survey of museum websites shows that they are mostly constructed in order to support physical museums. They are useful to check a museum's opening hours, selected content of permanent collections and special exhibitions, but to date they have not begun to replace the traditional museum.

In contrast, Roberta Buiani points to a few Web initiatives that aim to create "real" virtual museums, that is, virtual places that have no original in the physical world and are not intended to supplement, or simulate, a traditional museum. Examples include the *Walker Art Center* section on net art, *Gallery 9*, and the *Uruguayan Museum El Pais*. While the first one focuses on net projects designed and conceived to be viewed solely online, the second example contains pictures of real painting and sculptures that belong to private collections. Both share the characteristic of displaying artworks that could not be contemplated by the common public in the physical world. Another singular example is the *Virtual Museum of Canada*, "which unifies under a single roof the resources of all Canadian museums" (Buiani 8). In this sense it could be defined as a heterotopia of a heterotopia, since traditional museums are already heterotopias. The *VMC* is a website about Canadian culture, and although much of its content can be in fact found in physical museums, there is no a single physical place in which the *VMC* would be contained. These last three examples differentiate substantially between virtual and physical museums, emphasizing that although they can be complementary, they may also have completely different purposes. There are also Web pieces created to be viewed online and, in this case, there is no point in showing them in a physical museum. By contrast, there is always a degradation of experience when seeing a traditional painting on the Web, and that is why websites of traditional art objects would never replace physical collections. Paintings acquire totally different meanings when looked at closely. The effect of light on canvas, the perception of brush strokes, and many other characteristics require the observer's physical presence for full appreciation.

Hence virtual museums can be divided in two types. One complements physical museums and is meant as a guide to their collections. The second type does not have a direct link with a physical building and provides the public with artworks that, because they are dispersed in different locations or are on-line creations, do not require or could not be exhibited in a single physical environment.

Even after the emergence of virtual museums, the function of museum spaces remained largely traditional. They still consisted of impersonal, neutral and quiet spaces. Nonetheless, questions about the museum's function and structure started to grow. The hypertext structure of the Web directed people's attention to more flexible ways of constructing narratives throughout the museum. Also, the emergence of online multiuser environments showed that an interactive and ever changing space could enhance communication among users. These developments catalyzed a new kind of approach. Could this ever-changing virtual space be brought into a physical 3-D environment?

3.3. The hybrid museum

The attempt to adapt museum spaces to show web art during the past decade was a challenge to most traditional museums. How to deal with projections and black boxes instead of white cubes? How to connect remote virtual environments to the actual space? With the development of media arts, new challenges were inevitable and many museums wondered how to adapt their spaces to deal with this new type of art. Unlike virtual museums, here the challenge arises from new interfaces used inside (or outside) the public space of a museum, in contrast to accessing a museum at a remote distance. Nomadic technologies and smaller interfaces, as well as real-time cameras and sensors, are being used by artists to convey their message in ways no longer compatible to the separation of the visitor from the exhibition space. Art pieces are popping out from the 2-D flat wall to inhabit a 3-D space that is, moreover, changed by the visitor's actions, making it unlike sculpture and the plastic arts. Also, this space is no longer disconnected from outside reality; rather, it brings the visitor (now called participant) into the artwork, creating new kinds of participatory spaces.

Considering that virtual museums did not replace traditional museums, it is probably true that media art museums will not do that either. Traditional museums will most likely remain established places constructed to show conventional art, such as paintings and sculptures. Nevertheless, the emergence of new forms of art that employ pervasive and mobile digital interfaces demand the creation of new types of museum spaces for those institutions interested in adding them to their collections. I shall call these new types of institutions hybrid museums. Hybrid museums have two main

characteristics: (1) they merge the borders of physical and virtual spaces by means of the visitor's presence and mobility; (2) they promote direct interaction and communication among visitors and between visitors and the museum space.

According to Lev Manovich, "one trajectory which can be traced in the twentieth century art is from a two dimensional object placed on a wall towards the use of the whole 3-D space of a gallery".[9] However, he stresses that "this trajectory is not a linear development; rather, it consists from steps forward and steps back." The use of three-dimensional interactive installations dates back at least to the 1960s, especially in neo-concrete art. Brazilian artist Hélio Oiticica was among those who began to work with interactive installations, anticipating moving art off the canvas into the realm of life. By the mid-60s, Oiticica had abandoned traditional painting and sculpture in favor of freeform constructions *("Parangolés")*, such as capes meant to be worn or inhabited. Although his works did not employ electronic technology, they represented an important step toward reconfiguring the art object/viewer relationship. "Beginning in the 1970s", writes Manovich, "installation grows in importance to become in the 1980s the most common form of artistic practice of our times . . . Finally, the white cube becomes a *cube* – rather than just a collection of surfaces".[10] Accepting that information is never independent of the material interfaces that transmit it, we could argue that the present condition differs from previous concrete art and installations in the merging of virtual and physical spaces, a development hastened by nomadic interfaces and pervasive computing made possible by the increasing miniaturization of intelligent hardware.

Traditional museum practices, as well as artworks, have been affected by these new technologies. Many initiatives use nomadic and wearable interfaces in order to change the experience of walking through a museum. Flavia Sparacino's *Museum Wearable* (MIT) consists of a wearable computer that functions as a museum interactive guide. The *Museum Wearable* is an interface carried by the visitor, composed of an audio system and a "private eye" that personalizes the museum visit. For example, if the visitor spends a long time in front of a specific painting, the system delivers audiovisual information about that work. Therefore the guide is configured differently for each visitor. According to Sparacino, the goal of the project is to create "a system which can be personalized to be able to dynamically create and update paths through a large

database of content and deliver to the user in real time during the visit all the information he/she desires" (Sparacino 2). This project follows the tendency of major Internet content during the 1990s to create private spaces inside public spaces. Websites such as amazon.com created personalized information for different types of users. In addition, chat rooms and personal messaging further increased the sense of personal spaces inside the mega spaces of the Web. Although these technologies changed the museum space to some extent, they did not transform the fundamental meaning of what a museum could be.

In contrast, new media arts, transforming neutral spaces into participatory environments, changed the meaning of the space itself from a silent place to an actively experiential communication and learning environment. There are basically two ways in which media arts contribute to the creation of hybrid (vivid and participatory) places. One occurs inside museum spaces; the other happens in public spaces. The exhibition *nano*, about which we have heard and which will be analyzed later in this chapter, exemplifies the first case of transforming an interior space. *nano* constructs an architecture that is as part of the exhibit as the installations it contains. The second case is represented by large-scaled interactive installations placed in public spaces and new media exhibitions in city spaces, which use existing architecture contained in public spaces and then modify their original meaning.

Representative of this second case is the work of Mexican-Canadian media artist Raphael Lozano-Hemmer. He created public installations that changed how people behaved and perceived public spaces. *Vectorial Elevation (Relational Architecture 4)* consisted of 18 robotic searchlights installed on the top of buildings around the Mexico City's Zócalo Square (in its first version). The lights were controlled remotely via a website on the Internet, allowing users to draw different patterns on a 3-D model online that were then displayed in physical space. The online participant could view the physical result of her drawing with the aid of three webcams placed on the square. This project linked digital space with physical environment in a non-traditional way. Generally, cyberspace is viewed as a place in which users can enter and create new digital worlds, which are not contained in physical spaces. With *Vectorial Elevation*, however, digital space was used to modify a physical plaza. Equally important was the way Mexican

citizens reacted to the piece. The Zócalo Plaza was already an important reference point in the city. *Vectorial Elevation* increased its physical impact, since many people went to the plaza at night to observe the light patterns, transforming it in a vivid public space. The same reaction can be observed with other pieces by Lozano-Hemmer, such as *Body Movies (Relational Architecture 6)* and the recent *Amodal Suspension (Relational Architecture 8). Amodal Suspension* uses searchlights in a public space similar to *Vectorial Elevation*. However, instead of displaying online drawings, the searchlights "catch" still unread SMS (short message service) sent among users via the website or their cell phones. The messages are then encoded into a sequence of flashes and displayed in the sky around the Yamaguchi Center for Arts and Media (YCAM) in Japan. *Amodal Suspension* is virtual in a double sense: first because it connects users who are not physically present; second because it displays text messages before their actualization. It therefore catches virtual messages in a potential state, before they have been read, and transforms them into a physical entity.

Another example is The Chaos Computer Club's *Blinkenlights,* an eight-story façade used to play Pong or display large-scaled love letters, using cell phones as an interface. The project attracted a great number of people to Alexanderplatz in Berlin (2001/2002). Given these results, we can suggest that the importance of these projects is transforming circulation spaces, where people pass through but do not stop, into public places in which to gather. The space is no longer used for transit only but becomes a place where communication occurs and pleasurable experiences happen.

These works can be understood as attempts to transform spaces into places. Manuel Castells (Castells 409) creates a dialectical opposition between the *space of flows* and the *space of places*. The last one corresponds to the spatial organization of our common experience defined by cities and urban spaces, while the first one is a concept created to label a new logic of space structured on networks and flows of information. Castells suggests that the *space of flows* in traditional urban spaces transforms the city from forms into processes. Therefore, mega-cities no longer happen in a place but rather are "discontinuous constellations of spatial fragments, functional pieces, and social segments" (Castells 436). Felix Stalder, following Castells, observes that "the space of

flows is not so much organized to move things from one place to another, but to keep them moving around."[11]

If we consider metropolises like Los Angeles as representative of circulation spaces, where people generally do not walk on the streets and prefer cars and freeways to move around, it is possible to argue that urban public spaces have become increasingly non-places. Although Castells argues that the *space of flows* is not a placeless space, places have progressively lost their importance in comparison to flows. Especially after the advent of advanced transportation technologies in the 19th century, people started to circulate faster across urban spaces, losing the capacity to communicate and interact to each other while in transit.

With the advent of the Internet, communication places partially migrated into digital spaces. Online multiuser environments, for example, can be perceived as places in which people talk and interact to each other, even if they do not share the same contiguous physical space. In the past decade, they have often been regarded as ideal communication places, and some commentators predicted they would replace public spaces in the role of promoting interaction among people. Nowadays, however, it is possible to observe a tendency to bring these gathering and communication places again into physical space. As we have seen, many artistic initiatives strive to transform public urban spaces by making people stop while in transit across the city. Such installation pieces have been successful in making the circulatory *space of flows* again into a *space of places*. To this extent, people no longer use urban spaces only to circulate and go from place to place, but rather start enjoying going to public places as their destination.

Related initiatives go beyond changing a single physical infrastructure or a single installation in public space. Huge media arts projects may construct an entire art space in order to "revive" city spaces and improve communication among people. These art spaces can be considered new types of museums, designed specifically to accommodate non-traditional art that deal with new digital interfaces. For instance, in the Ruhr area in Germany, old inactive coalmines are being transformed into exhibition spaces for media artists. The exhibition *Connected Cities* (1999)[12] transformed the area into a temporary laboratory in which artists represented the urban industrial situation as an enormous collection of cities connected not only through the usual transportation systems but also

increasingly linked through invisible lines of communication such as networks and digital media. In this case, as well as in the previous examples, we can observe how embedding virtual into physical spaces can change our relationship to public spaces.

In this context, the concept of the virtual as it relates to a museum no longer means merely a website that can be accessed remotely. A different sense of the virtual is constructed as a potentiality that can be actualized. In a museum context, these virtualities are actualized by visitor's actions in physical spaces. Virtualities are potentialities always ready to emerge and to reconfigure the reality in which they appear.

4. The construction of hybrid spaces

4.1. Re-creating reality as an emergent potentiality: the virtual

Frequently the virtual has been considered to be opposed to the physical, mainly because cyberspace has often been considered an immaterial space. A hybrid space occurs when one no longer needs to go out of physical space to get in touch with virtual (or potential) realities. Hybrid spaces have three main characteristics: (1) the merging of borders between physical and virtual spaces, (2) the use of nomadic and pervasive technologies as interfaces, and (3) mobility and communication in public spaces. Hybrid spaces fold the virtual as potential into the nearby physical space, blurring the borderlands where the virtual transforms into the actual, and the actual fades back into the virtual. There is a dynamic interplay whereby virtual becomes actualized and the actual becomes once again virtual. In this sense, hybrid space is different from an augmented reality that superimposes graphic or sound information onto a view of the real world, or an augmented virtuality that refers to "augmenting or enhancing the virtual world produced by a computer with data from the real world." (Ohta and Tamura 2). Hybrid spaces are also unlike mixed reality as described by Paul Milgran (Milgran *in* Ohta and Tamura 10). Milgran suggests that a mixed reality occurs when "it is not obvious whether the primary environment is real or virtual," creating a RV (real-virtual) *continuum*. Hybrid reality, by contrast, does not oppose real and virtual; it includes the virtual in the scope of the real. Both the virtual and the actual are real; the difference between them is not reality or unreality, but rather their positions in the temporal dimension.

In contrast to this view, virtual spaces have usually been related to static interfaces used to connect to the Internet and Web, such as desktop computers, large monitors, and corded mice. One needed to "enter" the Internet in order to "inhabit" a virtual space, by implication temporarily leaving physical space behind. Virtual reality has also often been connected to a Platonic logic of representation, later developed by Jean Baudrillard (Baudrillard 1-48), as a simulated (hyperreal) space that could be more or better than reality. This viewpoint influenced the perception of digital spaces as virtual spaces. Now nomadic technologies, smaller interfaces, and wireless sensors are embedding this virtual reality in public spaces, not because one is able to connect to the Internet while in movement, but because these interfaces re-define reality, expanding the emergence of possible and distant realities within the nearby space. It is important to stress that the disconnection between virtual and physical spaces contributed to the perception of an opposition between the concepts of virtual and physical. In newer hybrid realities, the virtual is conceived not as opposed to physical but as a potentiality already present in the physical. In this sense, virtual represents a broader aspect of reality.

Exploring this sense of virtuality, Gilles Deleuze (Deleuze 212) suggests that differentiation is creation. Differentiation is synonymous with actualization, since in the movement from virtual to actual an idea or a concept can potentially be differentiated into several actual instances. The potential to be actualized and differentiated into diverse realities is what makes the virtual an important part of the real rather than opposed to it. *"The virtual is fully real in so far as it is virtual,"* says Deleuze (Deleuze 208). The virtual is always ready to emerge, wishing to have actual existence. Deleuze focuses on the process of actualization as acts of differentiation, genesis, or creation. In this sense, artworks can be perceived as incarnations of potential ideas and desires, manifestations of potential structures. According to him, the act of creation in art occurs not between two actuals but between the virtual and its actualization.

The movement from virtual to actual (actualization) can be used to think about media artworks as virtual pieces. Every artwork can be envisioned as a virtual piece, which is differently actualized by each viewer. However, interactive pieces *per se* are fully potential entities that can only be completed when the interaction with the user occurs. Each user, in turn, actualizes the artwork in a different way, revealing some (but

not all) aspects of its potentiality. This interaction can often be accomplished by the physical presence of the visitor and sometimes by her remote presence. Brazilian Professor Andre Parente (Parente 14) defines the virtual as a desire to constitute the real as new. In this context Deleuze, as well as Félix Guattari, Pierre Lévy, and Jean-Louis Weissberg, consider the virtual as a function of the creative imagination as well as a product of different articulations among art, technology and science. Therefore the virtual is capable of creating new conditions to model the subject and the world.

The emergence of hybrid spaces changed the relationship between reality and its simulation, and therefore the articulation between real and imagined spaces. As we have mentioned, the Internet has been regarded as a virtual simulated space, in which users would project imaginary and utopian spaces, mainly when inhabiting multiuser environments and creating new types of communities. Hybrid spaces bring these communication places again into urban spaces, but do they also bring imaginary spaces formerly projected onto digital spaces? How are imaginary spaces re-defined today with the emergence of a hybrid reality that merges actual and potential states? A brief glance at the world around us suggests that nanotechnology has an active role in constructing new imaginary spaces.

nano, for example, combines real and imaginary spaces, representing the world of nanotechnology through art and science fiction. *nano* not only blurs the borders between what is real and what can be imagined; the show also re-defines imaginary spaces by changing their traditional location. Imaginary spaces have historically being created outside the borders of physical and known spaces. Science fiction works about nanotechnology bring imaginary spaces as (unknown) folds within the known space.

4.2. Re-defining places of imagination: physical, virtual, nano

The projection of imaginary (inner) spaces onto external reality by means of art and narratives is as old as the human culture. Throughout history these projections of possible (or virtual) realities have been redefined many times. Although there are numerous sources of imagined realities, generally they have been connected to one idea: the existence of unknown and distant worlds. Whereas in former times imaginary spaces

were located *outside* known and familiar space, they now move *deeper into* known space, which contains within itself the invisible nanoworld.

In order to better understand why imaginary spaces are today seen as inhabiting known spaces, it is helpful briefly to map the successive displacements of the imaginary from the physical to the digital and then to the nanoworld. During the Middle Ages, much of the popular imaginary was based on travelers' tales. Travelers went to distant and unknown places, which generally had no precise geographical position, and then returned to narrate their experiences. The construction of the imaginary has always had a close connection to the definition of borders, that is, to what is inside and outside the known space.

Travelers' tales were considered valuable not necessarily because they were accepted as literally true but because they stimulated the imagination. Italo Calvino starts the narrative of *Invisible Cities* as follows:

> "Kublai Khan does not necessarily believe everything Marco Polo says when he describes the cities visited on his expeditions, but the emperor of the Tartars does continue listening to the young Venetian with greater attention and curiosity than he shows any other messenger or explorer of his." (Calvino 5)

Because Polo represented the outsider, the one who came from a distant and unknown land, the veracity of the narrative was irrelevant as long as it nourished the Great Khan's imagination. It achieved reality through affirmation. The veracity of imaginary places constructed through the mediation of travelers' tales can thus be considered as mediated spaces. Imaginary spaces are frequently created when one is not able physically to access them. Mediating interfaces, standing at the borders of real and imaginary spaces, are critical to building these imagined (and often imaginary) realms.

As the globe has been increasingly mapped in more and more detail, imaginary spaces have been successively relocated. Science fiction illustrates how the space of the imaginary was moved from Earth to outer space. The work of Edgar Rice Burroughs, creator of Tarzan, exemplifies this trend. The Tarzan novels were conceivable at the beginning of the twentieth century because Africa was still not completely explored by Europeans. Because it was unknown, it served as a space for the projection of the imagination. But once Africa had been completely mapped, Burroughs stopped the

Tarzan series and started writing about the planet Venus as an imaginary space. By the twenty-first century almost all planets of the solar system have been explored, and we are fairly sure there is no life close to us (with the possible exception of Europa). So where do imaginary spaces open up in the twenty-first century?

During the last twenty years cyberspace has frequently been regarded as the place where the projection of imagination could occur. The digital space represented a non-place, or a space located outside the borders of physical space. The idea of immateriality was critical to defining cyberspace as an imaginary place. Because it has been considered immaterial, it would be free from the constraints of the physical world. Therefore, it would be possible to create new places and new identities. It would be feasible to lose one's material body and still travel around the world as a body of information. In contrast to the Deleuzian idea of the virtual as potential, in the rhetoric of cyberspace the virtual has often been regarded as simulation: immaterial, non-physical, and non-real rather than as emergent potentiality. Several science fiction works in the past two decades have helped to project imaginary spaces onto cyberspace. William Gibson's trilogy, including *Neuromancer* (1985), *Count Zero* (1986), and *Mona Lisa Overdrive* (1988) made cyberspace a household name. Neal Stephenson's *Snow Crash* (1992) also helped to popularize virtual spaces.

Due to the increasing number of websites and cyberspace's commercialization, the desire of freedom does not quite fit what the Internet has become today. Nowadays, we can perceive a migration from cyberspace to nanotechnology, as authors become interested in representing the really small. In such works as Neal Stephenson's *The Diamond Age* (1995) and Michael Crichton's *Prey* (2002), nanotechnology becomes a territory waiting to be explored, albeit within known and inhabited spaces. Not coincidentally, both these works associate nanotechnology with the exploration of mysterious spaces at the margins of cities or densely populated areas; for *Prey* it is a nearly uninhabited desert, and for *The Diamond Age* the underwater realm of the Drummers.

The fact that these marginal spaces are associated with nanotechnology indicates that there is a possibility of creating the unknown even within the known. It is no longer necessary to travel to strange lands or to transport into cyberspace to find the unknown; it

is folded within the known objects and spaces we inhabit in our everyday lives. Nano particles, generally not well understood by the general populace, are invisible even to scientists. One of the mechanisms to "visualize" atoms is the scanning tunneling microscope (SMT). In the STM's operation, a tunneling current flows when a sharp tip approaches a conducting surface of atoms at a distance of approximately one nanometer. The tip movement over the atoms and molecules is recorded and the data can be used to construct an image of the surface topography. At constant current flow, each individual atom on a surface can be resolved and displayed. Metaphorically, it is like a blind person who only knows the world by feeling its surface and can therefore imagine how surfaces would appear.

Interestingly, attempts to actually *see* atoms through the Transmission Electron Microscope (TEM) sometimes fail because some molecules cannot support the high energy levels that come from the microscope's electrons, "burning" the molecules. The TEM works much like a light microscope. However, the difference is the source of illumination: whereas the light microscope uses a beam of light, the electron microscope uses a beam of electrons to illuminate the sample. The wavelength of electrons, which is much smaller than the wavelength of visible light, sometimes destroys the tiny particles it attempts to illuminate.

Because nanotechnology is quite new and not generally understood, it has become an important source for the projection of imaginary spaces. Humans have always had a difficult time trying to understand what appears not to follow the "normal" course of nature (beasts and weird races), as well as what is not visible. Nanoscience encompasses both, since in the nano world particles are not visible to the human eye and behave differently than large-scaled matter. The *nano* exhibit speaks to our desire to know imaginary spaces by representing cellular patterns and mapping the invisible using sounds and graphics.

4.3. *nano*: representing the hybrid space

The creative team working at LACMALab on the *nano* exhibit created hybrid spaces that would reveal the interplay between actual and virtual realities. At sub-atomic levels particles pop in and out of existence, surface boundaries are dynamically unstable,

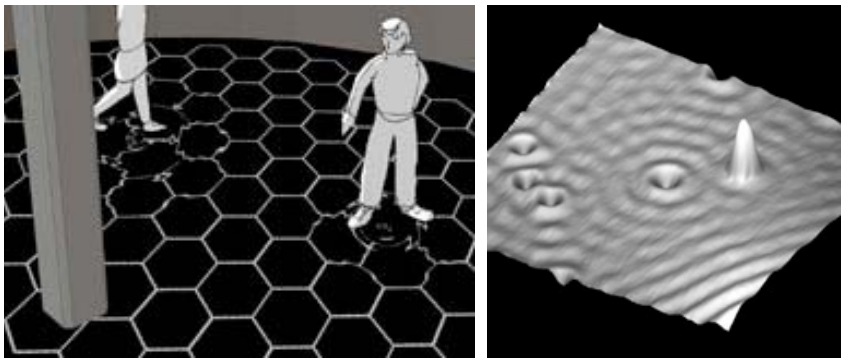
and the observer affects what is observed. *nano* takes advantage of art mediated by technology to represent the universe of potentialities discovered and explored by nanosciences. Connecting nanotechnology to imagination does not imply that the science itself is imaginary; rather, it is related to how people project their imaginaries onto a potential and unexplored part of the real.

As previously discussed, the emergence of media arts is responsible for reconfiguring museums as public spaces, creating more interactive and participatory spaces. The museum space becomes a hybrid environment encompassing virtual and actual realities. *nano* creates a hybrid reality by allowing remote visitors to use physical avatars *(robotic spheres)*, merging physical architecture with projections that represent "invisible" realms (floor projection grid), and treating human beings as quantum particles that interfere in non-contiguous spaces *(Quantum Tunnel).* Most of all, it creates a hybrid space because it merges potential and actual spaces.

The hybrid space starts to configure as soon the visitor enters the exhibition. The placement of the visitor's picture inside the virtual projection on the wall, mixed with other faces that have been there before but are absent now, is the first sign of hybridization. The mixing of virtuality and actuality is strengthened by text passages projected on the wall. "You are the sum total of your data,"(DeLillo, *White Noise*, 141) a text passage close to the camera swarm, asserts that human organisms are "digital/genetic" data.

Sense Spaces invite the visitor into the invisible realm of nanotechnology by creating an immersive sensation that is mainly evoked by audible and tactile experiences. According to Andrew Pelling, a nanoscientist graduate student co-responsible for the sound, *nano* aims to make sound itself a tactile experience. Part of Andrew's research focuses on converting the ASCII data obtained from oscillatory (beating) movement of cells sensed with the Atomic Force Microscope (AFM) into sounds. Nanobots (nano-sized robots) are often envisioned as armies of microscopic machines. Similarly, inside a cell millions of proteins are "swarming" to make things happen. Therefore, in *Sense Spaces* small sound bits and words come together and swarm, contrasting with large moments of silence and "background" noise.

The *Inner Cell* works with sound in a similar way. Sub-woofers are used to make the visitor feel the bass associated with the floor, so that the floor surface pulses and responds to movement by people and *robotic spheres* in its space. The floor projection, an analogy to nano-space, is composed of a grid representing a hexagonal pattern of graphite carbon atoms. In the nano-world every particle influences each other, so the space is deformed by the presence of other particles, in this case visitors and *robotic spheres*. The floor has a wave-like behavior, similar to what happens in the nanoworld. When the STM scans atoms, the data is used to produce visualizations. The wave-like behaviors revealed by the visualizations are caused by electrons, which can behave like waves as well as particles. Therefore they are dispersed in space, and this nano-dispersion is represented by wave-like appearance. Every nano-particle that comes close enough to an atomic surface affects it and is affected by it. Causing perturbations in the floor projection, visitors are like atoms experiencing quantum mechanical interactions.



The graphite floor and the scanning of graphite atoms with a STM

The *Inner Cell* also mixes the actual architectural space with potential representations of cellular movements. The interaction with the Buckyball projection includes a double sense of the virtual. Molecular structures resembling the buckminsterfullerene C-60 carbon molecule are born on the virtual space of the wall, and visitors can manipulate the molecules with their shadows. The piece acquires meaning through interaction with visitors. The molecules can be moved and squeezed in different ways, creating interactions in which visitors and atoms mutually influence each other.

The C-60 molecule represented by the piece was discovered in 1985 in an experiment to unravel the carbon chemistry in red giant stars. Until then, carbon was known in the form of diamond and graphite. Whereas diamond has a modified tetrahedral structure, graphite forms a flat grid composed of hexagons. In contrast, the buckminsterfullerene carbon-atoms are connected with a slight angle in between, creating a closed cage structure that resembles a soccer ball formed by 12 pentagons and 20 hexagons. The deformation of the buckyballs in the piece is similar to what happens when an STM pushes the C-60 molecule using electrons that come from the microscopic tip. Electrons flow gently through the tip, and if this flow is monitored, it is possible to see the deformations created by the tip literally "poking" the buckyball. In the projection, the visitor's shadow works as a tip that can deform and move the buckyball. Only slow and smooth movements can move the molecules, indicating that fast and rough movements are not (yet) effective at the atomic level while manipulating atoms. In playing with scale, the piece aims to make people aware of how atoms and molecules behave at this invisible level of reality.

Finally, the *Inner Cell* is inhabited by *robotic spheres.* Representing giant atoms, these spheres embody virtual participants, inverting the traditional meaning of a digital avatar. The Hindu word avatar, widely used among the digital community, designates a being who is the embodiment of the god Vishnu. In digital parlance, when one chooses a virtual character to represent oneself, this "creature" becomes one's avatar, so that an avatar is a digital representation of a physical body. In the case of *robotic spheres* this relation is inverted, since the *spheres* have actual existence that respond to actions of individuals who are not physically present in the *Inner Cell*. The initial idea behind the *robotic spheres* was to create a remote website through which they could be controlled. Later, the control interfaces moved to the *Atomic Manipulation Space*, allowing participants in that exhibit module to interact with the adjacent *Inner Cell* module. In both cases the idea is to combine remote and contiguous spaces into a hybrid environment and also to have visitors interacting with physical avatars. Manipulating the *spheres* also affects the visitors in the *Inner Cell*, because they feel compelled to move whenever a *robotic sphere* approaches. In this sense, visitors also have the power to manipulate and affect other visitors in the exhibition. The remote manipulation of the

spheres has been inspired by the work of Donald Eigler and Erhard Schweizer who in 1989 spelled out "IBM" by individually arranging 35 xenon atoms onto a nickel surface with a STM.[13] The ability of remotely influencing and rearranging the *spheres* represents the idea behind (the imaginary of) nanotechnology in building matter from the bottom-up.

The same thought is represented in the *Nanomandala*. As mentioned before, the installation deals with the process of constructing our universe by connecting grains of sand as a metaphor for the basic structure of life to atoms as the building blocks of our universe. The *Nanomandala* also connects the LACMA East, a traditional museum where the original mandala constructed by the monks is exhibited, to the LACMALab, since it projects over the sand the original work in the adjacent museum. Following the purpose of traditional museums, visitors are not able to interact or touch the Mandala exhibited in the LACMA East. Conversely, the *Nanomandala* is designed to invite interaction, encouraging visitors to play with the sand, highlighting one of the characteristics of hybrid museums.

Hybrid spaces can also be understood as a dynamic enfolding of different contexts and scale levels into one another, via digital technology. Kaleidoscopic structures spread throughout the exhibition contribute to folding the space of the exhibition inside itself. When the visitor moves around *nano*, he or she is able to look at distorted views of the *Inner Cell* while being immersed in a soundscape of fictional narratives about nanoscience. The Kaleidoscopes play with the idea of looking *in* from the *outside*, creating an interplay between inner and outerspaces.

Lastly the *Quantum Tunnel*, like other parts of the exhibit, is based on the idea of potentiality and possibility. Quantum tunneling is described by quantum mechanics as the probability that an electron, when encountering an energy barrier, goes through it instead of bouncing back. There is a finite probability this could happen with large-scaled entities like human beings, although here the probability is so infinitesimal that it would not happen once during the lifetime of the universe. The *Quantum Tunnel* addresses human beings as if they were electrons tunneling from one space to another, capable of altering other people's particles. To illustrate this dynamic, imagine a traditional theater with a stage and characters. Now suppose that the stage is elastic and deforms itself depending

on the characters' movement. It is as if the stage is also a character, interacting with other characters.

The distinction between the actual and virtual blurs in the nanoworld, since electrons have no precise physical location, can behave like particles or waves, and can apparently jump from one point to another without moving through the intervening space. Nano-particles are simultaneously potential and actual entities, revealing the merging of these states into a hybrid reality. How can anything be considered as strictly *either* potential *or* actual in the nano-world?

5. Conclusion: blurring borders between real and imagination – potential futures

The blurring of potentiality and actuality in the nanoworld, and the lack of general knowledge about nanotechnology, create a fertile imaginary around the new discipline. A common nightmare speculates that, with the aid of nanotechnology, researchers will build nanostructures capable of replicating themselves like nano-robots. UCLA Professor James Gimzewski relates that when he worked at IBM "a newspaper called the *Bild* printed a front page story saying 'IBM creates nanobots that can cure cancer' with a picture of them swimming inside the human body and describing it as having a cancer-killing unit that used lasers to 'blast away' the cancer cells."[14] Immediately, there were people from all over the world calling IBM and asking how to get these nano-bots.

The nano-bot story was not true, but there are many future developments for nanotechnology that might potentially have a great impact on our future. Several possible inventions aim to develop biochemical sensors responsive to the environment. For example, windows can cool the ambient air if it is too warm outside, and clothes can warm the wearer if it is cold or cool one down if it is warm. Another application envisioned by Professor Gimzewski is the use of biodetectors in restaurants "and in any public place, which can be used by uneducated people and that will detect the presence of viruses and different types of hazardous material."[15] Nanotechnology can also be used to engineer intelligent drug release systems and to manipulate cell structures inside the human body. This idea has been explored by science fiction for some time. For example, the 1985 movie *Innerspace* narrates the story of a group of people who are miniaturized

and injected inside the body of a hypochondriac. Most of the dreams and nightmares related to nanotechnology are connected to the creation of nanostructures and molecular machines that could go inside the human body in order to fix or destroy it.[16] Other favorite science fiction themes include the creation of pervasive surveillance and invasive devices that could be injected inside the body. What if somebody could control a person's dreams without any visible interface?

Mark Weiser used to say in the last decade that ubiquitous interfaces could be considered "natural" because their existence would not be perceived.[17] The smaller the interface, the more "natural" it is. With nanotechnology some interfaces are no longer perceivable by the human eye, and so will "naturally" become an accepted part of the environment. In this context, media arts play important roles in making people aware of new technological innovations. Art has always been concerned with representing imaginary worlds, and it has also often pushed the limits of technology to change the physical world around it. Initiatives like the *nano* exhibit, and more broadly the shows commissioned by LACMALab and other such experimental venues, foment this type of discussion, rethinking the role of art and technology and re-defining the borders between real and imaginary spaces. The dialectic now takes place between the actual and the virtual, both of which are participating in constructing our reality. In working with the in-between space that connects art and technology, *nano* and LACMALab create a hybrid space that, without being didactic, enlarges the scope of the real to include what potentially can be as well as what actually is.

6. The visitor glances back

From the *Studio Area* (10), I look at the wall and read in very big letters: "Nature is Imagination."[18] Watching visitors at the Boone's Children Gallery, I think that the museum is no longer the same, and neither are our imaginative constructions of the spaces in which we live.

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12. 08turbulent_text: Illustration of *Turbulent Text*, by Ashok Sukumaran.
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Endnotes

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[2] All images in this essay are illustrations developed during the process of producing the exhibition. While they are not photo-realistic pictures from the show, they represent the early intentions of artists and scientists involved in its development. Therefore they can be viewed as potential spaces that will be actualized in the final *Nano* show. The final pictures can be found in a special signature in the middle of the book.

[3] This is a fictional walk-through the *nano* exhibition by an imaginary visitor. This description does not intend to cover the entire show, for its richness and complexity exceeds the scope of this essay. Elements that belong to the exhibition but have not been mentioned: *Seeing by Feeling*, the *Mandala Kaleidoscope, Virtual Crystal Assembly, Model Assembly*, and the *Lounge Area with Nanofurniture*. This was the status of the exhibition in December 2003. As the exhibit continues to evolve, some of its components may also change.

[4] For a more detailed discussion about nanotechnology and surveillance mechanisms, please refer to the chapter, “Less is More: Much Less Much More: the Insistent Allure of Nanotechnology Narratives in Science Fiction,” by Brooks Landon.

[5] The exceptions are viruses.

[6] The installation is based on *Zero@wavefunction: nanodreams and nightmares*, the first collaboration between artist Victoria Vesna and scientist James Gimzewski. <http://notime.arts.ucla.edu/zerowave>

[7] Robert Sain, LACMALab Overview Catalogue.

[8] Foucault, Michel. *Of Other Spaces (1967), Heterotopias.* <http://foucault.info/documents/foucault.heteroTopia.en.html> (October 16, 2003).

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[12] For information, see <http://www.connected-cities.de/>.

[13] For a more detailed explanation of Eigler and Schweizer's experience, please refer to Nathan Brown's article in this book, "Needle on the Real: Technoscience and Poetry at the Limits of Fabrication."

[14] Gimzewski, James (interviewed by Rebecca N. Lawrence). *Magazine: BioMedNet.* <http://news.bmn.com/hmsbeagle/118/notes/biofeed> (May 30, 2003).

[15] Gimzewski, James (interviewed by Rebecca N. Lawrence). *Magazine: BioMedNet.* <http://news.bmn.com/hmsbeagle/118/notes/biofeed> (May 30, 2003)

[16] For more dreams and nightmares, visit *Zero@wavefunction* website at <http://notime.arts.ucla.edu/zerowave>.

[17] Weiser, Mark and Brown, John Seely. *Designing Calm Technology*. <http://www.ubiq.com/weiser/calmtech/calmtech.htm> (August 25, 2003).

[18] William Blake, *The Complete Writings of William Blake*, edited by Geoffrey Keynes (London: Oxford University Press, 1966), letter to Dr. Trusler, 23 August 1799, p. 793. The capitalization is Blake's.