

Article

Contemporary aesthetic forms and scientific museology

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The use of various expressive artistic forms in science centres and in interactive museums is becoming increasingly widespread. This paper proposes an interpretation of this phenomenon that emphasises how contemporary art contributes to experimentation with new forms of scientific communication. Furthermore, it examines the considerable overlap apparent between the themes addressed by contemporary artists and current scientific developments.

Indeed, just as can be seen in science centres, artistic experimentation has assumed a new role: raising public awareness of what is happening around us today.

Introduction

Science centres were created in order to provide a fertile ground for the development and dissemination of scientific culture. In this sense, they represent a social space for interaction between people. Their mission is to make available the necessary tools not just to allow visitors to interact, but to render this experience enjoyable, engaging and varied, and thus to encourage an increasingly conscious and deliberate participation, even in terms of determining a community's cultural and socio-political choices and policies.¹ To achieve these aims, scientific museology is evolving constantly and focusing increasingly on expressive forms and, in particular, on the visual and performing arts.

Indeed, more and more, art – in all of its possible applications – is one of the innovative elements being used when designing new science centres or renovating existing ones, and in the context of temporary exhibitions and the informal scientific education promoted within these structures.

It thus seems opportune to analyse what shape this phenomenon is taking, and to systematise the methods, typologies and functions these artistic interventions are assuming in some of the international scene's most representative science centres. This brief consideration – which naturally only aims to initiate and share a general discussion about this topic – will be guided by an attempt to trace areas of overlap, synergy and synaesthesia between contemporary aesthetic forms and scientific museology. It is precisely in identifying these shared characteristics that an initial interpretation of the phenomenon will emerge.

This paper thus attempts to outline an exposition which – in the service of brevity – analyses only a few significant cases of science centres that are engaged in a dialogue with art on various levels, ranging from the Exploratorium in San Francisco (the earliest example of a science centre, founded in 1969) to the CosmoCaixa in Barcelona (recently inaugurated on 25th September 2004) and the Phaeno in Wolfsburg (Europe's newest science centre).

A history of art: between participation and interaction

Before we address the question of science centres, however, it will be necessary to retrace some of the fundamental stages of contemporary artistic research in order to show which elements most firmly form the basis of the current overlap between art and science. Several themes in particular will be examined: the concept of interactivity and, at the same time, the return to the "object"; developments resulting from the introduction of new technologies; and those areas of scientific interest that are increasingly at the centre of artistic research.

Participation by the public; the concept of a network; art as a process, way of life and performative gestural expression; the idea of no longer separating the artist and viewer and of establishing spontaneous social aggregations and networks of relationships; the artistic event aimed at producing feelings, moods, anxieties and not just objects – all these are theoretical products that underlie contemporary artistic research, but that clearly derive from the history of the *avant-gardes*.² Their roots thus reach back to the same period during which, in the field of scientific museology, the conditions were being created that eventually led to the emergence of science centres in the 1960s. A significant example is the Deutsches Museum in Munich, which introduced the first forms of interactivity with the public. A shift was made from the traditional “look but don’t touch” to “press the button”; in other words, the public was invited to activate mechanisms by pressing a button and watching what happened.³ This early form of interactivity, understood as “reactivity” (i.e. the response of an electrical or mechanical device to human input), subsequently – once again, parallel to what occurred in art – assumed more complex forms and meanings, such as the interaction between two or more individuals, mediated, encouraged or triggered by the device.⁴

In artistic research, it was precisely beginning with the *avant-gardes* that creation became no longer limited to an artist or designer’s individuality, but had the quality of also being shared with those at whom the creative process was aimed.⁵ The theoretical contribution of Walter Benjamin, who considered the importance of technology and the moment of reception to be constituent elements of an artwork’s very existence, remains fundamental. “The manner in which human sense perception is organized, the medium in which it is accomplished, is determined not only by nature but by historical circumstances as well”.⁶

The notion of interactivity as a physical and not just mental act by the user could already be found in some of Marcel Duchamp’s works. Kinetic art also required the participation of the user, who was invited to deconstruct the work, while optical art called for his or her optical-psychological collaboration to observe the visual effects and perceptual illusions generated by the pieces.⁷

Still, beginning with the historical *avant-gardes*, “it had always been a question of a direct process which, even if in some cases assisted by complex tools and mechanisms, was never run by systems with the kind of processing capacities” offered by new contemporary technologies.⁸ Indeed, a technological device, “in addition to amplifying and magnifying various social necessities, assumes the form of a system that is able to communicate a wide range of different things; in addition, it has proven capable of revealing and arranging all the data generated by any given interactive process”.⁹ “In this context, artistic research plays an essential role in revealing the elements of an aesthetics of relationships – in addition, of course, to participating in defining an ethics of said relationships”.¹⁰ “It is in this respect that the role and figure of the artist also changes and touches another delicate point, the artist becoming a planner not only of events but of behaviours as well”.¹¹

Here, too, we may introduce another consideration in passing, which we shall return to presently: namely, the question of how new technologies, PCs and multimediality have been important tools in developing the first generation of science centres,¹² as well as many later ones such as the Tech Museum of Innovation in San Jose (2000), for example, and the Wellcome Wing at London’s Science Museum (2000).

We have briefly mentioned the concept of interactivity in its various forms: in the artistic research of the *avant-gardes* and also – as we well know and have attempted to outline summarily above – at the basis of the philosophy of science centres. We have also introduced the first elements to consider in relation to some of the transformations caused by the introduction of new technologies. Let us now continue our discussion by taking a closer look at the contemporary scenarios that artists are showing an increasing interest in and need to tackle, thereby becoming interpreters of these scenarios’ complexity. Indeed, as previously mentioned, this represents another important link to the science centres, for it will be easy to establish how the themes at the heart of artistic experimentation overlap with those of scientific research and technological applications.

We need only consider some of the themes frequently explored by artists – artificial intelligence and life, telepresence and telerobotics, virtual reality, the Internet, visualisation of data, network activism, game and narrative environments – to perceive the powerful urge to transform electronic space from a tool of representation into a tool of action and interaction.

New definitions – such as Evolutionary or Generative Art (drawings made to evolve via calculator using the techniques of genetic algorithms), Biotelematics (art in which a biological process is intrinsically connected to digital networks) and Transgenic Art (based on the use of genetic engineering techniques to create living beings) – are continually arising that reflect the major ongoing debate concerning genetically modified organisms and the field of influence created by a future economy based on genetic variations.

All these things – as well as the world of robots, cyborgs and “post-human” bodies, dematerialised and depersonalised – are difficult to accept, and it is as if the use of processes and elements from the field of biogenetics allows artistic experimentation to learn about, participate in and control what is happening. Beyond this, there is also a more general interest in investigating the philosophical and political dimensions of processes of communication.

At the same time, however, artistic research also strikingly reveals the paradoxical “growth of incommunicability in modern communications society and of forgetfulness in the age of extended memories”,¹³ strongly urging us to find alternative forms that go “beyond speed”.

Art enters science centres

Clearly, the themes discussed up till now are at the heart of the scientific debate and thus also of spaces designed to popularise science, such as science centres. In fact, it is precisely this convergence of shared expectations which, in recent years, has led to more and more artistic interventions within these centres. Before we proceed to an analysis of several museum experiments, there is one further remark – or rather, clarification – that should be made regarding this point. Thus far we have mentioned electronic art and interactive art to emphasise certain similarities and especially the parallel origins they share with the latest generation of museology, which no doubt encouraged the natural convergence of these two realities. Yet there are also many works associated with traditional fields of visual arts production that address very topical scientific and social themes. This current of artistic research is also assuming a central role and importance in science centres, highlighting another element that is making increasing headway in the field of new generation scientific museology. In fact, we will see how these two expressions of artistic research – interactive art and traditional visual arts – frequently exist side-by-side in science centres, reciprocally complementing one another. To date we have outlined the historical development of the phenomena of dematerialisation, virtualisation and the importance of processes and relationships in the fields of both museology and artistic research; however, what we are seeing today (as often happens in complex systems) is a pervasive need for a longer period of “sedimentation” and reflection, and a return to the real – and thus, in a certain sense, to the object as well. Jorge Wagensberg, Director of Barcelona’s CosmoCaixa, defines this new situation well: “We have to invent a new museography: museography with objects that are real but able to express themselves in a triply interactive way: manually interactive (“hands on”), mentally interactive (“mind on”) and culturally interactive (“heart on”). They are objects that tell stories, that talk to each other and to the visitor. They are objects with associated events, living objects, objects that change. It is one thing to exhibit a sedimentary rock on its own and another to associate an experiment that shows the process in real time of how the rock was formed”.¹⁴ In this sense, a work of art – whether a watercolour or bronze – that communicates with the emotion of its essence also becomes a central tool in museological considerations.

This brief exposition will examine precisely how, today, at the forefront of artistic interventions, and more generally of the intersections between art and science, there is an increasingly wide range of possible attitudes and different applications (not always formalised) that span from interactive electronic art to traditional visual arts. It is precisely this scope and wealth of expressions that make this topic so interesting and allow it to serve as a key for understanding far more extensive and complex changes in the field of scientific museology.

The Exploratorium

At this point it will be useful to examine some specific cases, beginning with a particularly significant example: the Exploratorium in San Francisco, which can be considered the “spiritual father” of science centres.

The centre’s full name is “Exploratorium. The museum of science, art and human perception”, and its founder, Frank Oppenheimer, describes the role art plays in it as follows: “Art is included, not just to make things pretty, although it often does so, but primarily because artists make different kinds of discoveries about nature than do physicists or geologists (...)”.¹⁵

Indeed, the Exploratorium was born of a temporary exhibition dedicated to the relationship between art and science, and, since its founding in 1969, visiting artists have been commissioned to create many of its exhibits (or should we say works?). To get an idea of the importance of their involvement in the project and the range of possible contributions, one need only read the application for the artist-in-residency programme, in which the Exploratorium impels “installation artists, exhibit artists, filmmakers, media artists, performers, and sound artists (...) to create artworks, installations, films, and performances that can augment large-scale thematically based exhibitions”. Artists are invited to work within the structure for several months, absorbing the atmosphere and consequently producing their own contribution. In fact, according to Oppenheimer, non-specialists’ need some sort of guidance in approaching the world of science and technology, and aesthetic perception is suited to accomplish this “siren-like” mediation.

Light, colour, movement and form initially attract visitors because they are fascinating and beautiful, and subsequently through the meaning and scientific content that they convey.

The Wave Organ by Peter Richards, from 1986, is an example of the works presented at the Exploratorium.¹⁶ Located at the end of a jetty close to the Exploratorium, the organ is a granite “sculpture” interlaced with pipes of various lengths made of PVC that end in the water. The intensity and complexity of the music produced by the waves is directly related to the tides and atmospheric conditions.

Cité des Sciences et de l’Industrie

A second example is the Cité des Sciences et de l’Industrie in Paris.¹⁷ Since its founding in 1986, it has declared that “the works, the environments, must show the vitality of the exchange between the most cutting-edge techniques and the openness, imagination and direct explanation contained in art”.¹⁸

The expository areas include many artistic installations, such as *La Clepsydre sonore* by Louis Dandrel, a sound installation that envelops the Geode, and *La Serre, Jardin du future*, dedicated to biotechnologies, in which the works “provoke dissonances – create a rift – by playing on humour, criticism and poetry”.¹⁹ Interestingly, the Cité’s Département Action Culturelle (Department of Cultural Activities) offers “artistic walks through the Cité des Sciences et de l’Industrie”. Visitors are guided on these theme-based tours with the aid of didactic materials that provide information and encourage them to closely examine and discuss the content and meaning of the works. Two of these tours, for example, are entitled *L’art et la lumière (Art and Light)* and *L’art et le temps (Art and Time)*.

In addition, the Cité des Sciences et de l’Industrie also pioneered the creation of *Ars Technica*, a French-Italian association established in 1989 thanks to the initiative of various artists and scientists. The association was created in the wake of a conference entitled *Vers une culture de l’interactivité? (Towards an interactive culture?)*, which brought together international artists, technologists and scientists. This event was also of particular importance to Italy because it led to the creation of an important satellite of the association in Turin, ArsLab.²⁰

To return to the Cité’s activities, also worth noting are the major temporary events that it dedicates to artistic research. Of particular interest is *La Villette Numérique*, an international (biennial) festival dedicated to creativity through new media: “emerging, changing and as yet poorly-defined art”.²¹ Indeed, spaces for reflection must be dedicated to the visions of the world emerging from the experience of new artistic practices: “Investigating the relationships between art and technology is not just necessary – it is inevitable”.²²

Science Museum

To continue our exploration of some of Europe's most important science centres, let us now turn our attention to London's Science Museum.

The origins of the museum date back to the 19th century, when it took root in the midst of a cultural climate which aimed, among other things, to improve scientific and technical education. Beginning in 1851, using the proceeds of the World's Fair, institutions were created to promote and improve the technological industry. In 1857, the government established the Science & Art Department, which in turn created the Museum in South Kensington, the original core of what later became the Science Museum of London. Beginning in 1993, the museum underwent a major overhaul, developing a series of educational programmes, events and exhibitions in addition to interactive galleries and hands-on exhibits, thereby fully joining the new generation of scientific museums. The most recent renovation project was the Wellcome Wing, which is dedicated exclusively to contemporary science and technology. Opened in 2000, the new wing explores current ideas and questions through interactive devices that aim to thoroughly involve visitors. Significantly, many of the installations and exhibits within the scope of this project have been designed and executed by international artists. The works of artists active in the fields of sculpture and painting exist side-by-side with those of artists clearly capable of meeting the challenge posed to human creativity by the new technologies and media. The result is a juxtaposition that is very effective, in every sense of the word.

The Wellcome Wing is laid out on three levels: *Who am I*, *Digitopolis* and *In Future*. Visitors are introduced to the centre by the Talking Points section, composed of a series of exhibits aimed at immediately shaking up thinking and raising awareness about the influence of the modern sciences in our society. Some are the work of artists, including Yinka Shonibare, whose work *Effective, defective, creative* investigates the ethical dilemma created by advances in the field of medicine.

On each level, the Science Museum has given one or more artists the opportunity to tackle that section's theme. The works' titles are frequently in the form of a question, and the installations have a strong impact on visitors, encouraging and allowing them to respond, thus creating a forum in which ideas and imagination give rise to debate. The museum has several important works of art, including *Iron Baby* by Antony Gormley²³ and two watercolours by Marlene Dumas.²⁴

The Hygiene Museum

In contrast, the Hygiene Museum in Dresden is very interesting from a different point of view. Not only is it smaller than the museums analysed so far, but its current permanent sections fit within the framework of traditional scientific museology. The Hygiene Museum was founded by the manufacturer of the mouthwash Odol, Karl August Lingner, who had already sponsored the first international exhibition on hygiene in 1911. However, it was the second international exhibition in 1930 that resulted in the creation of the actual museum, which is housed in the very same building where the exhibition was held.

Over the course of the many years during which the Hygiene Museum's activities have been based around a thoroughly traditional permanent exhibition, the museum has also given a great deal of room to contemporary artists, organising temporary exhibitions which, in some cases, have even been curated by the artists. A recent example is *Sex – Facts and Fantasies*, held in 2002, which documented the powerful connection between art and sexuality, exhibiting works by many artists who, over the course of history, have opened up new horizons and helped overcome numerous taboos.

In 2004 there was a temporary exhibition dedicated to the "Ten Commandments", comprising some 100 pieces by 69 international artists. Speaking of this centuries-old system of rules and its possible relevance in a globalised society, curator Klaus Biesenbach (Kunst-Werke Berlin, PS1/MoMA New York) said: "The works shown were not created in direct engagement with the individual Commandments, nor do they illustrate them, but were rather chosen so as to show ways of seeing social and ethical fields of tension in the world of today. (...) Just as the biblical Ten Commandments speak explicitly to the individual, the works of art direct their questions at the individual and his or her own ethical convictions".

Ars Electronica Center

The Ars Electronica Center²⁵ brings us to yet another aspect of our discussion. Indeed, the Ars Electronica is a true example of a “hybrid museum”, halfway between science centre and contemporary arts centre. As such it represents a particularly interesting model for the analysis we are attempting to undertake here.

The centre is located in Linz, Austria. It promotes activities that investigate the relationships between art, technology and society, generating a high degree of synergy between exhibition activities, forums, research and events. Over the twenty years of its history, the Ars Electronica festival has been a fundamental point of reference at the international level on the media arts in general and on new media in particular. A building entirely wired with fibre optics that boasts the most cutting-edge graphic stations, multimedia centres and digital archives make the centre a veritable workshop for innovation. The numerous interactive installations and the CAVE Project directly encourage interaction between visitors.

The festival further amplifies this aspect by organising meetings and large conferences concurrently with the installations. Each year, a theme is chosen and artists, scientists, philosophers and journalists are invited to examine and expand upon its various facets.

What is particularly interesting and original about the festival is how it has succeeded in illustrating and revealing that – even when it comes to difficult scientific developments that are often confined to research laboratories and political environments – the contribution by artists in involving the public in the debate is decisive and important, through an approach in which interaction and the exchange of ideas focus more on questions and contradictions than on answers and solutions.

Each year, Ars Electronica also commissions technological artists and designers to create a certain number of installations devoted to the annual theme. These works are then shown during the Festival, in close connection with the debates and discussions held in conjunction with the event, in which, incidentally, the artists themselves are asked to participate. To help the artists create their works, the centre allows them to take advantage of its workshops and technical staff. This fact of producing and creating workshops within the exhibition spaces is another strength and innovation of this new generation of museums.

Città della Scienza

Our overview also includes the Città della Scienza in Naples. Since its creation, through the activities implemented since 1987 by the Fondazione IDIS (the foundation responsible for creating and organising the Città della Scienza), the centre has recognised the central role of art and has worked to consolidate the dialogue between art and science to assure an exchange of energy between these two fields. In addition to several prestigious permanent installations superbly integrated into the architectonic context and fabric of the scientific exhibitions (such as those by Sol Lewitt, Studio Azzurro and Dani Karavan), the Città della Scienza has also hosted temporary exhibitions by numerous artists, including Fabrizio Plessi, Piero Fogliati, Studio Azzurro, Mario Ceroli, Paola Levi Montalcini, Mario Canali, David Rokeby and Berrocal.

An important case in point is *Bit*, an interactive installation by Studio Azzurro in which a synthetic figure engages in a dialogue with the public in real time. In the installation, the figure appears in one or more positions and is directed remotely by an animator wearing a cyberglove, who controls the synthetic figure’s movements as though it were a puppet. An “electronic” mask allows viewers to “act” as well: a double mask, it transforms the passive audience into an active one, creating a veritable forum in which the public not only converses with Bit, but also activates processes of communication within the group. This installation has the potential to generate discussions and reflections regarding a constantly evolving range of scientifically-relevant topics.

Another example is David Rokeby’s *Very Nervous System*. It is composed of a computer connected to a camera that is positioned in such a way as to reveal the movements of anyone that passes through its range. Software analyses each movement and transposes it into a series of sounds. This artistic installation poetically interprets the theme of non-verbal language addressed by the exhibition “Segni, Simboli e Segnali” (“Signs, Symbols and Signals”).

CosmoCaixa

I would like to end this brief investigation with an especially noteworthy example: the CosmoCaixa Museum in Barcelona.

There are two reasons why I consider this case of particular interest. First of all, the CosmoCaixa is one of the most recently inaugurated science centres and, as such, an important demonstration of the very vibrant contemporary interest in the potential relationships between art and science. It includes many installations, sculptures and contributions both inside and outside of the exhibition areas. Many of these works were designed and executed in close collaboration with the museum's project group. They also contribute to creating a different notion of "museum time" – a sign that symbolically represents an alternative and a response to the phenomenon of "acceleration" typical of today's social system, which undoubtedly does not encourage the processes of critical thinking. Secondly, Jorge Wagensberg, in addition to being the CosmoCaixa's active and dynamic director, is also a keen theorist and thinker in the field of scientific museology. He is also one of the first museologists to begin to address this theme systematically in his writing, of which we will cite some short excerpts. As already mentioned briefly in the introduction to this paper, in the article Wagensberg presented at the 4th Science Centre World Congress, he does an admirable job of addressing the concept of the object and the real that underlie his consideration of a museum's functions.²⁶ If museums are places that stimulate creativity and the search for answers, this is because thinking originates in real objects. One could provide museums with all the most futuristic devices for visitors to interact and relate with, and yet a fundamental aspect would be missing – namely, reality as an essential element of relating. When a good museum leaves you with "more questions when you leave than you had when you entered" this is because, though reality has not changed, the museum has suggested new relationships and associations. To date, citizens have a limited role in determining how resources are used in scientific research. The underlying condition of Wagensberg's "total museum" is that citizens be given the tools to make social choices as well.

It is in this sense that Wagensberg claims that "science museums can open the door to the scientific intuitions of artists. Art and science are two forms of knowledge that behave like two independent pendulums".²⁷ When a museum is beautifully and intelligently designed, individual and social interest become enormous. The emotions, objects and real events that bring a museum to life do not refer to any particular social class or level of culture, and it is thanks to them that the museum can welcome a universal public. "Art and science can lend their greatnesses to each other".²⁸

A brief note regarding the Phaeno

On the 24 November 2005 the Phaeno Science Centre was inaugurated in Wolfsburg. We shall mention it only briefly, while awaiting to get to know it better. This major science centre will have a strong artistic character, beginning with the building itself, designed by Zaha Hadid.²⁹ It will include the installation *Lasso - Kette* by Norman Tuck,³⁰ and *Toposonic* by Sabine Schafer and Joachim Krebs, a three-dimensional sound installation.³¹

Some final considerations

In conclusion, this paper has tried to reconstruct how, over the course of the 20th century, the two spheres of artistic research and scientific communication, with a particular view to the system of science centres, have developed shared expectations – quite as one would expect, incidentally, since both these fields are examples of interpreting reality and, above all, the complexity of our system. Just as can be seen in scientific museology, artistic experimentation has assumed a new role: that of participating in and informing the public about what is happening around us today. Thus, the challenge has been to not simply repeat what some people may already take for granted, but rather to seek out the instances, tools and themes where there is the greatest overlap between these two fields and which have created a convergence of places and forms of communication between art and science.

Indeed, let us conclude with a summary of the places, themes, methods and aims shared by these fields of knowledge.

The places are science centres, whose role as a social place for interaction between people is becoming increasingly consolidated. This is also occurring thanks to an overall context that is more favourable and sensitive to these values, and which – albeit with different characteristics than those seen in science centres – is witnessing the proliferation of initiatives that bring together art and science within contemporary art centres and through temporary events such as exhibitions and festivals.

The themes range from modern science to current scientific developments: in addition to classical physics, the areas explored include artificial life and intelligence, cyborg, biotechnologies, genetics, new technologies, environmental sustainability, environment, ecology, and others.

The methods for exploring the complexity of these phenomena are interactivity (especially in the more up-to-date and mature meaning of the term as the activation of relational processes between people through the use devices), exhibitions and experiential activities. Moreover, however, as we have seen – in the case of Barcelona's CosmoCaixa in particular, though also with London's Science Museum – there has also been a return to the object “in a new guise”, which affects the “fruition time”, providing a period of time – critical and conscious – for considerations to crystallize.

Finally, the element that is doing most to bring art and science ever closer together is the fact that they share the same goal – namely, that of building and encouraging a dialogue with civil society.

It thus seems possible to interpret this tendency to introduce installations, events, artistic workshops and performance as the result of a new awareness of the profound anthropological shift that is being propagated by changing modes of production and consumption, and changing relationships between individuals, work and society. As a result, there is a tendency to challenge visitors to engage in a political, ethical and cultural debate by weaving signs derived from the codes of art (and, in particular, of contemporary art) throughout the fabric of scientific demonstrations.

Art, precisely because of its ability to immediately involve people emotionally and to activate processes of participation and dialogue, and because of its attention to processes-in-progress rather than consolidated systems, seems to offer the best way to convey restlessness to even the segment of the public that visits science centres, which is almost always still of learning age.

The underlying idea seems to be that combining the manual and technical “capacity to do”, the abstract “capacity to learn”, the “capacity to observe/hear/perceive” the essence, beauty and meaning of natural and human creations, and above all the “capacity to discuss, participate and construct ideas democratically” is the only possible way to arrive at an analysis that is equal to the challenges posed by contemporary means of producing and disseminating knowledge.

Translated by Sophie Schlondorff.

Notes and references

¹ See the report prepared by the European Commission, Research DG, Study IFOK Interim Report, “Governance of the European Research Area ‘The Role of Civil Society’”, *Study IFOK Interim Report*, Bruxelles, May 2003, p. 32, 64. The chapter entitled “Public Understanding of Science (PUS)” includes several references to the central role of science museums and centres.

² See S. Vassallo, A. Di Brino, *Arte tra azione e contemplazione, L'interattività nelle ricerche artistiche*, Edizioni ETS, Pisa, 2003.

³ See the interesting American documentary filmed around the 1920s in some of the major European science museums, including the Deutsches Museum. Entitled *Museum of New Age. A Study in World Progress*, the documentary was produced under the supervision of Charles Guynne and directed by Arthur Edwin Krows. It was presented on the occasion of the annual ECSITE conference held in Munich in 2003.

⁴ See the research carried out by C. Heath, D. vom Lehn, and J. Osborne, “Interaction and interactives: collaboration and participation with computer-based exhibits”, *Public Understanding of Science*, 14, 2005: p. 91-101.

⁵ See U. Eco, *Opera Aperta. Forma e indeterminazione nelle poetiche contemporanee*, Bompiani, Milano, 1976. Eco, starting from the premise that “the artwork is an essentially ambiguous message” and that “in contemporary poetics this ambiguity becomes one of the explicit aims of the work” (p. 16 of the “Introduction” to the 2nd edition, 1967), examines the “reaction of art and artists – of the formal structures and poetic programmes that govern them – to the challenge of Chance, the Indeterminate, Probable, Ambiguous, Polyvalent; in other words, the reaction of contemporary sensibility to the suggestions of mathematics, logic and the new epistemological horizons opened up by these sciences” (p. 2 of the “Introduction” to the 1st edition, 1962). See also G. Salvatori, “‘Opera Aperta’ e interattività nelle arti. Sguardi sugli anni precedenti l’era del Web”, in G. Salvatori, A. Drioli (eds), *Paradossi. Schegge di arte elettronica e interattiva*, Seconda Università degli Studi Napoli, Santa Maria Capua Vetere, 2004, p. 24-32; and L. Meloni, *L’opera partecipata. L’osservatore tra contemplazione e azione*, Il Rubettino, Soveria Mannelli,

- Catanzaro, 2000. In both these texts, the authors retrace the origins of participatory works beginning with the historical avant-gardes.
- ⁶ W. Benjamin, *L'opera d'arte all'epoca della sua riproducibilità tecnica*, Piccola Biblioteca Einaudi, Turin, 1991, p. 24. (Published in English as *The Work of Art in the Age of Mechanical Reproduction*.)
- ⁷ L. Vergine, *Arte programmata e cinetica 1953-63*, Mazzotta, Milano, 1983; I. Mussa, *Il Gruppo Enne*, Bulzoni, Roma, 1976; G.C. Argan, "La ricerca gestaltica" and "Forma e formazione", *Il Messaggero*, Rome, 24 Aug. 1963 and 10 Sept. 1963; R. Arnheim, *Arte e percezione visiva*, Feltrinelli, Milano, 1962; U. Eco, "Arte Programmata", in *La definizione dell'arte*, Garzanti, 1978; U. Eco, *Opera aperta. Forma e indeterminazione nelle poetiche contemporanee*, cit.; G. Kepes, *Il linguaggio della visione*, Dedalo, Bari, 1971; F. Menna, "Arte cinetica e visuale", *L'Arte Moderna*, Fabbri, Milan, vol.XIII, 1967; P. Serra Zanetti, "Ricerche ottico-visive e arte cinetico-programmata", in R. Barilli et al. (eds), *L'arte in Italia nel secondo dopoguerra*, Il Mulino, Bologna, 1979.
- ⁸ P. Rosa, "L'arte fuori di sé. Pensieri ancora sommari sull'estetica delle relazioni". In S. Vassallo, A. Di Brino (eds.), *Arte tra azione e contemplazione. L'interattività nelle ricerche artistiche*, ETS, Pisa, 2003, p. 43.
- ⁹ *Ivi*, p. 42.
- ¹⁰ *Ivi*, p. 44.
- ¹¹ *Ivi*, p. 45.
- ¹² See the Fondazione Giovanni Agnelli's interesting analysis from the conference of 9 March 1998 in Turin: *L'esperienza internazionale degli science centre*, Fondazione G. Agnelli, Turin, 1998. Another authoritative and widely-cited definition of the "generations" of science centres was proposed by Bradburne in J.M. Bradburne, "Beyond Hands-on: Truth-telling and the Doing of science", 1991. In R. Glanville, G. de Zeeuw (eds.), "Mutual Uses of Cybernetics and Science", special issue of *Systematica: Journal of the Dutch Systems Group*, Thesis Publishers, Amsterdam, 1991.
- ¹³ P. Rosa, "Punto e caos". In G. Salvatori, A. Drioli (eds.), *Paradossi. Schegge di arte elettronica e interattiva*, cit., p 51.
- ¹⁴ J. Wagensberg, "The Total Museum. A Tool for social change", *Provocative Paper*, 4th Science Centre World Congress, Rio de Janeiro, 10-14 Apr. 2005, p.3.
- ¹⁵ This quotation is taken from the Exploratorium website, available at: <<http://www.exploratorium.edu/about/air.html>>
- ¹⁶ See the website, available at: <http://www.exploratorium.edu/visit/wave_organ.html>
- ¹⁷ See the interesting document by Emma Abadi, director of the Cité des Sciences et de l'Industrie's "Action Artistique": E. Abadi, "Des Usages de l'art dans l'exposition scientifique. L'expérience de la Cité des Sciences et de l'Industrie", *DESS Conception et Réalisation d'Expositions*, Université Paris XIII, Paris, 1999. In this text, Emma Abadi outlines the history of the Cité's artistic policy, investigating its motivations, methods and the difficulties it has encountered.
- ¹⁸ Letter dated 18 Jul. 1984 addressed to the Minister of Culture, Jack Lang, by François Barré, Managing Director in charge of creating the Parc de la Villette's artistic policy and Adviser to the President of the Cité des Sciences et de l'Industrie, Maurice Lévy: "Les œuvres, les environnements, doivent montrer la vigueur de l'échange entre les techniques les plus avancées et ce que l'art recèle d'ouverture, d'imaginaire et d'explicitation immédiate".
- ¹⁹ E. Abadi (ed.), *La Serre, Jardin du Futur*, exhibition catalogue, Ed. Caractère, Aurillac, 2000, p. 3: "provoquent des décalages, introduisent une rupture, en jouant de l'humour, de la critique et de la poésie". *La serre, Jardin du futur*, inaugurated in 1997, is a 400 sq m section of vegetables, fruits and ornamental plants produced using biotechnological techniques. Twenty-three artists are represented, including Piero Gilardi, Xavier de Richemont, Marionette Cuenco, Alberta Pellicani and Jason Karaindros.
- ²⁰ According to the ArsLab Project Committee, from the very beginning, the life and soul of Arslab have been art, science and new media: "that which is aimed, on the one hand, at popularising science, and which chooses to present itself in an exceptional 'container', namely the work of art; and, on the other, at continuously investigating the hybridisation of the artistic impulse and science as creation, in search of the subversive values of the 'inappropriate' use of technology (again, the work of art) and the emotional, psychological and social impact that is the direct result of it".
- ²¹ "Art en émergence, mutant et encore mal défini". Available at: <http://www.cite-sciences.fr/francais/ala_cite/expo/tempo/artsnum/2004/pages/index.php?ver=fr>
- ²² "Interroger les relations entre art et technologie est, plus qu'une nécessité, une évidence". *Ibidem*.
- ²³ *Iron Baby* represents a newborn that seems so vulnerable that it is impossible not to be moved in looking at it. Made of iron, the hardness of the material creates a striking contrast to the delicacy of the sculpture.
- ²⁴ *The Experiment* and *The Expert* by Marlene Dumas are part of the "Rejects" series and invite the visitor to think about the meaning of science and of being a scientist. Dumas explicitly asks "Would you believe this person?" in reference to the portrait of *The Expert*, while the question she poses with respect to *The Experiment* is "What have scientists done to this person?". The artist's response to both questions is "We don't know".
- ²⁵ Ars Electronica Center, *Linz, Museum of the future - der Zukunft*, Ars Electronica Center (AEC), Linz, 1996. See the centre's web site (available at: <<http://www.aec.at/>>) which includes a vast archive documenting all of the AEC's activities since its inception.
- ²⁶ J. Wagensberg, "The Total Museum. A Tool for social change", cit. Also see J. Wagensberg, "Basic principles of modern scientific museology", *Food for thought and discussion*, ECSITE newsletter, no.3, 2000.
- ²⁷ J. Wagensberg, "The Total Museum. A Tool for social change", cit., p.8.
- ²⁸ *Ivi*, p. 10.
- ²⁹ The science centre's building seems to be a mysterious object that inspires curiosity and the desire to explore it. It occupies a very unusual position in the city: on one side it rounds off a series of important architectural works (by Aalto, Scharoun and Schwegler), on the other it creates a link to the new "Volkswagen Car Town". Various pedestrian and vehicular currents flow towards the site, composing a dense network of pathways. The ground floor is transparent and permeable. The main volume – the exhibition space – on the other hand, is raised and covers a "square" of sorts, intended for commercial and cultural functions, surrounded by cement cones. Inside the exhibition space there is an artificial crater landscape that creates diagonal views at

various levels, while protruding volumes host the centre's other functions. An extension of the existing bridge enters the building like a tunnel, allowing for further views onto the exhibition space, through its transparent surfaces. The centre's key design features are flexibility, efficiency and comfort in consideration of the various purposes it will serve.

³⁰ A wheel suspended from a chain turns evenly as a result of the chain's movement, which seems to stir with three-dimensional life!

³¹ The new three-dimensional sound worlds are enhanced by a system of acoustic radiation created by invisible sound surfaces installed in the area, creating the impression that the generated sounds are coming directly from the walls.

Author

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