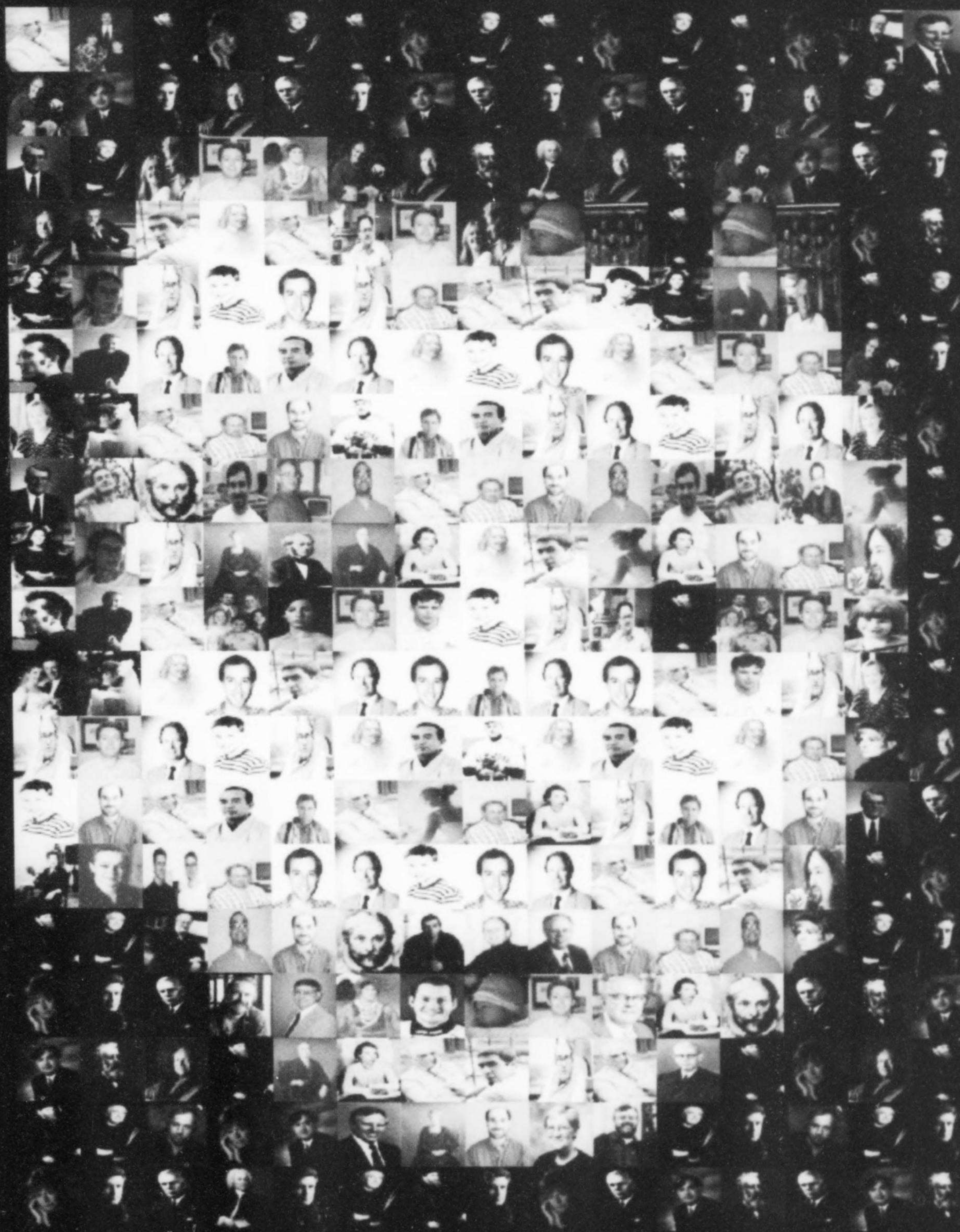


# LEONARDO

Journal of the International Society for the Arts, Sciences and Technology

Volume 39 Number 1 2006



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*Live Art and Science on the Internet:* Martha Wilson

*College Art Association 2005 Conference Papers:* Yvonne Spielmann and Jay Bolter

*Archiving, Collecting, Documenting and Conserving the Media Arts:* Jean Gagnon and Alain Depocas

*Burning Man: Fanning the Flames:* Louis Brill

## The Leonardo Scientists' Working Group

Leonardo has made a commitment to revitalize its connection to scientists, an effort begun in earnest about a year ago, with the announcement of Robert Root-Bernstein's guest editorship of the ongoing special section "ArtScience: The Essential Connection." But why would *Leonardo*, the journal for arts, sciences and technology, need to revitalize this connection at all? Perusing the 2005 issues of *Leonardo* reveals a partial answer to this question: Artists' contributions that explore technology, with a clear emphasis on new media and biotechnologies, dominate the journal. Among the smaller number of contributions from scientists, we find an emphasis on physics and math. We barely sample the vast world of the sciences, and thus we limit the ways scientists and artists can communicate and collaborate deeply with one another.

The relative paucity of contributions by scientists is reflected in Leonardo's reach outside the journal. As the interest in science among artists has grown over the years, so has Leonardo's institutional commitment to these artists, as demonstrated in its coordination of panels at conferences, the co-sponsorship of conferences, and awards to groundbreaking artists. By contrast, our institutional collaborations have not yet extended into the scientific community—in part owing to the lack of organizational structures to facilitate the work of scientists with a deep interest in the arts. To put it bluntly, scientists interested in the ArtScience connection are lonely, finding themselves isolated in their workplaces without like minds to communicate with.

To formalize our commitment to bring more scientists into the ArtScience conversation, Leonardo's governing board has initiated the formation of the Scientists' Working Group (SWG). To begin, we are creating a database of scientists interested in the arts. This database will potentially serve several purposes, including providing a mechanism for artists to find scientist collaborators. The database will include

those whose work does not fit within Western scientific norms; it will also draw from disciplines other than math, physics and biology, most traditionally linked with art and aesthetics. By contrast, I, as a chemist, have an interest in bringing the paradigms of synthesis, transformation and molecular representation more overtly into the conversation between art and science.

An extension of the database will be the creation of an on-line discussion forum for scientists seriously committed to working at the intersections of science and art. The discussion in the current SWG provides a glimpse into some of the issues of concern to such scientists: the desire for a greater emphasis on (pure) science as opposed to technology in the artistic community; a need for a greater emphasis on conceptual, rather than visual, aspects of science; what scientific rigor means in an artistic context; and how to create forums for true ArtScience interdisciplinarity.

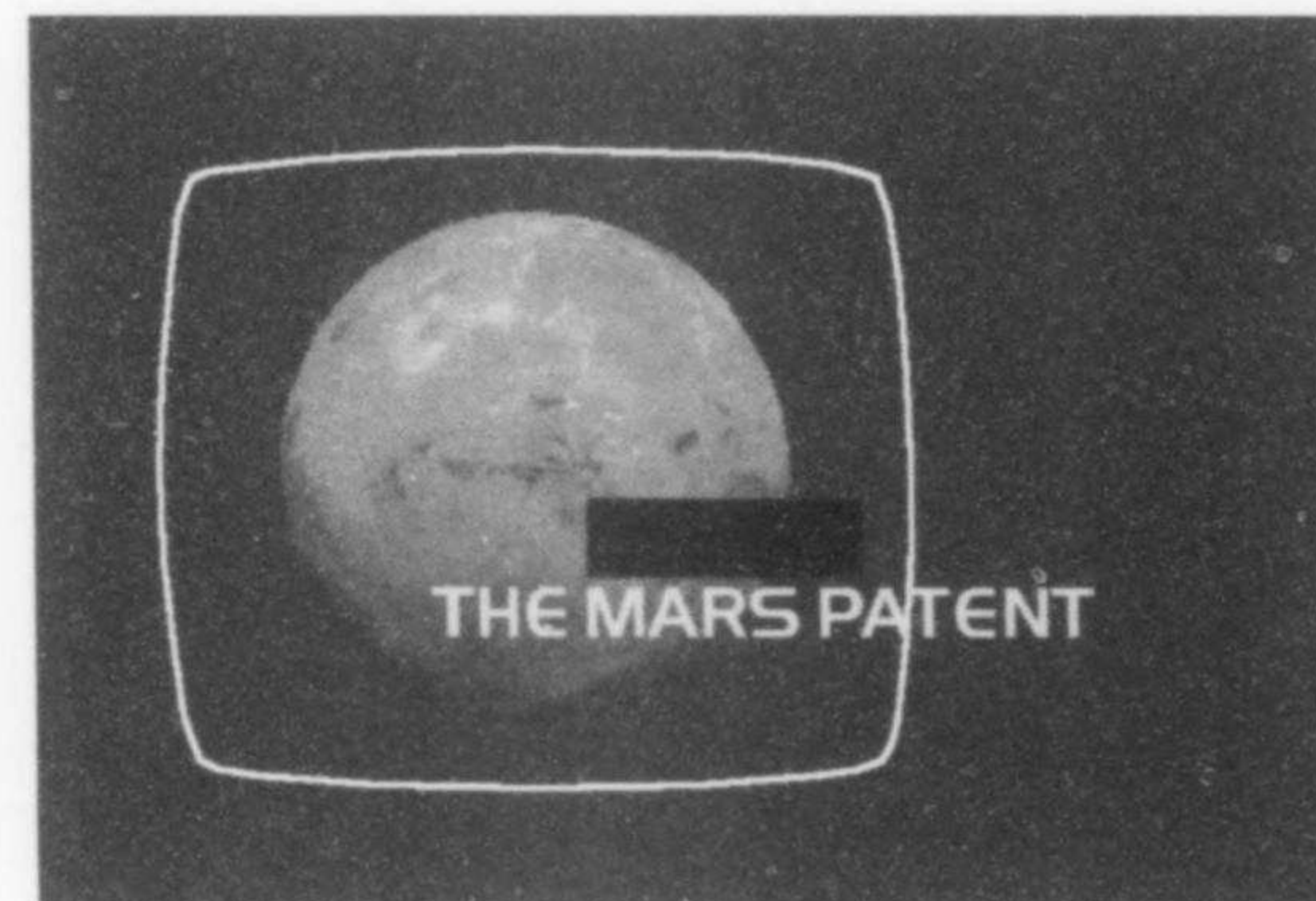
While more and more artists have committed themselves to exploring, applying and critiquing science, most scientists still hover on the borders of this vast territory. The burst of energy we saw in the last decade of art based on science has become a simulacrum, a reiteration of itself, precisely because there is so little communication between artists and scientists. Leonardo is the exemplary organization to catalyze another relationship between science and the arts: one that supports true interdisciplinarity and returns to the pre-19th-century conception of the phrase "arts and science," which lies outside the paradigm that produced the culture wars. We look forward to continuing this conversation with our scientific and artistic colleagues.

TAMI I. SPECTOR  
*Leonardo/ISAST Governing Board of Directors*  
*Professor of Chemistry*  
*University of San Francisco*  
*San Francisco, CA*  
*U.S.A.*

## Earth art invades Mars

If something (anything!) is teleported to the red planet and no one is there to see it, does it exist? Artists and curators Claudia Reiche and Helene von Oldenburg explore the outer limits of possibility for space art in their MARS PATENT project.

full article on page 19



(© Claudia Reiche and Helene von Oldenburg)

## The Philippine Triad takes on the West

Artist Fatima Lasay calls on the Datu, the Pandáy and the Babaylan, three roles from ancient Philippine society, to challenge Western philosophies and create new rituals for contemporary times.

full article on page 59



(© Fatima Lasay)

## From one to infinity

At first glance, computer art and Islamic art might seem worlds apart, but Laura U. Marks argues that the two are closer than we might think. Her exploration unfolds from the mosque to the pixel, finding parallels and influences in a multiplicity of examples.

full article on page 37

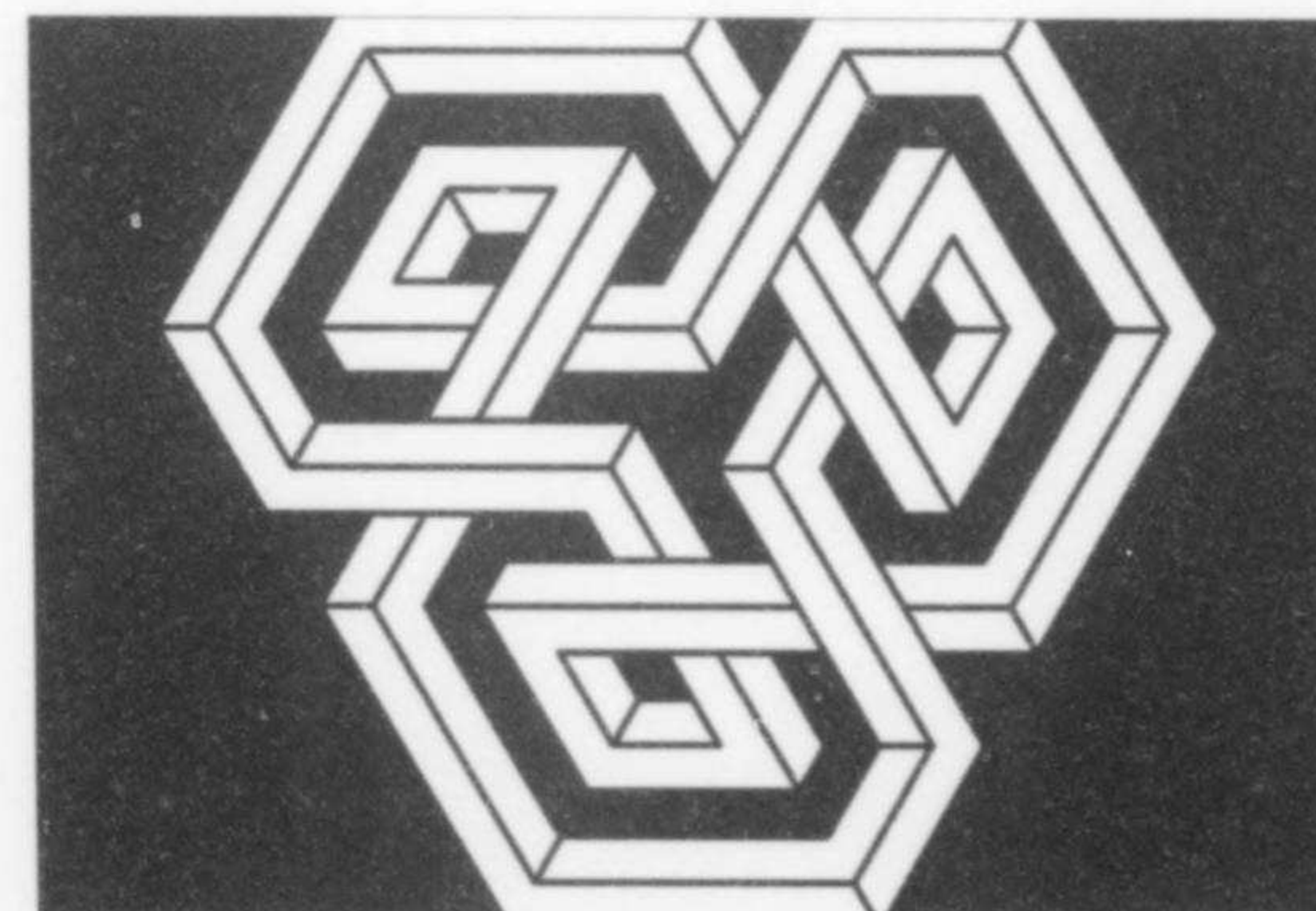


(Photo © Samirah Alkassim)

## Visualize the unseen

Art and science collaborate to demystify the invisible structures of subatomic particles. Physicist György Darvas studies the quirks of quarks and other abstract physical properties; artist Tamás F. Farkas creates artistic visualizations to help everyone understand these mysterious formations.

full article on page 51



(© Tamás F. Farkas)

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Front cover: Reynald Drouhin, *J/eux*, 2001. (© Reynald  
Drouhin) Mosaic-image generated by *Des\_Frags*, an  
on-line artwork. *Des\_Frags* was created by the artist in  
collaboration with a computer programmer. See arti-  
cle by Jean-Paul Fourmentraux on p. 45.

  
**BUD****AFTER MIDNIGHT  
PASZTOR//ERIKA**

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# THG17F

## Spicy Little Things from Budapest

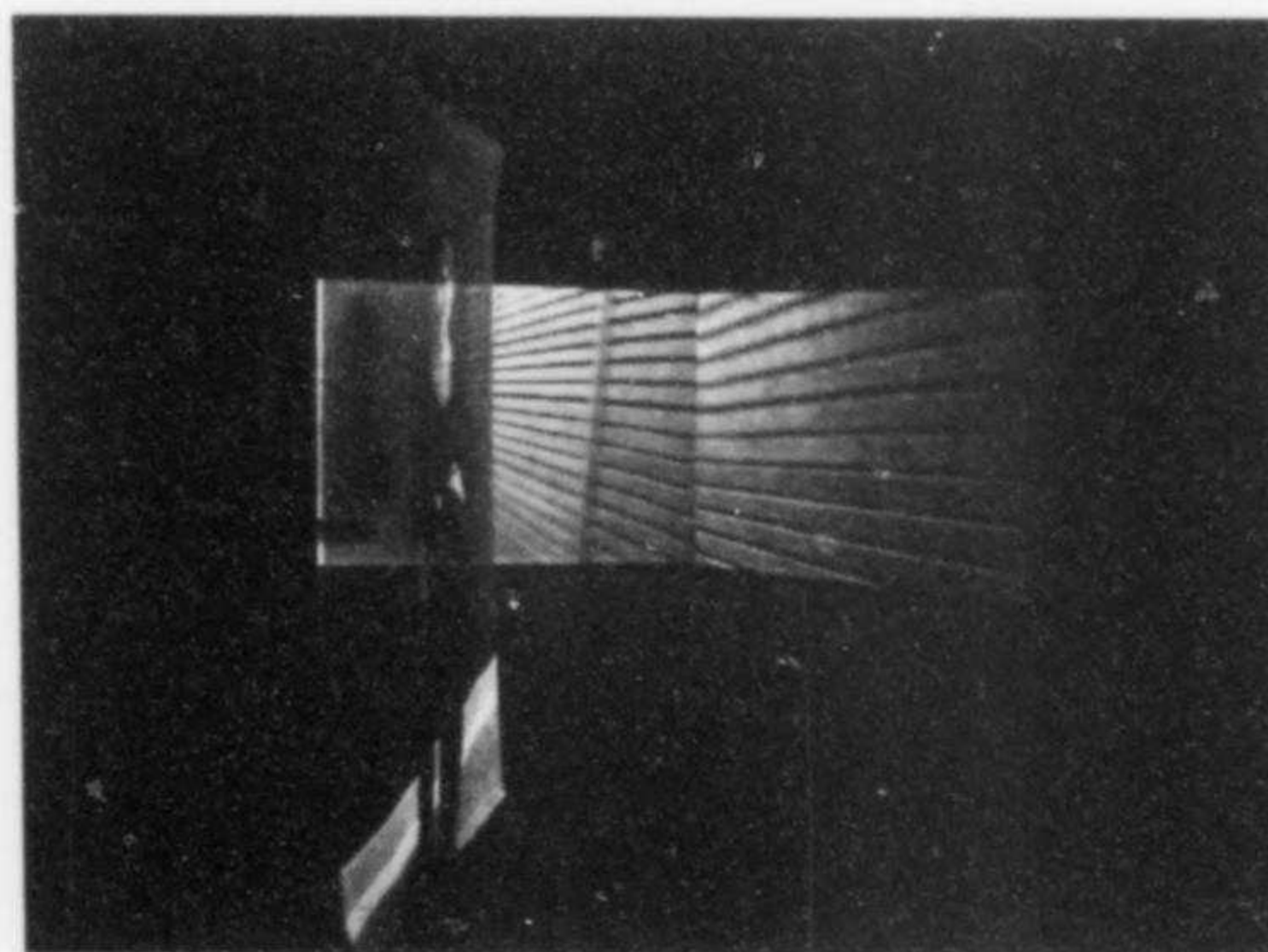
*A dispatch on the arts, technologies and cultures in the metropolitan community served by the Budapest airport.*

by Erika Katalina Pásztor,  
Architect, Media Artist,  
Designer

Although many of my friends look at the changes here with far less optimism than I, let us be practical: the optimistic version is much shorter. Besides, I had better look at my glass, as half (or only a tenth?) full rather than half empty. This is a mind game, in which pessimism was mainly the winner here for a long time. I will try to draw a rough sketch of some people and activities, that may, I think, influence peoples' minds, opening up new perspectives on the interactions between art, science and technology. These are the special spicy little things for me, the stand-alone civic initiatives, which—to play the optimistic mind game—will grow from the bottom to the top in the coming years. Yet first, I describe briefly the wider local context where these interactions may occur.

The financing of research activities (in art, science and technology) is a core problem here. It is definitely dependent on the ruling government

and its decision makers, as the private sector still takes only a small part in sponsoring these fields. Since 1989, in almost every segment of life, the government has granted special tax exemptions to the affiliates of large international companies and privatized the major share of the main industries to them. Resources are directed by companies' global enterprise strategies; therefore, fewer of these companies play a significant role in supporting local culture, art and science than might be expected. The R&D expenditure as a percentage of the GDP is about half as much in Hungary (~1%) as in the rest of the EU (~2%), where 55% of R&D funds come from the business sector. In Hungary, the business sector's contribution to R&D is around 30% of the total [1]. Coloring the picture, during the past 16 years Hungary has produced dichotomous political brands, strongly relying on different cultural accents. Overall values and terms such as "local vs. global" or "traditional vs. modern" are used to characterize the dividing line, but it has far more complicated and sensitive ramifications in daily life, in which oversimplified political propaganda spins it as "irreconcilable differences" to the public. After a decade of discussing the political situation, many people are fed up with the polarized mainstream politics, leaving more room for alternative movements. There is a growing bottom-up (and more or less independent) civic world, which makes our daily life rich in rising initiatives generating new spaces to transform the urban landscape both physically and mentally. By forming, developing and maintaining new communities, these young initiatives use the Internet and its related technologies intensively. New communities need new physical environments, so old houses or former industrial areas are being converted into new, usually temporary, pubs, galleries and workshops, or all-in-one cultural institutions.

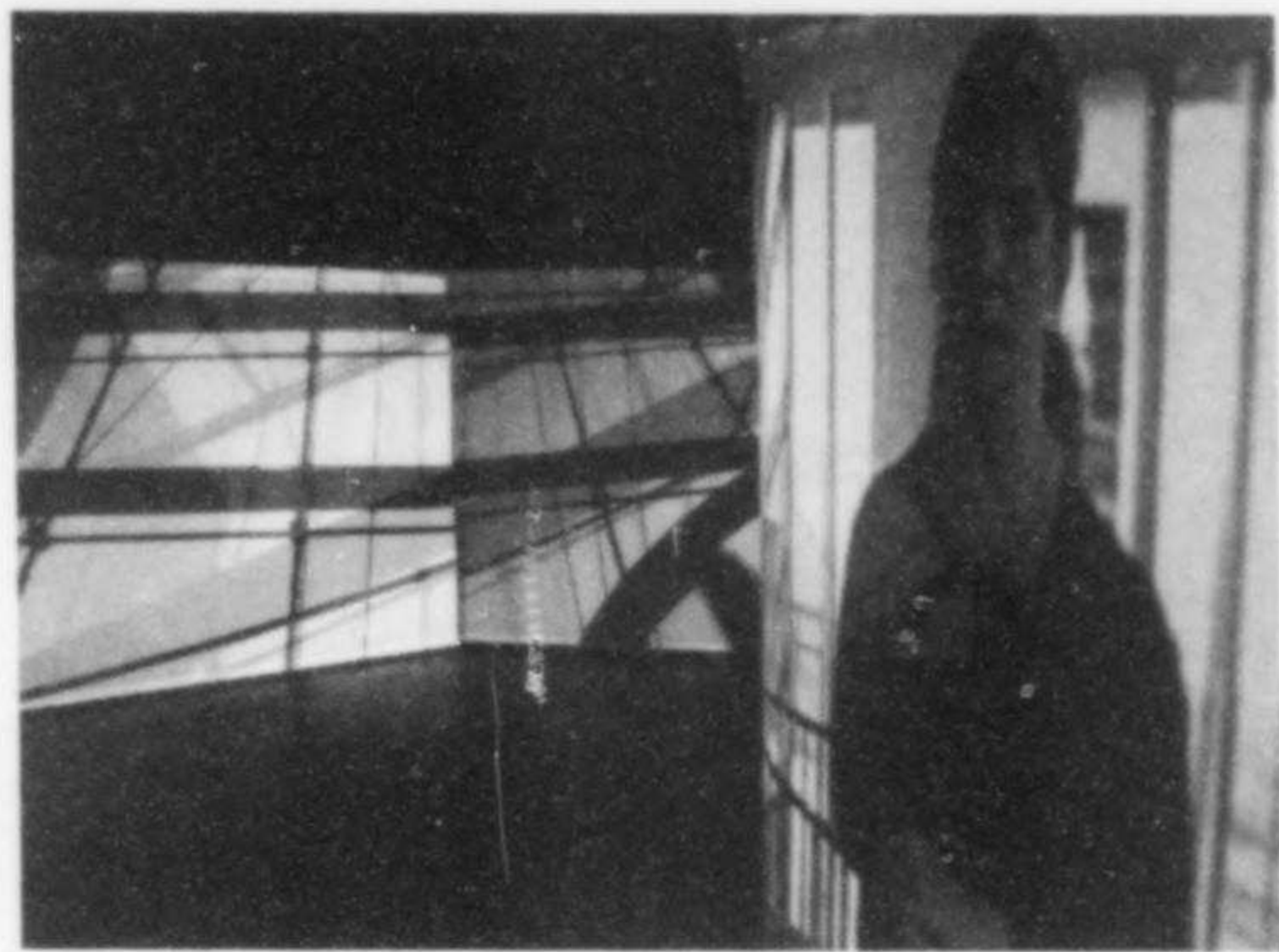


### INTENSIVE NETWORKING

This country with its 10 million inhabitants has about 800,000 micro and small enterprises. This means that almost every twelfth person is self-employed, relatively independent and certainly defenseless. Many are artists, researchers, journalists, etc. employed on a project or contractual basis, obtaining commissions via personal acquaintances. Physical and virtual public spaces become extremely important places/venues to meet and exchange information within this multi-interwoven social network. Everyone knows everybody via just a few other acquaintances in this city. This was the basic concept used by a few young guys (Péter Petrovics, Márton Szabó, Zsolt Várady, with backgrounds in information science, sociology and economy) and their artist friends when they founded the WiW (Who is Who) collective in Budapest in 2002 [2]. It started as a hobby with no money involved, and though it developed into a small enterprise, even today everyone works on the project without pay. The WiW is an invitation-based, database-driven Who's-Who web site collecting social connections. Entering the site, you can gather acquaintances, generate a graphical map of your social network, form teams and join projects, find a job or just use WiW to have a party. The average age of members is about 26, and now, after 3 years, WiW has more than 100,000 registered users and nearly 1.2 million connections. In September 2005, WiW will go international (in other languages) with a new brand name: iWiW.

### SHEDS INSTEAD OF GARAGES

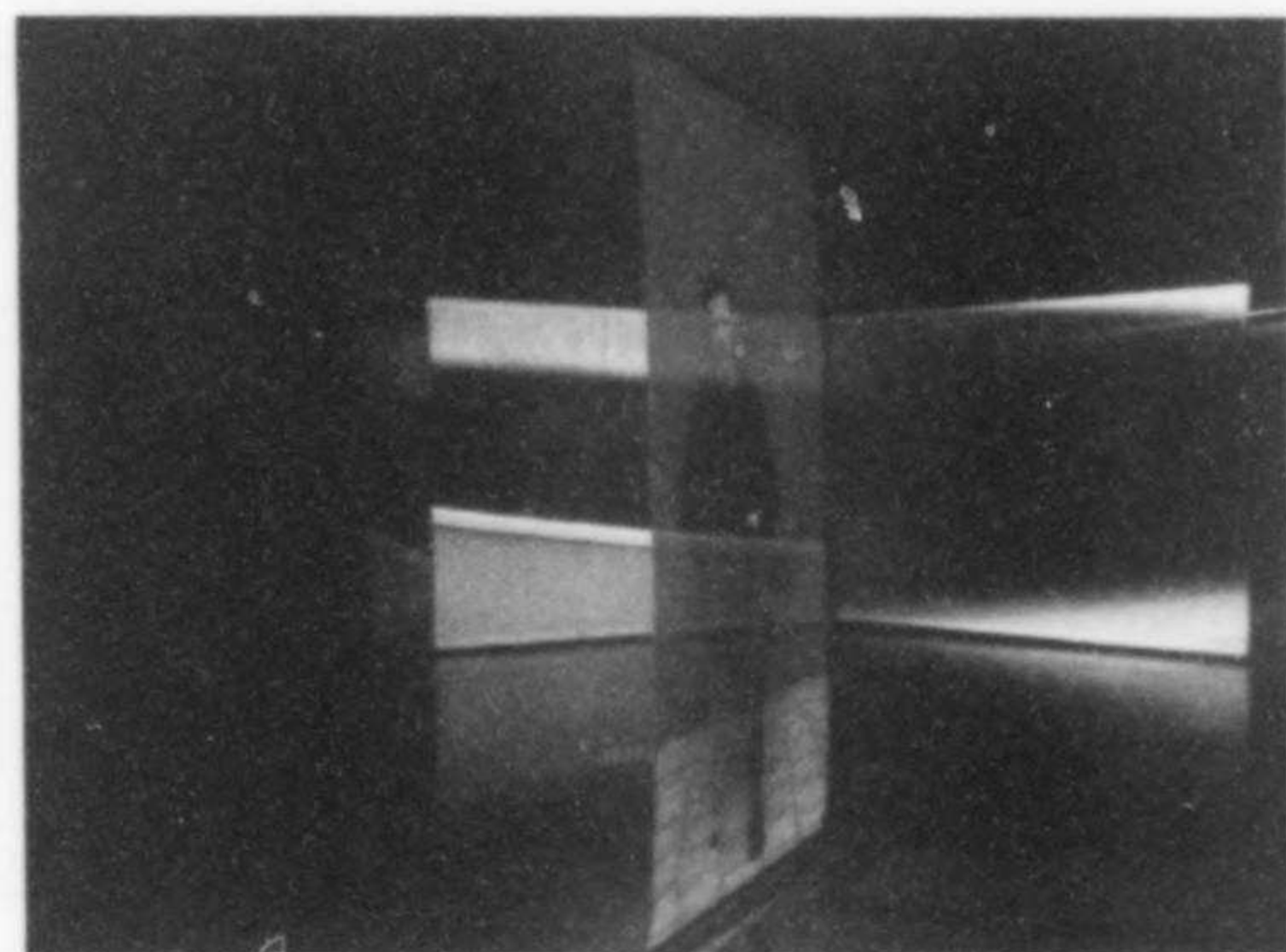
This year (2005) two great surprises caused a stir in the local media here. A high school student, Dániel Rátai (age 19), won several prizes and the category award in computer science with his invention at the world competition of Intel ISEF [3]. Rátai's invention, the *Leona3Do 3D for All!*, converts your personal computer into a fascinating 3D environment, where you are able to draw objects with a digital pen directly onto the screen. The remarkable thing is that he made it all at home, using materials worth less than US\$150. At the same time, he achieved better quality in many different aspects than similar systems developed through serious investment funding. It is a homemade innovation, like the young



Hungarian architect Áron Losonczy's global patent for LitraCon [4], a light-transmitting concrete that is a combination of optical fibers and fine concrete. This new material has won several awards. Probably the editors of London-based architecture and design magazine *icon* best defined its significance in choosing LitraCon (along with Ikea) among the "most influential" developments that will change the design landscape of the 21st century. Losonczy studied architecture in Budapest and Stockholm, and his workshop is in Csongrád, a small town 160 km south of Budapest. His invention is a great success, but it is still funny to imagine his small, low-budget operation as the birthplace of a completely new building material, which will enter the global market in autumn 2005.

### SMALL STEPS TO CHANGE MINDS

During the 5 years of its existence, the *architectforum.hu*—the single architectural daily in Hungary—has managed to become the most relevant resource in the fields of local architecture, its related public life and issues, urban development and visual arts. The main goal of this new media initiative was to



improve the quality of the local built environment by creating a fresh, independent and high-standard cultural environment on the Internet. Looking at the deteriorated conditions of public spaces, the founders identified an urgent need to integrate the questions of the built environment into the daily common talk of the local society. Later, the site's interdisciplinary team (media artists, architects, communication and information science specialists) introduced new art and research practices alongside their daily media practice. One of their several initiatives is a traveling video installation, *15 years transit*, which presents contemporary Hungarian architecture within a special framework. It is actually a qualitative survey of the local designers' world: an audiovisual sociological study (interviews with 27 leading architects and presenting 13 projects) projected on three large video screens. Currently the *architectforum* team works on a politically provocative Internet project, *Public Games*, investigating the effects on urban development caused by the changing motivations of city politicians.

While from a tourist point of view Budapest has amazing historical sites, fascinating views and a vivid cultural scene, permanent residents are becoming active in civic organizations dealing with environmental issues. The recently noticeable rapid growth of interest in sustainability has turned the public's attention toward new technological solutions in several different areas of life, especially in architecture and building construction. In 1996, architect Attila Ertsey, founding and leading the Soft Technology Foundation, built a life-size model of his *Autonomous House*. His team's aim was to prove that family houses installed with soft technology can function separately from public utilities, giving the inhabitants independence from service companies. Since then, he has extended his concept towards the autonomous region and city [5], and by developing detailed strategies of sustainability, he has contributed significantly to the local *eco-village* and to the currently emerging *eco-city* movements. In many polarized cultural discourses, especially in association with ecology, the traditional was turned against the modern, the village

against the city, the old against the new. Eco-consciousness in the formal Eastern European region is a quite new but rapidly unfolding issue. Designers like Ertsey, with their awareness of technology and their complex views, help to clear detrimental simplifications away slowly.

From this point of view, the lack of big science, big industry and high-tech definitely has advantages. It enforces creative survival. Of course, it is a hell of a job with many difficulties, and the most distressing thing is that there are huge obstacles everywhere, put up, of course, by our larger community. Most of us fail in this struggle, give up, or are just partly successful. This makes the glass halfway empty. However, these kinds of examples mentioned above are always inspiring alternatives, emerging from sheer civic courage, outstanding talent and/or from determined critical viewpoints. Halfway and a bit more, this makes me optimistic here after midnight.

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### References

1. The data comes from different years (EU: 2001–2002, Hungary: 2003). Resources: Hungarian Central Statistical Office <[portal.ksh.hu](http://portal.ksh.hu)>; EUROSTAT <[epp.eurostat.cec.eu.int](http://epp.eurostat.cec.eu.int)>.
2. Incidentally, with regard to WiW and its very up-to-date concept: In the same year that WiW was released in Budapest, the Perseus Books Group (Cambridge, MA) published an international best-seller, *Linked: The New Science of Networks*, written by Albert-László Barabási, a physicist of Hungarian origin.
3. Intel International Science and Engineering Fair, Phoenix, AZ, U.S.A.
4. See <[www.litracon.hu/about1\\_en.htm](http://www.litracon.hu/about1_en.htm)>.
5. Attila Ertsey: *The Autonomous City. The Expert's Vision 2004*. The research project ran from 2002 to 2004 at the Independent Ecology Center in Budapest.

*Images from 15 years transit.* (© Erika Katalina Pásztor, Attila Dröszler, Eniko Orosz)

*If you are interested in writing an "After Midnight" column on your virtual or physical city, send a 100-word summary of the basic idea to Leonardo at <[isast@leonardo.info](mailto:isast@leonardo.info)>.*

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- *The Cradle of Humanity: Prehistoric Art and Culture*, by Georges Bataille; Michelle Kendall and Stuart Kendall, trans. Reviewed by Allan Graubard.
- *Eyes, Lies and Illusions: The Art of Deception*, by Laurent Mannoni, Werner Nekes and Marina Warner. Reviewed by Martha Blassnigg.

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## THE INTERNATIONAL TRANSCIENT CARTOGRAPHICACY PROJECT

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Received 20 January 2005. Accepted for publication by Roger F. Malina.

The *International Transcient Cartographicacy Project* exposes both the continuities and the distortions of contemporary urban experience through storytelling and a series of superimposed audiovisual environments. The project challenges traditional cartography by attempting to blur the boundaries between politically

demarcated and subjectively experienced space by representing a hybrid, conceptual space through memories and personal experiences.

During the fall of 2003, we conducted interviews with family, friends and acquaintances who had traveled or lived in Mexico City. From the information we collected, we generated an interactive map of the city organized around these stories and personal experiences (Color Plate D No. 1). This map was placed on-line and made openly available for comments and additional stories. The map was specially created for this project by integrating the design for a simple, spatially oriented message board with a sophisticated PHP and MySQL database-driven open-source application called ActionApps [1].

In March 2004 we traveled to Mexico City, where, during a 2-week period, we explored and documented the city with video, film and photographs, using the map as a navigational and spiritual guide. In June 2004 we traveled to

Dublin, Ireland, to present our documentation as a series of public installations during the ReJoyce Dublin 2004 Festival, which marked the 100th anniversary of Bloomsday (the day on which James Joyce's *Ulysses* is set). The project was inspired by the "Wandering Rocks" episode (the 10th chapter of the novel), in which residents of Dublin are described moving about the city during the afternoon of 16 June 1904.

Over the course of a week, six installations were presented separately at six sites around Dublin. Each video was projected at near-human scale at sites chosen according to how well they connected with the presented footage. One video segment of Mexico City residents boating through the canals in the borough of Xochimilco was projected onto the banks of the Liffey River, making it appear as though the boats were floating through Dublin. On another night, in a corner of Meeting House Square, another video segment showed children feeding pigeons and couples strolling past what was once the hacienda of Hernan Cortés in the public plaza of Coyoacán (Fig. 1). The Mexican organ grinder in that video became a performer for Dubliners on their way to restaurants, pubs or the nearby Irish Film Centre. In another installation, the image of the Virgin de Guadalupe was displayed to visitors of St. Mary's Abbey. Tourgoers made their way through the exhibits set up in the last remaining structure of this ancient monastery while an image of Mexico City's *virgen* floated silently above them. In each of the installations, an audio soundtrack projected the stories that we had collected in our original interviews, plus sounds gathered in Mexico City. These sounds then mingled with and became part of the Dublin landscape, creating a third soundtrack of virtual resonance.

Through a layered combination of images, sounds and stories, barriers between time and territory collapsed into shared experiences, briefly turning differences into similarities.

### Note

1. ActionApps was developed by the Association for Progressive Communications.

Fig. 1. *The International Transcient Cartographicacy Project* (Public Space segment), 2003–2004. (© Gilbert Guerrero and Kathleen Quillian) Single-channel video installation with sound and on-line interactive map. Public space is given a new dimension as the daily activities of Mexico City residents moving through the Jardín del Centenario in Coyoacán are superimposed onto the landscape of Diceman's Corner, Meeting House Square, Dublin, Ireland.



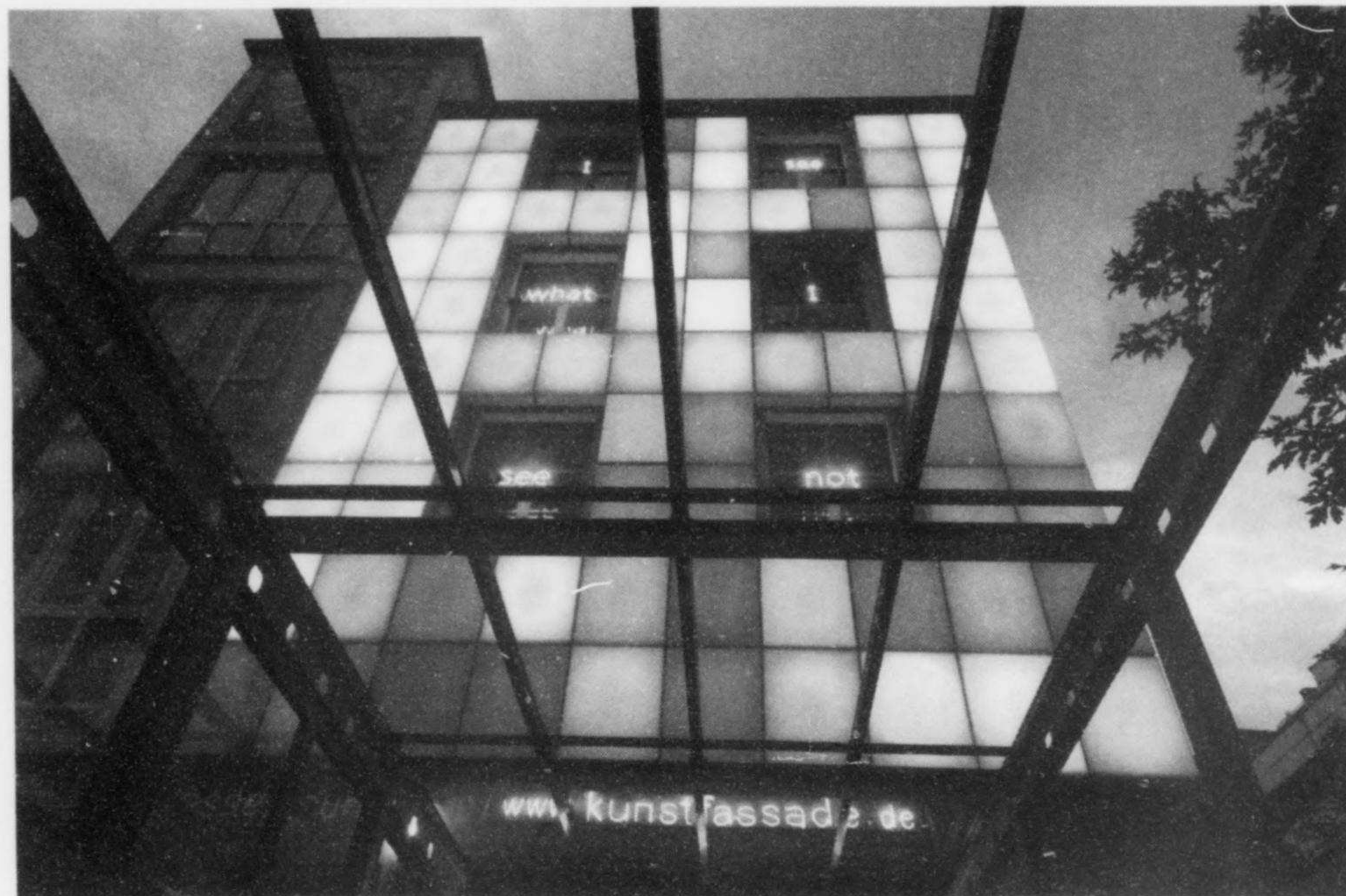


Fig. 2. Tim Otto Roth, *I See What I See Not*, cosmic particle shower live at the art façade in Munich, 76 RGB neon light elements controllable via Internet, 9 × 6 m, 700 square feet, 23 February 2005. (© Tim Otto Roth)

### A WALK ON THE RETINAS OF THE EXTREME SCIENCES: A MINIMALIST CONCEPT FOR AN INTERNET-BASED LIGHT ART FAÇADE IN MUNICH

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With *I See What I See Not* [1] (Fig. 2 and Color Plate D No. 2), I wanted to create a cosmic matrix showing the most advanced results of the imaging machines in astronomy and elementary particle physics. In 2003 I was invited to develop a concept for the light façade of the Communication Group Serviceplan to be shown during the winter months of 2003–2004. This façade, close to the Lenbachhaus in Munich, is distinctive because its 76 RGB neon light panels, spread over 63 square meters, can be controlled via the Internet.

This art-project façade represented a formal challenge. The basic question was whether it would be possible to show something that could still be called a picture on an area that consisted solely of 10-×-10-pixel elements—corresponding to the diameter of a

match on a normal computer screen. Therefore I decided to explore the images of astronomy and particle physics. In these advanced disciplines, a few pixels detected by the image sensors and detectors can refer to an astronomical object or to a subatomic particle. So I zoomed in on the pixel level of images from, for example, the Hubble Space Telescope, the Chandra X-ray Observatory, the Very Large Telescope at the European Southern Observatory (ESO), the Wilkinson Microwave Anisotropy Probe (WMAP) or Brookhaven's Solenoidal Tracker at RHIC (STAR) detector and conveyed the pixels 1 to 1 onto the light elements of the art façade. In this way the play of light on the art façade became a walk on the retinas of the extreme sciences that investigate the most distant boundaries of the cosmos.

For me it was important that this deep focus document what happens in science without being merely illustrative. So the project in Munich became a formal play with faraway and close-up perspectives. It also reveals, however, the aspect of revelation in science: Every single pixel is a potential sign representing a photon that has traveled for aeons through the universe or a subatomic particle. What makes these images so different and interesting is this *Aufladungsprozess* in which every

pixel gains an enormous significance and figurative power.

To keep the project closely tied to scientific results, I conducted an intensive dialogue with astronomers and particle physicists. The most impressive event in this process was a visit to ESO's Paranal Observatory in Chile's Atacama Desert. There I had the realization that astronomical observations involve more than just acquiring data. I felt a certain metaphysical tension in observing the scientists looking up into the eternity of the sky using the most advanced technology.

In winter 2004–2005 I took a more immediate look at the work of scientists, putting more emphasis on the raw images and data. During that winter cycle, the immediate, merely processed results from astrophysics and elementary physics were transmitted in near-real time to the façade. The partners cooperating in this live transmission were: the Max-Planck-Institut für Radioastronomie/Dominion Radio Astrophysical Observatory, the Solar and Heliospheric Observatory (SOHO) mission, the Forschungszentrum Karlsruhe, Brookhaven National Laboratory, the Stanford Linear Accelerator Center, Fermilab and the Japanese High Energy Accelerator Research Organisation (KEK). The project could be followed live daily via webcam between 17:00 and 20:00 MET until the end of March 2005. With *100 Days—100 Imachinations* [2], I was to launch a further Internet-based project at the end of November as a large projection work at the ZKM Karlsruhe linking various international scientific institutions such as Schloß Dagstuhl and the High Altitude Research Station Jungfraujoch (Switzerland). Finally, the project *Pixelsex* [3] (summer 2005) brought a life-science topic live to the largest light wall on the 80-meter-high KPN Telecom Tower in Rotterdam, showing simulations of myxobacteria based on cellular automata.

Last but not least, I take this opportunity to say thank you to the scientists who worked with me and are also a part of the project.

#### References

1. <www.kunstfassade.de>.
2. <www.imachination.net/next100/>.
3. <www.pixelsex.org/>.

## GENERATIVE FLOWERS AS A LANGUAGE OF FORMS FOR THE VISUALIZATION OF BINARY INFORMATION

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In the past few decades, fractal methods have become common in generative art. Such methods can be applied to data visualization, yielding generative objects open to interpretation in terms of a data structure. Various authors have proposed approaches based on botanically inspired Lindenmayer fractals [1] and related methods [2–5]. The method I propose here makes use of nonlinear fractal trees [6], which are bent as a function of the information present in a given bit string. I analyze the string by moving a  $p$ -bit window over it and determining coefficients for each of  $2^p$  strings of length  $p$ . The latter strings are associated with the leaves of a tree with  $2^p$  end-nodes, and the coefficients of these strings determine the curvature in the branches of the tree. Before it is bent, a tree-representa-

tion has to be initialized. An initialization is appropriate if the spatial structure of branches gives visual information about the  $p$ -strings attached. This can be realized if the initialization of the tree is a highly structured and familiar form. In Color Plate E, I use the boundary of the Mandelbrot set to initialize a tree.

After a tree is bent by data, I turn it into flower form. This is carried out in two steps. First, I interpolate endpoints with a contour. Second, I project this contour in a series of steps so that a surface is obtained. The projections are defined by successive small variations of the parameters associated with the tree. More concrete or more abstract flower forms result, depending on the choice of parameters. In an alternative method, the flower is generated and does not envelop the tree, but is put at different times on top of the leaves instead. The spread of the flowers over the leaves of the tree—as well as their attributes “size” and “open/closed”—are based on information derived from  $p$ -bit analysis (Color Plate E).

This procedure can be applied to bit strings that appear in fundamental domains such as one-dimensional cellular automata and tag systems (which figure in discussions about fundamental aspects of our world and our knowl-

edge [7]), or to visualize the properties of bit strings that occur in more applied domains, such as genetics or musical composition. If music is encoded in a long bit string over which a bit window is moved that is in turn analyzed in terms of smaller  $p$ -bit windows, a moving visualization results in which the tree structure is transformed continuously and the flower canopy on top of it widens and shrinks, and for which flowers continuously open and close as a function of musical progression.

### References

1. P. Prusinkiewicz and A. Lindenmayer, *The Algorithmic Beauty of Plants* (New York: Springer, 1990).
2. E. Kleiberg, H. van de Wetering and J. van Wijk, “Botanical Visualization of Huge Hierarchies,” in K. Andrews, S. Roth and P. Wong, eds., *Proceedings of IEEE Symposium on Information Visualization* (Los Alamitos, CA: IEEE Computer Society Press, 2001) pp. 87–94.
3. B. Shneiderman, “Tree Visualization with Tree-Maps: A 2-D Space-Filling Approach,” *ACM Transactions on Graphics* **11**, No. 1, 92–99 (1992).
4. H. Koike and H. Yoshihara, “Fractal Approaches for Visualizing Huge Hierarchies,” in *Proceedings of the IEEE 1993 Symposium on Visual Languages* (Los Alamitos, CA: IEEE Computer Society Press, 1993) pp. 55–60.
5. P. Van Loocke, “Data Visualization with Fractal Growth,” *Fractals* **12**, No. 1, 123–136 (2004).
6. Van Loocke [5].
7. S. Wolfram, *A New Kind of Science* (Champaign, IL: Wolfram Media, 2002).

## CALL FOR PAPERS

### **Archiving, Collecting, Documenting and Conserving the Media Arts**

Throughout the 20th century, and certainly at an increasing pace since the 1960s, new art forms that feature technological components have been throwing traditional conservation and documentation practices into upheaval. These works of art are many and varied. They may be analog or digital, mechanical, and/or electronic; they are often multimedia based and include a variety of components, such as mechanical parts, software, electronic systems, varied electronic media formats, etc. Museums, which are charged with preserving and providing access to these works, often find themselves without adequate resources and must make do with methods and means that are poorly adapted to a growing number of artistic practices.

Guest Editors Jean Gagnon and Alain Depocas from the Daniel Langlois Foundation (Montreal) invite researchers, scholars, artists and others to submit articles for publication in a new special section in *Leonardo* concerned with documenting and conserving the media arts heritage. This new section is the journal's contribution to a larger research alliance bringing together museums, universities and organizations from Canada, the U.S.A. and Europe with funding from the Social Sciences and Humanities Research Council of Canada (SSHRC) and the Daniel Langlois Foundation.

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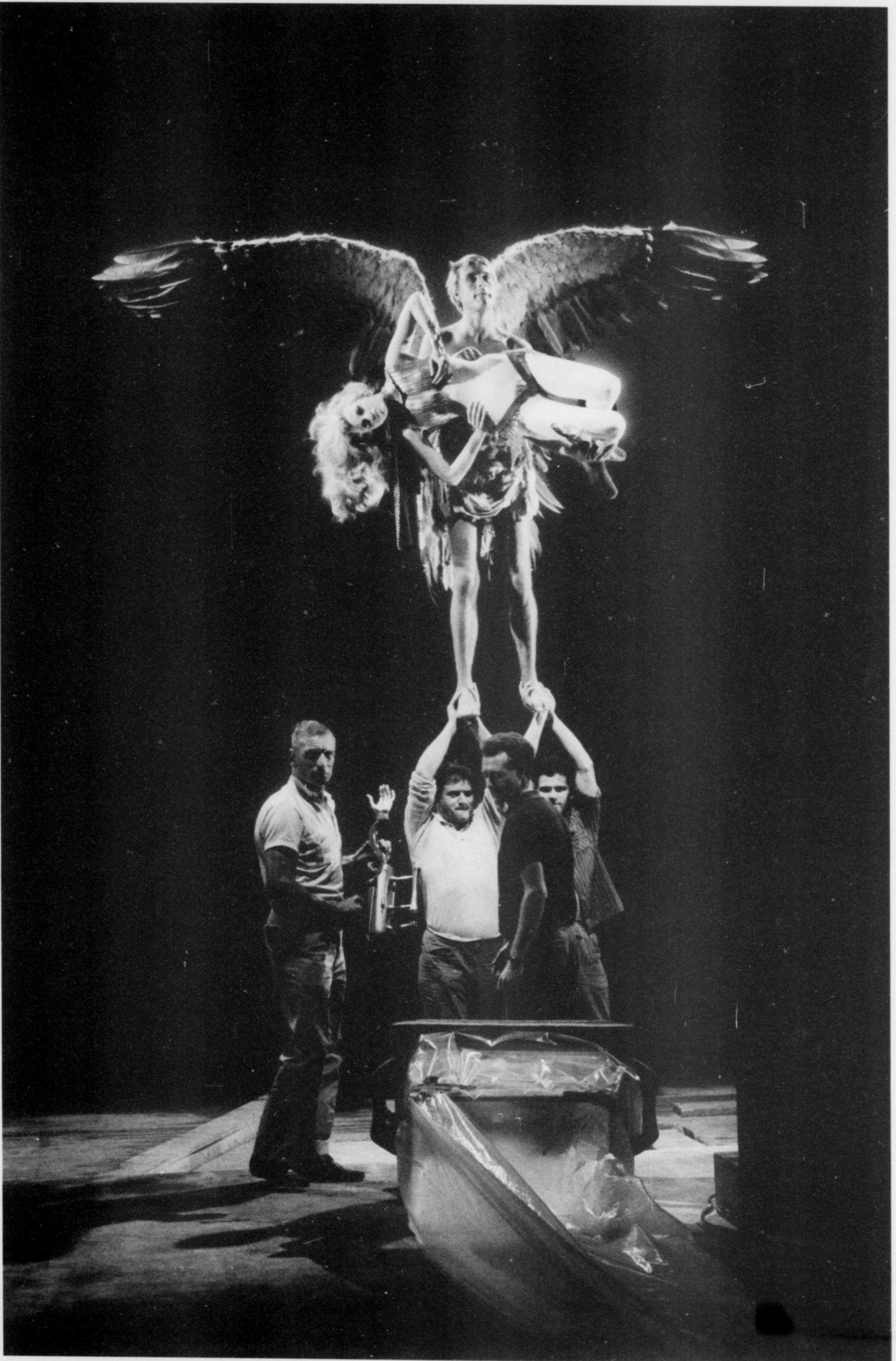
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Special Section

# Space: Science, Technology and the Arts

*Guest Editor: Annick Bureaud*

Selected papers from "Space: Science, Technology and the Arts" (7th Workshop on Space and the Arts), held at the European Space Research and Technology Center (ESA-ESTEC), Noordwijk, the Netherlands, 18–21 May 2004. This presents the second installment of papers from the workshop; the first installment was published in *Leonardo* 38, No. 5 (2005).



# From Méliès to *Galaxy Quest*: The Dark Matter of the Popular Imagination

*Michael Punt,  
Martha Blassnigg  
and David Surman*

## MICHAEL PUNT: INTRODUCTION

This paper was stimulated by the film *Galaxy Quest* (Parisot, 1999), which collapses the fictitious dimensions of space travel into the scientific perception of real space travel in order to reveal some insights into the cultural construction of space. In this collaboration, the three authors [1] inquire into the metaphorical, metaphysical and metadiscursive aspects of technology by integrating a range of scholarly activities and amplifying them through non-hierarchical collaboration within an institutional environment [2]. It combines the research of artists, filmmakers, photographers and designers with the aim of advancing our understanding of the history of technology and exploring new modalities of academic and practical research. Consistent with this overarching concern, this paper deals with the human imagination and regards it as a mirror image of space. Like space, the imagination is largely unknowable, and all that we can ever say about it as an entity is based on conjecture drawn from our fragmentary perception of the wake of its apparently infinite energy. We have chosen, as a methodology, to study the visible residue of the human imagination in the arts, science and technology and to extrapolate the network forces that seem to intersect at their instantiation, aware all the time that we are describing a human and cultural condition rather than explaining it. For this group of authors our common point of departure is cinema, a technological anachronism that initially caught the public imagination in ways that no scientist, inventor, technologist, entrepreneur or showman ever predicted. The 19th-century conjuror and cinema pioneer Georges Méliès and a few British eccentrics—mediums, showmen and instrument makers—are possible exceptions.

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Based on a paper presented at "Space: Science, Technology and the Arts" (7th Workshop on Space and the Arts), European Space Research and Technology Center (ESA-ESTEC), Noordwijk, the Netherlands, 18–21 May 2004.

Article Frontispiece. David Hurn, *Untitled*, 1967. (© David Hurn)

## ABSTRACT

The authors argue that an interrogation of cinema can reveal the fragility of our knowledge and the underlying imperatives that the social construction of space responds to. A revisionist overview of the issue of professional interfaces in the popular arts is followed by a discussion of the influence of space technology and natural space phenomena on human personal and collective belief systems in order to open the way for an outline of the concept of participatory cultures and the relationship between fiction and science.

Méliès is perhaps best known in space research for making the first space movie (indebted no doubt to Jules Verne), and his career as a shoemaker, conjuror, theater owner and early film producer provides evidence of the technological imagination as it reveals the residues of the very antagonistic energies that stimulated the enthusiasm for cinema. Méliès was not unique in his fascination with the ecology of technology at the close of the 19th century. Perhaps less familiar is the British filmmaker James Williamson, who made *The Big Swallow* in 1900, a time when, for metropolitan audiences at least, moving pictures were becoming familiar, and the sight of a cinematographer filming a busy street—or sometimes even the venue of a forthcoming séance—was also becoming a commonplace. As the sales catalog note that accompanied the film at the time tells us, we see an ordinary man become so irate at a ubiquitous photographer that he swallows him up, camera tripod and all. After his mischief he backs off from the film camera, smacking his lips, and hams up the joke for the audience in a gesture of mutual conspiracy. It is a simple gag film manifesting an antique humor, but it would be a mistake to see it simply as a schoolboy joke, since, although there is a displacement from the cinematographe to the still camera, the film is nonetheless suggestive of a certain unease—even antagonism—arising from the gap between a photographic technology that is used to represent the world and those who look at its representations. This particular disaffection is elegantly summed up in the conspiratorial gesture Williamson's actor makes as he digests the machine that represents him; he takes technology into the imagination of the interior body from which it was born as an invention. Re-assimilating the machine is a sentiment that, judging by our own cinema, has persisted, as we see a recirculation of both a celebration and a covert criticism of new technology in popular movies such as *Jurassic Park* (Spielberg, 1993), *Barb Wire* (Hogan, 1996), *Twister* (de Bont, 1996), *Mission Impossible* (de Palma, 1996) and, as Martha Blassnigg discusses below, *Barbarella* (Vadim, 1968). As we sit in the cinema in the thrall of the technology, we celebrate its downfall as time after time the old values of embodied intelligence and intuition succeed where technology fails. This comfortable (even pleasurable) coexistence of apparently contradictory dy-



Fig. 1. David Hurn, *Untitled*, 1967. (© David Hurn)

namics in a coherent reality provides our first piece of evidence that the imagination is dark matter manifest to our intelligence in its various instantiations as complex, intersecting network forces beyond the reach of reason [3].

**MARTHA BLASSNIGG:  
DESIRE, IMAGINATION  
AND TECHNOLOGY: HOW  
TO LOVE (IN) SPACE**

This scientific idea of dark matter, whether meant in reference to the still unexplored mystery of the universe or used as a metaphor for our inexplicable human brain capacities, provides a per-

fect platform for imagination and fantasy within popular culture and offers a plane for metaphysical and imaginative inquiry. In a spiritual context, this concept of darkness and void apparently contradicts the prevalent imagination of divine light and the spiritual imaginary crowded with heavenly creatures, yet there are notions that relate invisible divine light to darkness [4]. In the most profound realm of darkness, the spacecraft and the angel both have conquered and colonized outer space as part of our human attempts to overcome the material limits of three dimensions by fusing the spiritual with technological media. Their histories have become fused, so

that as technology has turned wireless, angels have become wingless once again [5]. My own field research reveals that they can present themselves in contemporary clairvoyant perception as rather abstract light-beings similar to the Aurora Borealis. In this interrelation of spirit and technology, the angel can be seen as a symptomatic concept that exceeds its religious connotations and, as we will see, can be turned into an intercultural, interconnecting, service-oriented, mobile, flexible, genderless and ubiquitous mediator. Traveling through and beyond the material limits of time and space, the angel becomes an almost perfect companion to the bytes and bits of contemporary communications technology.

In comparison to the dominant expressions of fear and destruction confronting alien space in most mainstream movies, more constructive imagination has been projected and reiterated in popular subcultures since the technological venture of space travel in the 1950s. As we have seen, almost from its earliest beginnings, cinema incorporated popular and esoteric interpretations of metaphysics into its "imagination." As a consequence, cinema can provide an evidential base in both its medium and content for the exploration of the way space and time have been imagined and also how they have been understood scientifically. Edgar Morin, for example, reflecting upon the similarities between the cinematographic experience and human imagination [6], notes how cinema offers a symbiosis that integrates the spectator in the flux of the film, and the film into the psychical flux of the spectator [7]. Cinema, the dream machine or time machine, and "homo demens," the producer of fantasies, myths, ideologies and dreams, both evoke magic as an interiorized quality through affection. Robert D. Romanyshyn argues that when Alberti (1404–1472) invented the linear perspective of depth with a vanishing point, the inexplicable moved inside and became an interior quality of imagination. This new perception not only moved angels and demons out of heaven and clouds onto the same horizontal plane in paintings, but also prepared the imagination for space travel by liberating the figure from the base line of the image and situating it in the middle of the frame [8].

Cultural expressions in various media productions are indispensable both to illustrate and to justify scientific technological ventures [9]. In this sense, many have argued for the important role played by the transmission of film images

of the 1969 moon landing in touching, involving and convincing a broad audience of the actuality of the event [10]. Unlimited outer space offers an open platform to express our imaginations and reflects like a 360°, three- (or maybe more?) dimensional screen or plane, inviting us to experience not merely an audiovisual performance, but also a multi-sensorial event and engagement that includes the body [11] and our consciousness as equal faculties. In what follows I discuss the idea of space travel as an instantiation where imagination, desire and technology meet and interact [12] in one particular appearance that seems to have resisted historical change in its various recent reiterations: the story of *Barbarella*.

*Barbarella*, the 1968 science fiction movie directed by Roger Vadim [13] (Article Frontispiece, Figs 1–3), is based on a 1962 French comic strip by Jean Claude Forest. The film launches desires and imagination related to the liberational political agenda of the 1960s into a space comedy: sexy, playful, humorous, ironic, erotic, fantastic, political... However, alongside the film's outspokenness and directness in matters concerning sexual desire and utopian technology, there is also a rather concealed desire for a quest for innocence and restoration of an ideal world, bound into ecological, democratic, left-wing concerns and dreams of 1960s social and political movements.

In Vienna in March 2004, the story of *Barbarella* celebrated its world premiere as a theatrical production [14], advertised as a sexy rock musical. In the musical, *Barbarella*, the sexy space agent traveling in outer space, has to save her crew on planet Sogo and, with the help of the angel Pygar, she gains victory over the Black Queen, who tries to seduce her. In the reception room of the Raimund Theatre in Vienna, where the musical was staged, the Italian coffee brand Lavazza exhibited its "2004 Mission to Espresso" calendar with photographs by Thierry Le Guès. The promotional calendar refers directly to *Barbarella* [15]. Lavazza's public photo contest "Espresso, Space and Time" has produced a series of portfolios centered on coffee, space, desire and imagination and reflects the public's affinity for the subject of (outer) space.

Concurrent with the *Barbarella* musical, the Architektur Zentrum Wien in Vienna's MuseumsQuartier presented "The Austrian Phenomenon," an exhibition of 1960s neo-avant garde architecture that surpassed the limits of physical construction and became a medium for

concepts on the exploration of space (Color Plate B). In a transfer between technology, art, pop sensibility and architecture, the experimental projects on exhibit displayed a technological optimism in their futuristic visions. Event and play temporarily modulated the meaning of the body in urban spaces and presented constructed extensions of consciousness: "a space travel, like astronauts, but into inner space" [16].

These three contemporary examples of the common practice of cultural reiteration and simulation above (musical, coffee promotion and installation) show the complexity of interrelated references and a certain exoticism in the treatment of the subject of space travel. Displacing the idea of space research from the laboratory into a comedic framework creates the opportunity for unlimited imagination to expand and explore the desirable otherness of the unknown. In the example of *Barbarella*'s reiterations, the displacement occurs by the projection of human desires onto a particular scientific research project, so that the gap between popular culture and the scientific community is seemingly decreased. As the popularity of the cult movie *Barbarella* shows, audiences are still responding to this mechanism and carrying it forward into future imagination [17].

### The Angel and Technology in *Barbarella*: A Brief Case Study

The interior of *Barbarella*'s cozy spacecraft, where she performs her famous striptease [18] at the beginning of the movie, presents an analogy with the angel Pygar, whose feathered wings and cozy nest serve *Barbarella*'s pleasures. Both the spacecraft and Pygar are used in the film as agents to extend human travel through space and as amplifiers of human physical and mental capacities: When *Barbarella*'s spacecraft malfunctions, Pygar takes over and transports her to her destiny, the palace of Sogo. Even though the angel Pygar is shown with an anthropomorphic shape, attributed with an attractive, winged, masculine body, it is treated like an object by the inhabitants of the city of darkness. Consequently, Pygar's appearance and blindness are reminiscent of a machine, a hybrid form between cyborg and human in space, slightly like the character Data in the *Star Trek: The Next Generation* series. In this view, Pygar is an angelic machine that extends *Barbarella*'s capacities, being operated by her: *Barbarella* heals Pygar of its inability to fly by making love to it, which could be read as a reparation

or restoration of its functioning, and its wings are treated like a mechanical extension of its body [19]. The angel's superhuman capacities not only are at the service of *Barbarella*, but also seem to be under her control.

At first sight, the character Pygar represents seeming opposition to technology in its traditional sense by virtue of the angel's human-like appearance and its incorporation of virtues such as love and empathy. But at the same time Pygar forms an analogy to the many erotically shaped and attractive machines in the décor on Sogo, forming an organic part, connecting technology with body shapes and connoting physical desire. A comparison between the movie and the musical *Barbarella* reveals this relationship in the story's crucial love scene: In the movie, *Barbarella* makes love to the angel Pygar, who then regains its will to fly. Here Pygar wears only feathered pants, whereas in the musical the angel is covered with an armor-like outfit, hiding its muscles. Apart from the angel's more machine-like appearance, the musical rather relates to the original comic strip in this respect. *Barbarella* does not make love to Pygar but instead to the robot Victor: a metallic cyborg, a "love-machine."

The 1960s film of *Barbarella* clearly expresses how, in popular culture, technology itself can serve as a medium for the production of sensory experience. Duran Duran's pleasure machine offers both pleasure and the potential to physically destroy *Barbarella*; in contrast to the material, eternal and Divine love is evoked by the angel Pygar, who finally embraces both the hero *Barbarella* and the wicked Dark Queen. Pygar wears wings, *Barbarella* is armored; together they incorporate forces that act on the desires projected on the imaginary of technology and spirituality. It seems as if they both need each other: humans and angels and humans and technology, hand in hand, even in love, in physical union to explore dark matter, confront alterities and re-establish order in the universe [20]. When *Barbarella* curls into Pygar's protecting arms at the film's end, accepting the union in this love together with the Black Queen, she seems to be transformed into a child, a being beyond sex, regaining her own innocence. Sex served as a medium to relate to the unknown and alien environment and encounters, and now the universe and *Barbarella*'s body are reconciled and she returns to Earth, where physical sex has long been transformed into a telepathic orgiastic ritual.

The contemporary reiteration of these attributes in cinema, and indeed the continuing reincarnation of *Barbarella's* image-culture in the last 40 years, not only express the unchanged, profound human desire to explore the unknown, but also evoke metaphors of the metaphysical in scientific space and the desire to explore experiences in a multi-sensory, sensual environment instead of a purely virtual or scientific one. In this context, the angel serves as a metaphysical model that operates as a screen for projections of human desire and for the imagination of superhuman capacities. In *Barbarella*, as discussed above, spirituality and technology are interrelated and interconnected. In a metaphysical view of technology, genderless angels relate closely to genderless technology. *Barbarella* and her persistent imagery, however, have gendered space: We have: (1) a sexy Barbie doll seduced by men in the 1960s, which has in our own time become a feminist agent (in the musical, *Barbarella* enters erotic relationships only with women, the angel Pygar and the robot Victor); (2) a space traveler with the mission to explore the "Espresso planet"; and (3) even an empowered blonde in control as played by pop star Kylie Minogue in one of her music videos (as David Surman argues below). Through the introduction of sex in relation to the angel and technology, we see physical pleasure and the subject of the body applied to metaphysical and technological ventures. Friedmar Apel argues that the

Romantic period at the turn of the 19th century demonstrated an embodiment of the senses and restoration of mythology in the appearance of angels in the arts, as a contra movement against the mechanization and rationalization of the world. A desire for love, eroticism and sexuality infiltrates the longing to reach the invisible, divine or transcendental. Reviewing recent spiritualist movements and the broad popularity of the subject of angels, I join Apel in questioning if the beginning of the third millennium brings back a similar tendency, a desire to restore sacred spaces, esoteric knowledge and, as he calls it, a *Himmelssehnsucht* (a "longing for heavenly realms" [21]).

The myth of *Barbarella* suggests a constructive look into the infinite, unknown and mysterious universe by applying love and awe, instead of fear, against deterministic, destructive visions of alienated extraterrestrial space. The symptomatic reiteration and persistence of a cultural phenomenon, as in the case of *Barbarella*, calls for strategies of synthesis in order to reconfigure our understanding of popular imagination and help find new portals and bridges between academic discourse and the aspirations of contemporary popular culture.

#### DAVID SURMAN: PLAUSIBILITY AND THE TECHNOLOGICAL IMAGINARY

I would like to conclude this collaborative presentation by proposing a number

of core principles in the theorization of space, popular culture and audience. The examples I take to illustrate my view express a particular involvement in the popular. Little effort was needed on my part to draw together the various instances shown here to illustrate the popular (albeit fictional) representation of space. Imaginary "outer" space is everywhere.

As we have seen, in a large variety of cultural instances the expression of space exploration as a thematic, iconic or symbolic referent diverts drastically from the pioneer image of space exploration first popularized by Russian and American efforts. In the continuities and discontinuities of visual culture, it is reasonable to suggest that, while there has been little modification of the image of space offered by popular science, the aesthetic modalities of science fiction have—in a sustained dialogue with its various audiences—developed a *modus operandi* quite distinct from its rationalist counterpart.

Of course, science-fictional representations of space precede any *actual* human intervention into that domain. In imagining ourselves there, our exploratory desires manifest in technologies capable of achieving our original speculation. Imagination, technology and desire constitute an interdependent cycle that affects and sustains our technological development. It seems, however, when looking at the popular representation of imagined technology, that such a paradigm is more complex. Desire, a constituent part of our elusive consciousness, is never focused in its entirety upon any singular instance. Spiritual, technological and libidinal desires intermingle in the imaginary, and while rationalist science effaces the trace of such cross-pollinations, the popular imaginary of science enjoys the product of this meta-combination of influences.

The plurality of desires manifest in science fiction ensures its continuity and accommodates a far larger range of interpretations than the rhetorical strategies of "popular" science, which still expresses a modernist conception of its audience. In science fiction, the spectator is always prepared to meet the creator halfway, permitting lapses of rational coherence for the greater good of an *affective* experience that is continuous with both contemporary and comparable earlier works.

Consider the layered desires that combine in the cover image of the May 1951 issue of *Marvel Science*, a popular pulp magazine of 1940s and 1950s America: The sexuality of the Hollywood icon is



Fig. 2. David Hurn, *Untitled*, 1967. (© David Hurn)

idealized in the image of a woman who is being carried into a space ship by two suited astronauts, dually representative of both science fact and fiction. All the while, the woman seems not to need a space suit in outer space. A similar example of this surreal image of difference can also be seen on the cover of the June 1941 issue of *Thrilling Wonder Stories*, in which women again do not seem to require special clothing for outer space.

Representations of space in the cinema are characteristically divided between those that sustain the scientific rhetoric of technological development (*Apollo 13* [Howard, 1995], *The Right Stuff* [Kaufman, 1983]) and those that utilize the environment of outer space to play out distinctly "earthly" preoccupations. Steven Soderbergh's recent remake of *Solaris* (2003) uses the master signifier of the space station to illustrate the tragic fragility of earthly memory. Drawing a parallel between lost memory and the frustration of an unknowable region of space, Soderbergh's feature film uses the image of space as a potential future into which domestic frustrations are sustained.

How are these images culturally legitimated, when their irrationality seems so explicit as to debunk the value of their narrative content? And secondly, why are such desire-driven images so persistent in our visual culture? The film scholar Christian Metz developed a critical definition of "plausibility" with which we may account for those images that persist in culture, compared with those that do not. He writes,

The Plausible... is an arbitrary and cultural restriction of real possibles; it is in fact censorship; among all the possibles of figurative fiction, only those authorised by the previous discourse will be chosen [22].

There is much to extract from this. The representation of space, in the early cinema of Méliès at the turn of the 20th century and, even earlier, the humorous cartoons of 19th-century caricaturist Rodolphe Töpffer, preceded the actuality of space exploration.

The moon landing and its subsequent realm of representation is scientifically plausible. And yet, should we set the cultural presence of this particular mode of representing space against that which we may broadly term "science fiction," there is an unarguable predominance of fantastical imagery in our everyday domestic culture. The lure of the rational is nothing compared with the refined articulations of the imagined.

The irrationality of images such as those of the above-mentioned pulp magazine covers is not simply the expression of uneducated comic artists. It represents the most persistent means of creating space as a plausible phenomenon, to the extent that it is even rendered domestic, as in *Solaris*. On the magazine covers, the men, protected in their space suits, are accompanied by a woman who apparently has no need for such technological baggage. She is in her *element*. This principle of sexual difference is maintained in the representation of extraterrestrials in a host of varied instances, most notably in recent blockbuster franchises such as *Alien*, with the female alien seducing/destroying the human as astronaut-explorer-imperialist. In any sign system, meaning—it is argued—is the product of a regulated system of differences, and in developed systems certain signifiers become invested with paradigmatic differential significance. From a feminist position it is argued that the sexualized woman becomes the sign for *anything* that is other, including aliens, and consequently retains its signifying power despite changes in cultural styles. Jane Fonda's striptease at the beginning of the movie *Barbarella* was recently imitated by the pop star Kylie Minogue in the video for "put your self in my place." In the video, Kylie similarly strips off a pink astronaut's suit from the relative confines of her space station. Empowered by her technology, she blocks the gaze of the gray-suited male astronauts outside of her spaceship with a plume of smoke. The video is rendered "plausible" by its continuity with *Barbarella* and the broader trends of science fiction. Difference articulates the desirability of the protagonist and provides a means to permit identification between audience and moving-image text.

I would like to suggest that "difference," that everyday determinant against which we develop our identity, is needed in the representation of space in popular science. The role of gender, sexuality, race, class, physical ability, even hair color, is necessary to the future plausibility of represented space.

Identification is a fiercely contested principle in the humanities, and there are vast tracts devoted to often-opposing theories of how identification functions. Be it cognitive, psychoanalytic, phenomenological or narratological, all theories of identification, and specifically those in film studies, locate difference as the core principle through which audience participants relate to the world of representation. All representation functions

through the articulation of types, and yet the representation of the human in the space of popular science has been woefully devoid of difference, choosing instead to recall tenuous continuities to the (now distant) moon landing.

For popular science to plausibly represent our ongoing role in space, it must necessarily engage with a more sophisticated representational approach to space, one that locates difference at the core of the scientific imaginary. Modernist accounts of the audience no longer account for the heterogeneity and complexity of mass culture. The realization that the vast majority of space is unknowable echoes the topography of the popular imaginary, whose complexity has evaded scholarship since the 1960s. It is, however, possible to observe the continuities and discontinuities, what is permitted to rehearse its codes of representation and what is disavowed. In Metz's terms, the most plausible of images, primarily those that recall our foundational experiences of difference, will presumably be those toward which popular science may move if it is to articulate its message in the vocabulary of the popular imaginary.

## References and Notes

1. We are grateful to Annick Bureaud, Roger Malina and David Raitt for comments on this paper. We are also grateful to David Hurn for his cooperation with the rights for the pictures of Jane Fonda.
2. This research project began at Metatechnology Research, which was founded at the University of Wales College Newport in February 2002 by Michael Punt. In January 2005, he reformed it as Trans-technology Research at the University of Plymouth, where he is now a Reader in Art and Technology.
3. For further discussion of the relationship between space exploration and cinema, see Michael Punt, "Digital Media, Artificial Life and Postclassical Cinema: Condition, Symptom, or a Rhetoric of Funding?" *Leonardo* 31, No. 5, 349–356 (1998).
4. Among others, the Syrian monk Dionysius the Areopagite (6th century), a pagan philosopher, and the German abbess Hildegard of Bingen (1098–1179) have perceived visions filled with endless choirs and hierarchies of angels, beings of light. An old Jewish notion in the Bible mentions that God dwelt in ineffable darkness, a "truly mystical darkness of unknowing" (Exodus 20:21). And Dionysius the Areopagite wrote in a letter: "The divine darkness is that 'unapproachable light' where God is said to live," in John Gage, *Colour and Culture: Practice and Meaning from Antiquity to Abstraction* (London: Thames and Hudson, 1993) p. 60.
5. Since the first half of the fifth century, winged angels have been populating space throughout art history. Fritz Saxl suggests that the wings of Christianity's angels go back to such Greek mythological figures as Mercury and Iris, but mainly Victory, who also played a crucial role in Roman art. This pagan image has infiltrated Christian mythology to an extent that it even contradicts the original writings of the Bible, in which angels had to announce themselves for who they were, as they otherwise were not recognizable, being human in their appearance. In Fritz Saxl, *A Heritage of Images* (Middlesex, U.K.: Peregrine, 1970) p. 22f.

6. Gilles Deleuze writes in this respect: "The whole of cinema can be assessed in terms of the cerebral circuits it establishes, simply because it's a moving image. Cerebral doesn't mean intellectual: the brain's emotive, impassioned too." Gilles Deleuze, *Negotiations 1972-1990* (New York: Columbia Univ. Press, 1997) p. 60.

7. Edgar Morin has stressed the importance of processes of projection and identification, "cosmorphism" and "anthropomorphism," which perpetually inoculate humanity to the exterior world and vice versa. Edgar Morin, *Le cinéma ou l'homme imaginaire: essai d'anthropologie* (Paris: Les Editions de Minuit, 1956). An English translation is now available: *The Cinema, or The Imaginary Man* (Minneapolis, MN: University of Minnesota Press, 2005).

8. Robert D. Romanyshyn, *Technology as Symptom and Dream* (London and New York: Routledge, 1989) p. 44. Similarly, dark matter not only functions as screen but also turns itself into a projection of our internal imagination; through a look inside, our internal space consumes its own representation.

9. A famous example is the German physicist Werner von Braun's collaboration with the Disney television programs about space in the mid-1950s: *Man in Space, Man and the Moon* and *Mars and Beyond*. According to David R. Smith, director of the Disney archive, President Dwight Eisenhower requested *Man in Space* to screen for important audiences at the Pentagon in March 1955. Four months later, Eisenhower announced plans to launch the first satellite. Von Braun apparently remarked to the producer of the series, "They're following our script." Eugene S. Ferguson, *Engineering and the Mind's Eye* (Cambridge, MA: MIT Press, 1992) p. 2.

10. Several media theorists, including Marshall McLuhan, have argued that the moon landing as media spectacle dominates the question of whether the event actually took place. This notion links up with postmodernist theories, such as Jean Baudrillard's concept of the hyperreal and the fact that while people's imaginations demand the real thing, they must create fakes in order to get it. Jean Baudrillard, *Simulacra and Simulation* (Ann Arbor, MI: University of Michigan Press, 1994).

11. In recent years, the senses have been re-introduced most prominently into science; and since feminist perspectives have entered scientific discourse and artists' work relates more closely to scientific research, the faculty of the body cannot be denied any longer. Technology and spirituality have both shown a tendency to neglect the body in the past; contemporary discourses ask for a reconsideration and restoration of the union and interrelation between body and mind.

12. Michael Punt and Robert Pepperell have expressed this triangular relationship in their model of

technology-desire-imagination, three faculties that are interrelated and contingent: "The imagination is prompted by human desire to modify the world through technology, which in turn prompts desire," in Michael Punt and Robert Pepperell, *The Postdigital Membrane: Imagination, Technology and Desire* (Bristol, U.K.: Intellect Books, 2000) p. 25.

13. Directed by Dino de Laurentis, alias Roger Vadim, married at the time to actress Jane Fonda, who plays Barbarella.

14. Directed by Kim Duddy; music by Dave Stewart. See <<http://www.barbarellamusical.at>> (accessed 31 July 2005).

15. The September/October image, for instance, shows a robot constructed out of white espresso cups on the "espresso planet," holding the 2004 blonde Lavazza-girl in its arm, evoking images from the movie *Barbarella* rather than those of white male astronauts in white suits on an extraterrestrial mission. Jean Hugues de Chatillon (set design) says of the Lavazza girl (the model Ingrid Parewicz): "She's got charisma, a strong character, such blonde hair... her presence is classic but extremely elegant and a bit adventurous. I see her as the Barbarella of the future Lavazza world, who is astonished as she goes out to discover the world." He also expresses the mysteriousness of black coffee as an analogy to black space: "For the choice of the scenes I tried to approach the essence of coffee, which is a dark and soluble substance burnt by the sun and by fire." See <<http://www.lavazza.com>> (accessed 31 July 2005); note the similarity of the main page of this site to the homepage of the musical <<http://www.barbarella.com>>.

16. Quote from the "love-protector" by Haus-Rucker-Co, in Dieter Bogner, *Haus-Rucker-Co: Denkräume—Stadträume 1967-1992* (Klagenfurt, Austria: Ritter Verlag, 1992) p. 17. The exhibition "The Austrian Phenomenon" included the architects Raimund Abraham, Domenig/Huth, Haus-Rucker-Co, Coop Himmelb(l)au, Bernhard Hafner, Hans Hollein, Missing Link, Zünd up, and more. Some of Haus-Rucker-Co's projects' names are: Phy-Psy, Balloon for Two, Connexion Skin, Pneumatic Living Cells or Air-Unit, Mind-expander, Pneumacosc, Flyhead, Viewatomizer, Drizzler, Electric Skin, Environment Transformer, Roomscraper, Battleship, Yellow Hear, Vanilla Future. For more information on the exhibition, see <<http://www.azw.at>>, under "exhibitions" (accessed 31 July 2005).

17. To give another example that relates science fiction literature and film, Constance Penley has shown, in the context of slash subculture, how amateur (mostly female) writers have subverted and rewritten *Star Trek* to incorporate their own sexual and social desires. Constance Penley, *NASA/TREK: Popular Science and Sex in America* (London: Verso, 1997).

18. Domestic issues about living in space have been addressed by the European Space Agency in its feature "Daily Life" at <[http://www.esa.int/esaHS/ESAHI1V0VMOC\\_astronauts\\_0.html](http://www.esa.int/esaHS/ESAHI1V0VMOC_astronauts_0.html)> (accessed 31 July 2005), which comments on the complications of daily operations, such as getting dressed, in a zero-gravity environment.

19. Inhabitants of the planet pluck Pygar's wing feathers as if they were merely a costume, and Barbarella reanimates Pygar by moving its wings, rather than following the Dark Queen's advice to do a "mouth to mouth." This does not seem to bother Pygar, whereas in other fictionalized accounts in literature, wings are often presented as an integral part of an angel's body, being extremely sensitive to the touch (*Samara Trilogy*, by Sharon Shinn, 1997-1999); or sometimes a highly erogenous area (*The Vinter's Luck*, by Elizabeth Knox, 2000). Furthermore, Barbarella takes Pygar by its hand (as the player does in the video game *Icon*) and pulls it behind her, treating it like a toy—a sexual toy, whose maleness itself is linked to technology, as when Barbarella sneaks her revolver into its feather pants.

20. With a similar spirit, cyborgs of the 21st century that lose control are conquered or humanized and restored by love, as is most prominently at stake in Japanese anime: see, for example, *Chōjūki yōsai Macross: Ai oboeteimasuka*, by Noboru Ishiguro and Shōji Kawamori (1984); *Akira*, by Katsuhiro Ōmoto (1988); *FLCL*, by Kazuya Tsurumaki (2000); *Metropolis*, by Rintaro, based on Osamu Tezuka's comic (2001); and *Cardcaptor Sakura*, by Clamp (2001).

21. "Himmelssehnsucht" is difficult to translate. It expresses a longing for the "heavenly realms," while "Himmel" in German means both the sky and heaven (translation by Martha Blassnigg). Therefore this expression could also be translated to mean human engagement with space exploration. Friedmar Apel, *Himmelssehnsucht: Die Sichtbarkeit der Engel in der romantischen Literatur und Kunst sowie bei Klee, Rilke und Benjamin*. (Paderborn, Germany: Igel-Verlag, 1994).

22. Christian Metz, *Film Language* (New York: Oxford Univ. Press, 1974) p. 239.

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# What Is the MARS PATENT and What Does It Do?

*Claudia Reiche and  
Helene von Oldenburg*

**T**his paper consists of three parts. In the first part, the results of a poll of the so-called space community are presented, indicating the severe limitations of the majority of participants in conceiving something radically different from the traditional cultural imaginary when envisioning outer space. Second is an introduction to the MARS PATENT project, which involves both an Internet site and an exhibition site on Mars that is to receive every "thing" that does not fit entirely on Earth. The third part presents rules and information regarding the Oldenburg-Reiche Prize Competition, which calls for an answer to the question of how the MARS PATENT is capable of teleporting objects from Earth to Mars with its High Reality Machine.

## HOME AWAY FROM HOME: A POLL OF THE SPACE COMMUNITY

Table 1 shows the results of a May 2004 poll of 523 persons (project participants and friends of the MARS PATENT) who were asked six questions inspired by the expression (especially well-known in the U.S.A.) "Home away from home." The results of the poll make it clear that it is difficult to imagine something as far "away from home" as outer space is supposed to be, or something as different from Earth and life as the stars.

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Based on a paper presented at "Space: Science, Technology and the Arts" (7th Workshop on Space and the Arts), European Space Research and Technology Center (ESA-ESTEC), Noordwijk, the Netherlands, 18–21 May 2004.

## WHAT IS THE MARS PATENT AND WHAT DOES IT DO?

Have you ever dreamed of seeing works of art and theory on Mars? Now you can! (Fig. 1)

The MARS PATENT is an interplanetary exhibition space founded by Helene von Oldenburg and Claudia Reiche. You are invited to ex-

## ABSTRACT

The authors invite readers and others, including aliens (provided they claim to have female first names), to submit "things" to the MARS PATENT project for interplanetary exhibition on Mars and on the Internet. The MARS PATENT High Reality Machine will teleport sculptures, theories, web art and other things, imaginable or not fully imaginable, to the exhibition site on the red planet. The authors have also established the Oldenburg-Reiche Prize, an open competition challenging artists, scientists and others to come up with a satisfying explanation for how the High Reality Machine works.

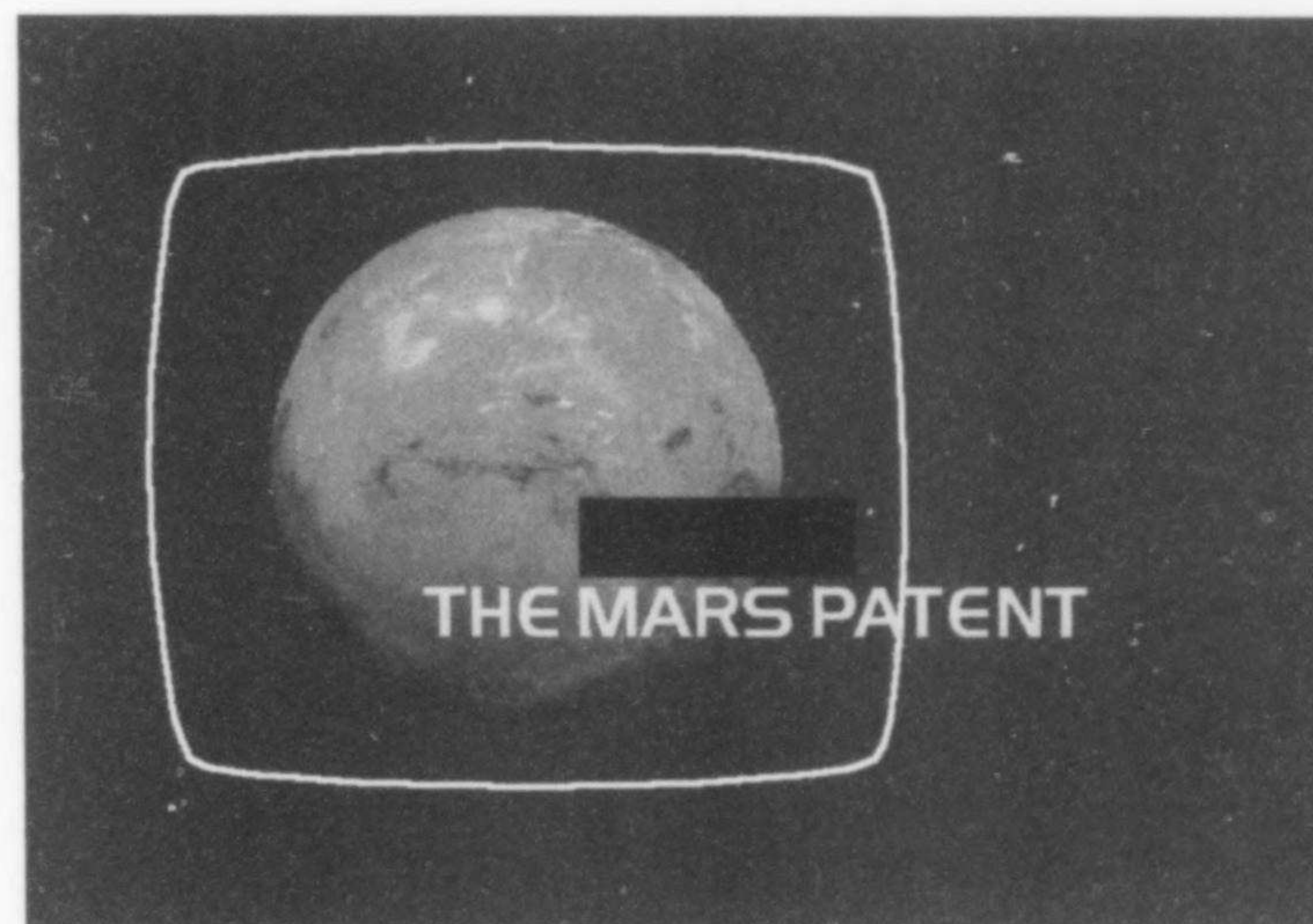


Fig. 1. The logo of the MARS PATENT. (© Claudia Reiche and Helene von Oldenburg) Please note the black rectangle and imagine what may be hidden from sight.

Fig. 2. The Mars Exhibition Site (MES). (© Claudia Reiche and Helene von Oldenburg)

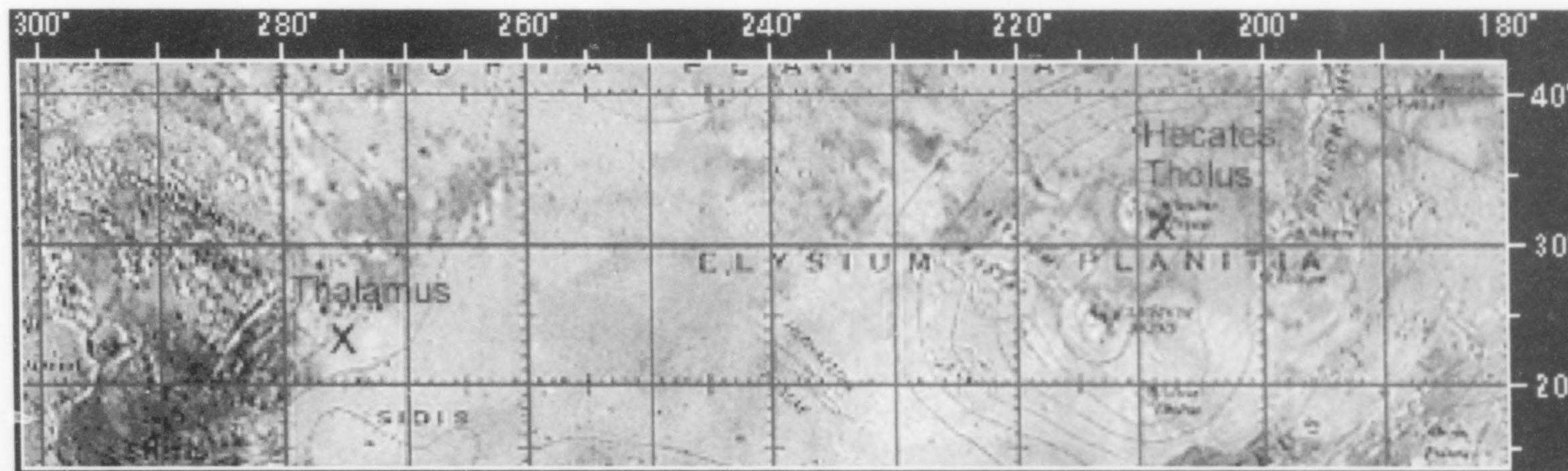




Fig. 3. A real thing?

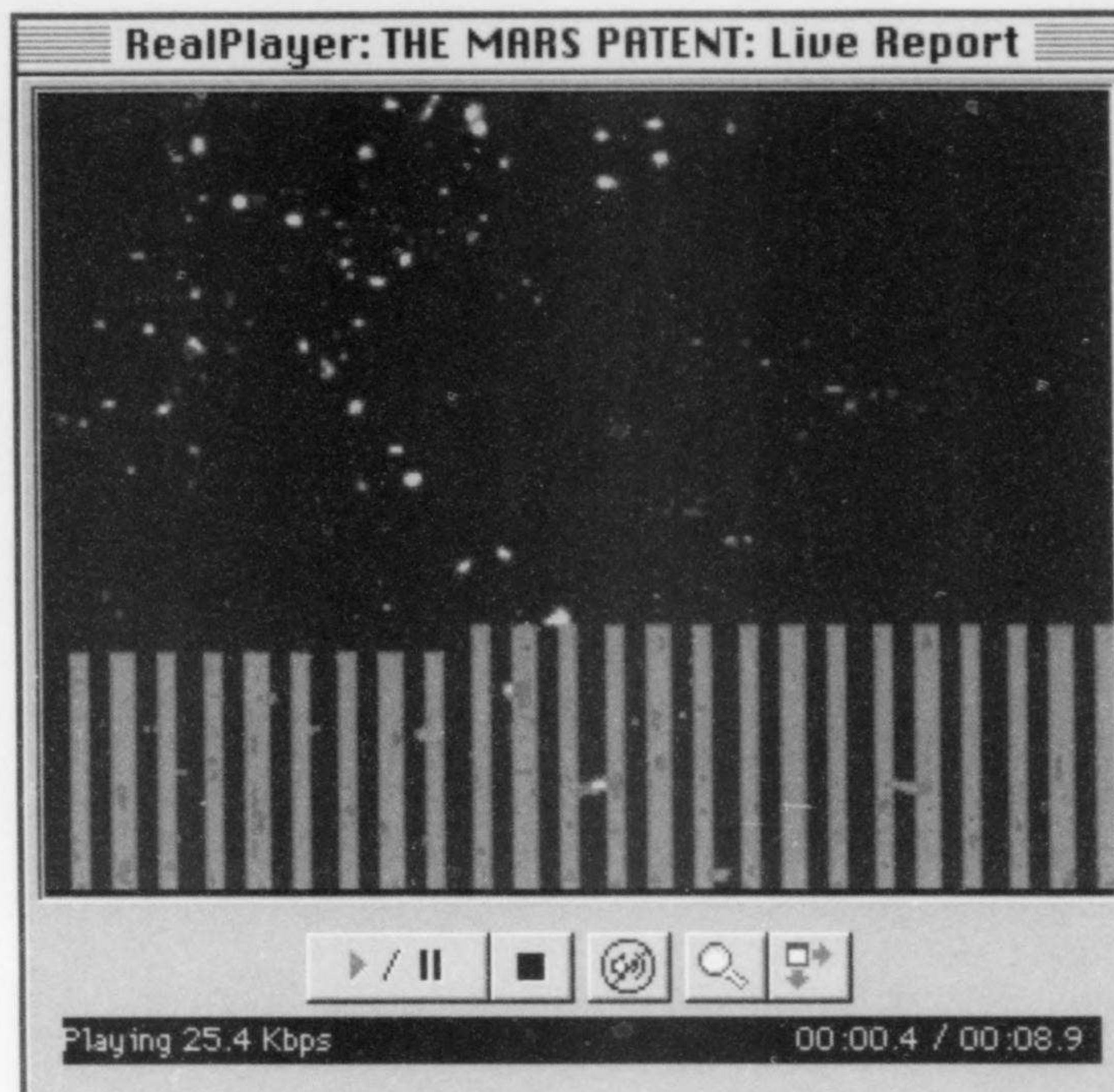


Fig. 4. Live Report by MARS CAM.  
(© Claudia Reiche and Helene von Oldenburg)

perience culture on a fascinating and promising new site. Although millions of miles away, the red planet now lies within reach—in an entirely new way. Since its early days, the MARS PATENT committee has worked hard to find a discriminating place for your desires that allows a new vision on Earth: The MARS PATENT offers its Mars Exhibition Site (MES) (Fig. 2) to you as a free experimental area and invites every thing that

does not fit entirely on Earth but gravitates towards the Mars Exhibition Site.

A thing? A real thing? It could be your idea, your object, your work, your question, your protest, your project, your desire... (Fig. 3).

Mars, still untouched by human hands, is a dry, cold and poisonous place that is often experienced to be of terrific beauty. The MES is located near the equator, in the north of a lowland area called Ely-

sium Planitia. Its slightly changing form is that of an elongated rectangle. The MES is a slightly floating area of approximately 3,148 square kilometers, offering a wide range of altitudes within a rocky landscape filled with extraordinarily shaped lava masses—exposed to storms and temperatures oscillating rapidly within a range of  $-127^{\circ}\text{C}$  to  $+15^{\circ}\text{C}$ .

The MARS PATENT is a site for art and theory and sensible to its various

Table 1. Results of the poll "Home Away From Home."

Result	What percentage of the "Space Community" (scientists, artists, entrepreneurs)...
82%	think that there is life to be found on Mars sooner or later
43%	think that all in all space is a better place to live
50%	believe in life after death
34%	have had contact with aliens
75%	are not sure that George W. Bush is not an alien
62%	believe that "developing countries" (a.k.a. "Third World") is a marketing name for regions in the nearby planetary system

Table 2. How to send "a line" to Mars (formatting for the HRM\_1.0n).

It is necessary to decide whether "a line" should be:

- sent as a mere concept?
- sent to a specified geographic position on the MES?
- marked (symbolically) on Mars's surface?
- drawn, engraved or printed (etc.) on Mars by a robotic device?
- pronounced [e lein] by a voice, to be heard somewhere on the Mars Exhibition Site?
- sent as a (handmade!) drawing on paper?
- (In this case you should indicate how the paper should be presented on Mars. For instance:
  - Should it be fixed with a stone to keep it from flying away?)
- accompanied by technical, philosophical, artistic etc. explanation on Mars?
- sent as data to Mars?
- sent as an image file (or else) on disk, CD-ROM or any other digital storage format? With or without a computer?
- transmitted as signals (like a TV-/radio-signal or a wireless modem connection) into the Martian atmosphere?
- etc.

Last Name	<input type="text"/>
First Name	<input type="text"/>
Attention please: Do not forget to fill in your first name. Female names only! As a future orientated device the HRM_1.0n only reads female names as valid identities.	
e-mail	<input type="text"/>

Fig. 5. The MARS PATENT's "female privilege" rule [3]. (© Claudia Reiche and Helene von Oldenburg)

concepts. With MARS PATENT's High Reality Machine, the HRM\_1.0n (Color Plate C No. 1), we offer cutting-edge technologies for installing sculptures, Internet relay chats, kinetic objects, art-and-media theories, science-fiction literature, telepresence systems, videos, sound installations, manifestos, web art, etc., via teleportation. This machine will become a potent device in your hands for placing your things on the Mars Exhibition Site.

The main feature of the HRM\_1.0n is its signal transmission from the "sender," located on Earth, to the "receiver," located on Mars. Teleportation by the HRM\_1.0n is an irreversible transfer from Earth to Mars. No matter treated by the HRM\_1.0n will remain without damage—from slight atomic disturbances to more destructive effects. We differentiate (a) matter-signal-matter transformation (complete teleportation); (b) signal-matter transformation (signal realization); and (c) matter-signal transformation (matter realization). The HRM\_1.0n's maximum Signal Processing Rate is 1027 Tetra Flop (FLoating point OPerations)/sec. The size of the transmission shaft is 32 cm × 24 cm × n cm.

In order to illustrate the conceptual process that has to be completed before any teleportation by the HRM\_1.0n takes place, the following example is useful. If a submitter plans to send "a line" to the MES, there are various possible meth-

ods of doing so and many questions to consider (Table 2). (Please note: the example refers to "a line" only in the geometrical sense.)

The means by which the HRM\_1.0n sends "a mere concept" of a proposal or sends it "as data" is a technically and epistemologically tricky (if not impossible) question. Nevertheless there has been no proof during previous tests with the machine on this problem that no concepts and no data were teleported. At least no material changes could be perceived, and thus this possible fault can be ruled out.

As a controlling device (for instance, in the case of sending a line), the MARS PATENT additionally provides ongoing live reports from the MES (Fig. 4) on the MARS PATENT web site. The 24-hour Mars Cam service for every project is accessible at <[www.mars-patent.org/report/report.htm](http://www.mars-patent.org/report/report.htm)>.

Note: Only female first names will be accepted! (Fig. 5)

The question "If I'm not of the female sex, may I register under a female name?" is answered in the MARS PATENT web site's Frequently Asked Questions [1]: "The HRM\_1.0n (High Reality Machine) is not able to control biological identity. It's your commitment that counts." Regarding participation by aliens, it states, "If they [the aliens] come up with a real e-mail address, they can always try.

With a female first name we encourage every alien to participate." The "female privilege" rule is thus carried out strictly symbolically and processed by the HRM\_1.0n's binary structure.

This call goes out to all readers of this text: Send your thing to the MARS PATENT! [2]

### THE OLDENBURG-REICHE PRIZE: COMPETITION RULES AND INFORMATION

In 2004 the MARS PATENT's founders, Reiche and von Oldenburg, agreed to underwrite a contest designed to prove that the HRM\_1.0n works and to explain its principal functions. We pledged a grand prize of two polished brass plates (Fig. 6) for the first scientist or artist whose solution is convincing to the MARS PATENT's grand jury. This jury consists of five members randomly chosen from among the friends of the MARS PATENT who have an international reputation and experience as jury or program committee members, chairs of institutions or other. To guarantee their independence, the jurors remain anonymous until the results of the reviewing process are declared.

One brass plate with the engraved name of the winner will be teleported by the HRM\_1.0n to the MES and fixed with two brass screws upon a beautiful rock on

Fig. 6. The Oldenburg-Reiche Prize, two polished brass plates to be engraved with the winner's name. (© Claudia Reiche and Helene von Oldenburg)



Mars at Latitude 19° N, Longitude 281° E, facing south. The second brass plate will be given to the winner to be installed (or not) wherever on Earth she or he wishes. Note: The "female privilege" rule is modified here. If there are two equally convincing submissions, the female author will be declared winner.

The winner will be announced on the MARS PATENT's web site, as is every submission, to allow a public discussion of the submissions and the jury's choice. (All submissions are on-line, but at the

time of this writing no choice has yet been made; the winner will be declared in November 2005.)

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milia Jazybekova, Saide Sesin, Paula Hasenzucker, Ma-tha-B Dao-in-space, Ursula Palla, Christina Goestl, Alice Bartle, Sandra Hastenteufel, Maria Deslibes, Maria Miranda, Norie Neumark, Valéry Grancher, Krista Beinstein, Phyllis Green, Chiara Passa, Louis Christian, Deb King, Amanda Steggell, Pernilla Platou, Anna Bardi, Ulrike Bergermann, Gisela Weimann, Sarah Smiley and Verena Kuni.

#### References

1. See <[www.mars-patent.org/faq/faq.htm](http://www.mars-patent.org/faq/faq.htm)>.
2. E-mail: <[office@mars-patent.org](mailto:office@mars-patent.org)>. See: <[www.mars-patent.org](http://www.mars-patent.org)>.
3. See <[www.mars-patent.org/form/form.html](http://www.mars-patent.org/form/form.html)>.

## CALL FOR PAPERS

### Live Art and Science on the Internet

The Internet has become a venue and medium for art as a means to broadcast ideas to a worldwide audience. Leonardo and Guest Editor Martha Wilson seek texts on the subject "Live Art and Science on the Internet" for a series of special sections in the international journal *Leonardo*, both in print and online.

As artists and others produce live art on the Internet, liveness, presence, mediatization, online activism, surveillance and identity/gender, among other issues, are being explored. We seek texts documenting such work, as well as texts on the history of this field of practice and on the vocabulary being used to describe it. We also seek texts from scientists who have used the Internet to conduct science investigations live on-line.

Guest Editor Martha Wilson and her peer review committee seek statements (500 words plus one image describing one work), notes (2,500 words plus six images describing a body of work), galleries (750-word curator's introduction plus up to 10 images by individual artists, each with a 200-word caption) and articles (5,000 words plus 12 images). Texts describing the work of a living artist or scientist must be written by the artist or scientist him/herself, with a co-author if necessary.

This call for papers is open for 2005 and 2006.

Please send an initial statement of interest with a brief explanation of your project to Martha Wilson: <[Leonardo@franklinfurnace.org](mailto:Leonardo@franklinfurnace.org)>. For author guidelines, follow the link "Info for Authors" on Leonardo On-Line <[www.leonardo.info](http://www.leonardo.info)>.

# Astro Black Morphologies: Music and Science Lovers

## Flow Motion

*I remember talking about Einstein with John Coltrane while we were having an egg cream at the drug store on St. Mark's Place & Second Avenue. Actually, he was talking about numbers and their relationship to music, how intervals affected certain kinds of chords and how they could be used to create a different order in music. He brought up the theory of relativity. To him it meant that many things already existing had a relationship in music, and it was up to the musician to discover these relationships and express them musically. I saw Coltrane for the last time in March 1967 at the health & food store on Broadway and Fifty Seventh Street. We picked up the same subject of relativity almost exactly where we broke off our previous conversation. More than anything else, I remember him saying, "The universe is expanding."*

—David Amram [1]

### POSSIBLE HISTORIES OF SCIENCE IN MODERN MUSIC Prehistories, Sonic and Cosmic

The story of modern music in the past 100 years could be told as the history of a dialogue between the sonic and the cosmic, whose prehistory extends as far back as Pythagoras. It is in Pythagoras's thought, influenced by ancient Egyptian pedagogy, that we find the idea that the orbit of each of the seven planets produced a particular note according to its distance from the earth. Pythagoras called this *Musica Mundana*, usually translated as "Music of the Spheres."

Here was a sound so harmonious and rarified that ordinary ears were unable to hear it, the cosmic music that Philo of Alexandria tells us Moses heard when he received the Ten Commandments on Mount Sinai, the same sound St. Augustine believed the dying heard in their final breath, revealing to them the transcendental truth of the cosmos. For Plato, writing in the *Timaieus*, the harmonious, mathematical nature of Pythagorean cosmology reflected the harmonious relations of proportion that informed the creation of the universe, and its correlative, the creation of "one visible living being, containing within itself all living beings of the same natural order."

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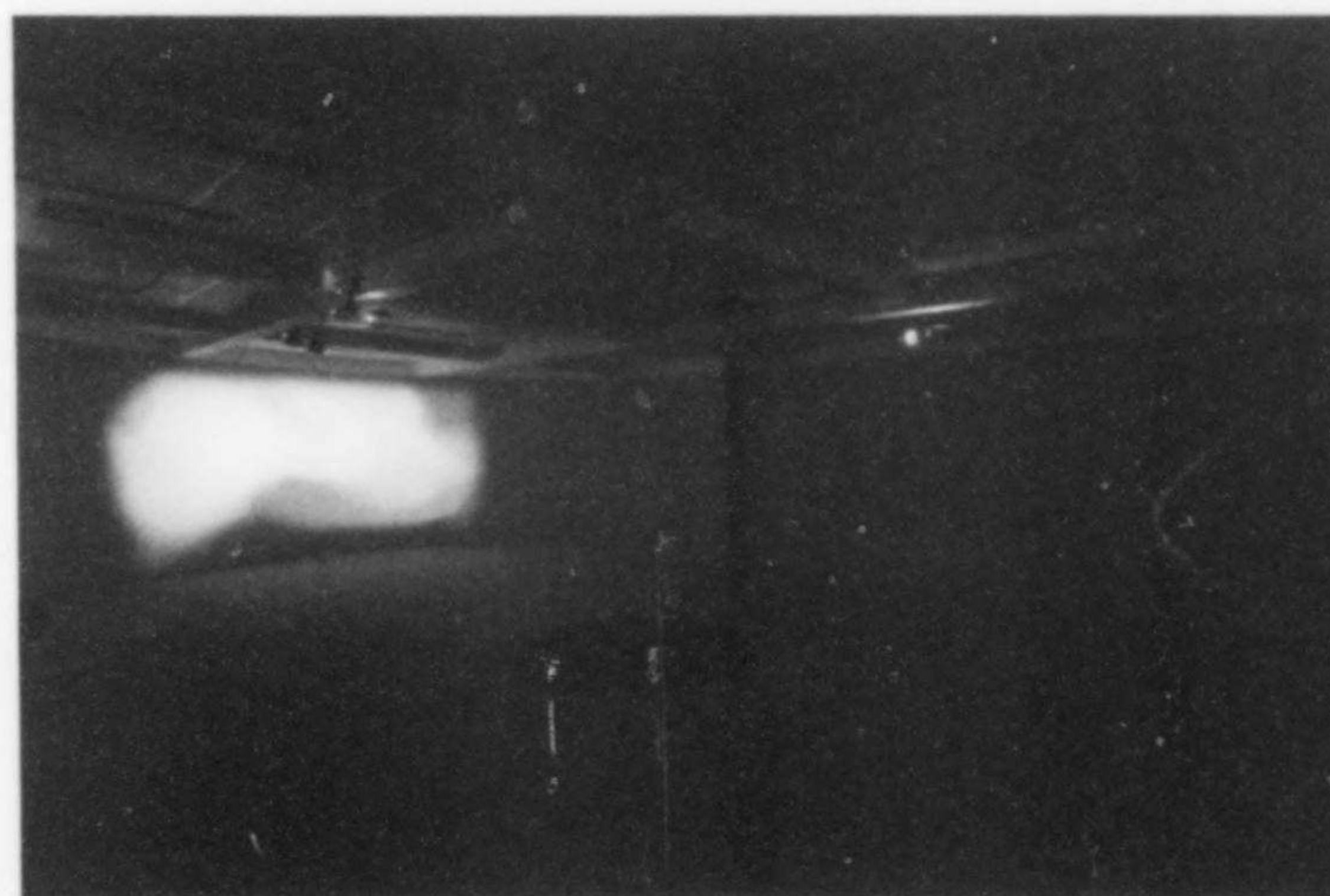
Based on a paper presented at "Space: Science, Technology and the Arts"  
(7th Workshop on Space and the Arts), European Space Research and Technology  
Center (ESA-ESTEC), Noordwijk, the Netherlands, 18–21 May 2004.

Twentieth-century music forms, from the jazz of Sun Ra and John Coltrane to the techno electronica of Underground Resistance, have continued the grand Pythagorean tradition of conceiving the cosmos as purely metaphysical space, a sonic dimension of spiritual transcendence.

"One bright morning/I'll fly away, fly away" [2]. "My ship set sail, my sun-jet in the sky" [3]: the story of modern music, from the Negro spiritual of the Five Blind Boys of Alabama to the Ethiopianist logorrhea of Lee "Scratch" Perry, can be told as a history of the cosmos as the darkness into which black music projected its quest for freedom, from slave ships to sun ships, segregation to post-colonialism.

Twentieth-century black music's concern with the cosmos was rooted in a liberationist aesthetic. This cosmos of racial yearning may have been, in a manner of speaking, the same as that evoked by Stockhausen in his *Mantra*, "a musical miniature of the cosmos, just as it is a magnification into the acoustic time field of the unified structures of the harmonic vibrations in notes themselves" [4], a cosmos contiguous or parallel to dub music's thunder-and-lightning evocation of Old Testament elementalism.

Fig. 1. *Astro Black Morphologies*: detail of installation at the John Hansard Gallery, Southampton, U.K., 5 April–14 May 2005. (© Flow Motion/Adrian Ward, 2005. Photo: Steve Shrimpton, courtesy of John Hansard Gallery) Generative design-based visualizations of X-ray data from Cygnus X1.



#### ABSTRACT

A compressed series of possible histories of science in modern music, the text outlines the themes of poetic and historic correspondences between music, cosmology and the body that informed the making of *Astro Black Morphologies/Astro Dub Morphologies*, a multimedia installation and live sound-art performance by Flow Motion in which data from possible black hole Cygnus X1 is transformed into an immersive electronic sound-and-image environment.

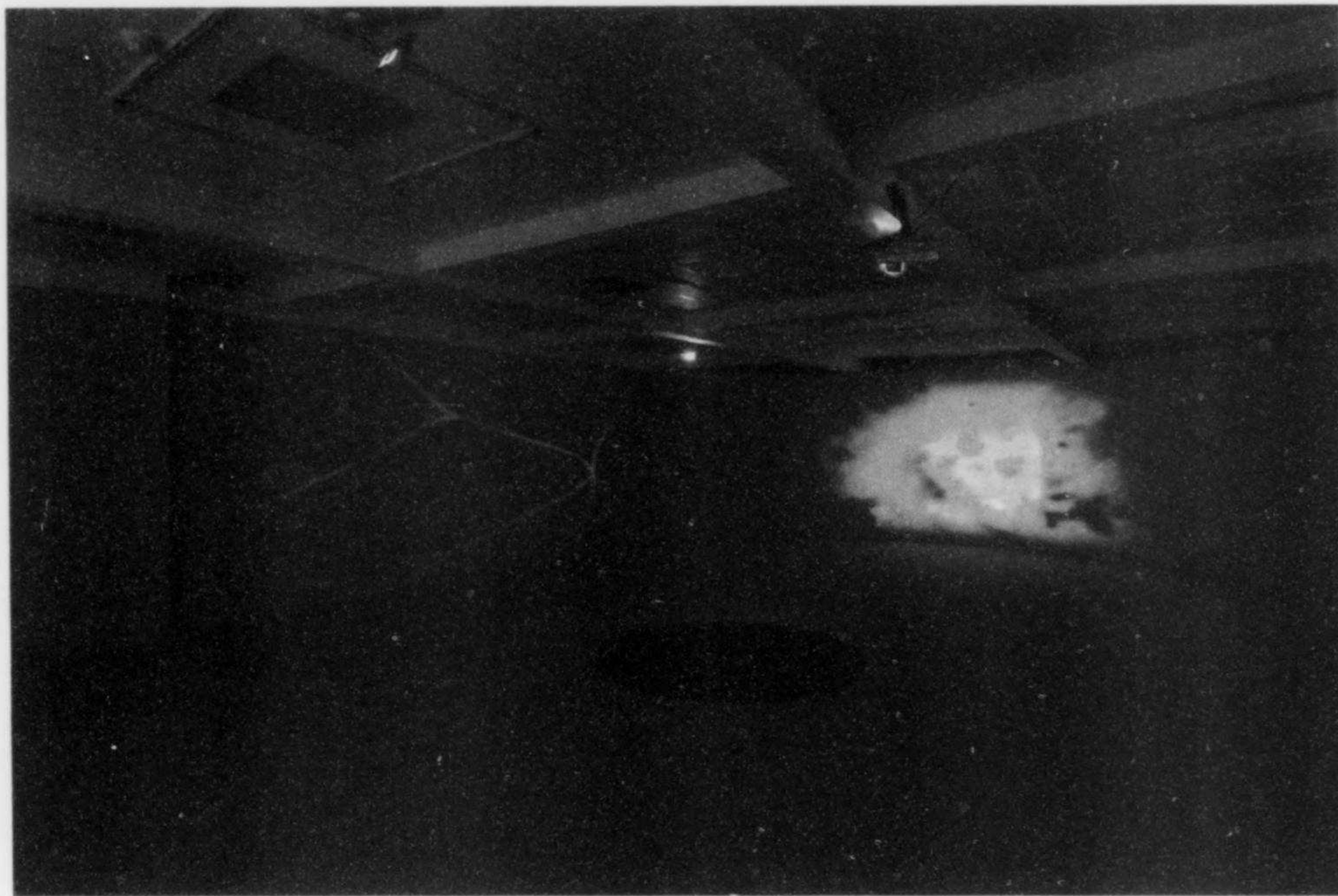


Fig. 2. *Astro Black Morphologies*, detail of installation at the John Hansard Gallery, Southampton, U.K., 5 April–14 May 2005. (© Flow Motion/Adrian Ward, 2005. Photo: Steve Shrimpton, courtesy of John Hansard Gallery) Generative design-based visualizations of X-ray data from Cygnus X1.

Whatever the case, our musical interstellar space has, in the past hundred years, become a busy place, from Gustav Holst's pre-World War I *Planets*, inspired by Alan Leo's book *What is Astrology?*, to Juan Atkins's post-Cold-War-era *Deep Space*, inspired by Detroit's Deep Space radio show of the 1990s.

### Cosmic Music and the Music of the Cosmos

The story of modern music could be told as a history of space exploration, a history of the cosmos as purely sonic, represen-

tational space; an audiophilic screen—the cosmos as sound-picture space, a successful adventure of colonization, an overcrowding, even. Think of all those voices, all those sounds, over all those radiophonic days and nights, still drifting through space.

Think of the names, think of the music: Joe Meek's "Telstar," Tim Buckley's "Starsailor," George Clinton's "Cosmic Slop," Jeff Mills's "Rings of Saturn," Kool Keith's "Earth People," David Bowie's "Starman," Ed Rush and Optical's "Wormhole," 4 Hero's "Parallel Universe," John

Fig. 3. *Astro Black Morphologies*, detail of installation at the John Hansard Gallery, Southampton, U.K., 5 April–14 May 2005. (© Flow Motion/Adrian Ward, 2005. Photo: Steve Shrimpton, courtesy of John Hansard Gallery) Generative design-based visualizations of X-ray data from Cygnus X1.



and Alice Coltrane's "Cosmic Music," Sun Ra's "Cosmic Tones for Mental Therapy"; the list could be endless. Now scientists are doing it too, an example being Dutch astronomer and computer scientist Alexander Ollongren's proposals for communicating music to extraterrestrials through interstellar messages, using Indonesian gamelan music.

So thoroughly seductive is modern music's idea of space as sonic imaginary that we could be forgiven for not wondering whether the cosmos had a music of its own. We know now that it does, beginning with the ground beneath our feet. The Earth hums, producing an inaudible, 4.6-billion-year drone that gives LaMonte Young an interesting organic precedent.

Scientists call Earth's planetary sounds tweeks, whistles and sferics. Jupiter has its music too. "NASA's Cassini Space probe is picking up an eerie melody as it approaches Jupiter," reported space.com in December 2002. Cassini was picking up low-frequency sounds that, when converted into audible waves, "suggest[ed] the strains of some alien folk tune."

This new knowledge of cosmic sounds finds its earliest precedent in Karl Jansky's discovery of a source of radio noise from the center of our galaxy in 1932, the year 0 of modern astro-sonics. Jansky's discovery gave birth to a golden age of invisible light astronomy, and to an entirely new way of understanding the universe.

### THE UNIVERSE IS IN MY VOICE

The story of astronomy in modern music could be the story of the discovery of the cosmos, or something of the cosmos, in the body.

Not an hour, if a few years, away from where John Coltrane and David Amram discoursed on the expanding nature of the music and the challenge physics suggested for music, a short, rotund black man from the planet Saturn stood on the corner at the crossroads of 125th and Lennox in Harlem, listening to the music in the busy four-way stretch of heavy traffic and to the sounds above the clouds, beyond the stars.

He was Coltrane's friend Sun Ra. "Trane knew Ra from Chicago, and he finally started visiting our studio on West 82nd Street. Sun Ra gave him literature on outer space and we talked tenor while I showed him some of the things the band and myself were doing at the time," said Ra's saxophonist John Gilmore. "Trane really wanted to play avant-garde

music, but he didn't get the foundation until he listened to Sun Ra a lot" [5].

The story of cosmology in modern music could have as its central protagonist the figure of Sun Ra. After all, Ra's 40-year legacy of compositions are an Olympian testament to 20th-century music's attempt to re-sound the cosmos in the ear of the other, from the perspective of a visitor who viewed and experienced Earth and human longing from a distant planet too harsh for human life.

To hear him tell it, Sun Ra, a.k.a. Mr. Re, a.k.a. Mr. Mystery, a.k.a. Herman Blount, who first visited Earth in 1914 as an African American in Birmingham, Alabama, was, he said, named by the Creator after the sun god of ancient Egyptian myth, Ra, kin by name at least to Amen Ra, the supreme god of ancient Thebes, whom the priests of Thebes declared to be one and the same as the widely worshipped sun god Ra.

Amen Ra was adopted by the Greeks, who called him Ammon and identified him with Zeus, and by the Romans as Jupiter, the planet whose four moons were first observed by Galileo in 1609, 11 years before Blount's African ancestors were first brought to America. Sun Ra also described himself as "a scientist, I deal with equations. You might say a spiritual scientist and also a cosmo musical scientist" [6].

It was as if Ra were trying to inscribe into his newly renamed self, to ingest into the body of this new self, as much of the universe of history, mythology and scientific inquiry as he could, exhaling the cosmos re-sounded as music composition. Perhaps it was this pan-cultural, transdisciplinary cosmology that he alluded to in a 1972 composition: "Astro-black mythology/Astro-timeless immortality/Find your place among the stars/listen to the outer world: the universe is in my voice" [7].

## THE UBIQUITOUS SOUND

The story of physics in modern music could begin with an echo.

Benoit Mandelbrot has said,

If you look at many shapes in nature—clouds, trees, small parts are the same as big parts: that's the definition of fractals. I used to be extraordinarily involved with music, especially opera. And then I became a slave of my creation. Now fractals are everything [8].

The story of physics in modern music could begin with an echo, or the invention of the reverb, delay or echo unit.

It could begin with noise itself, a bang, a hiss, a flicker or Mandelbrot's discovery

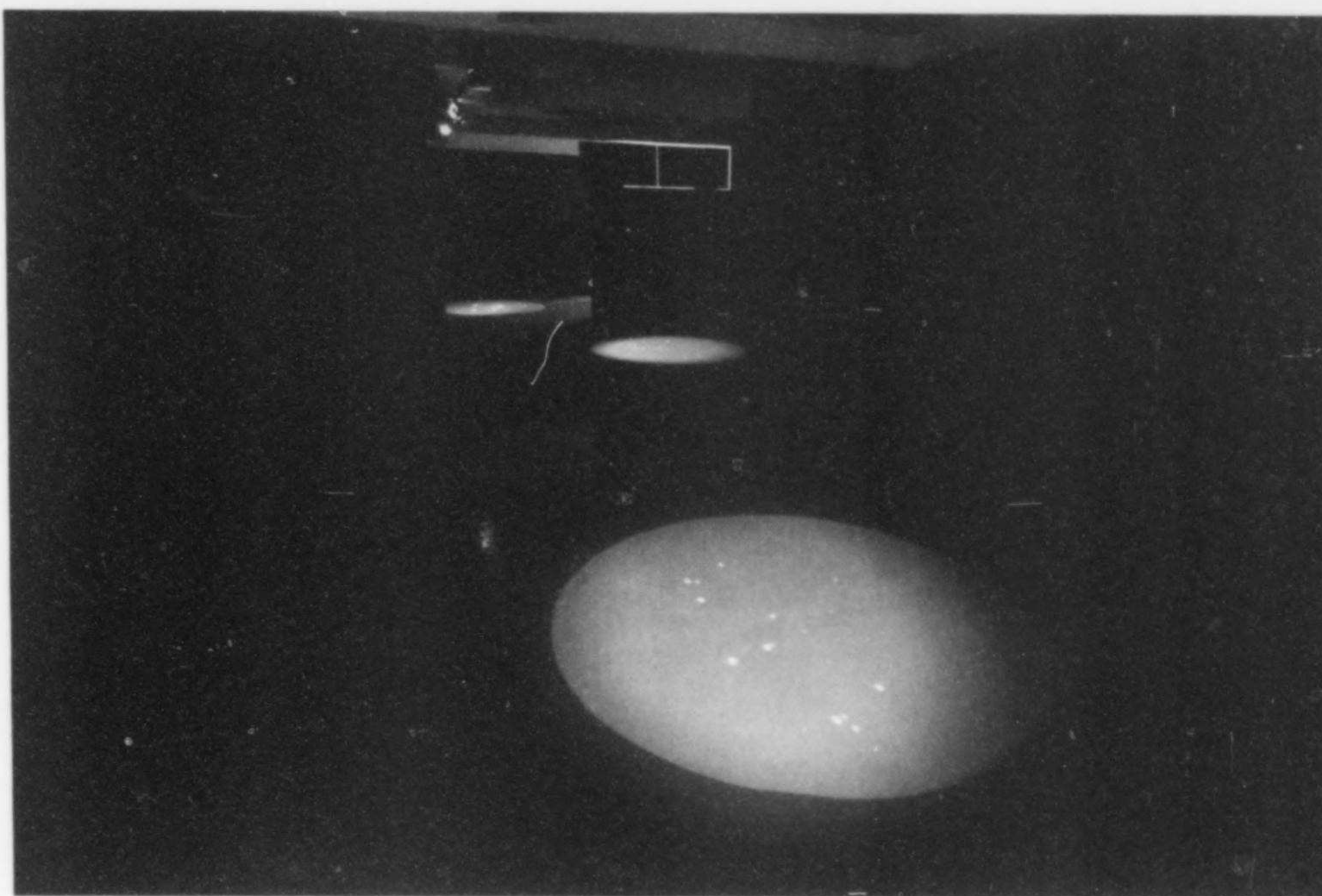


Fig. 4. *Astro Black Morphologies*, detail of installation at the John Hansard Gallery, Southampton, U.K., 5 April–14 May 2005. (© Flow Motion/Adrian Ward, 2005. Photo: Steve Shrimpton, courtesy of John Hansard Gallery) Generative design-based visualizations of X-ray data from Cygnus X1.

of flicker noise in systems as seemingly unrelated as the fluctuations of the stock exchange and the annual records of flood levels of the river Nile.

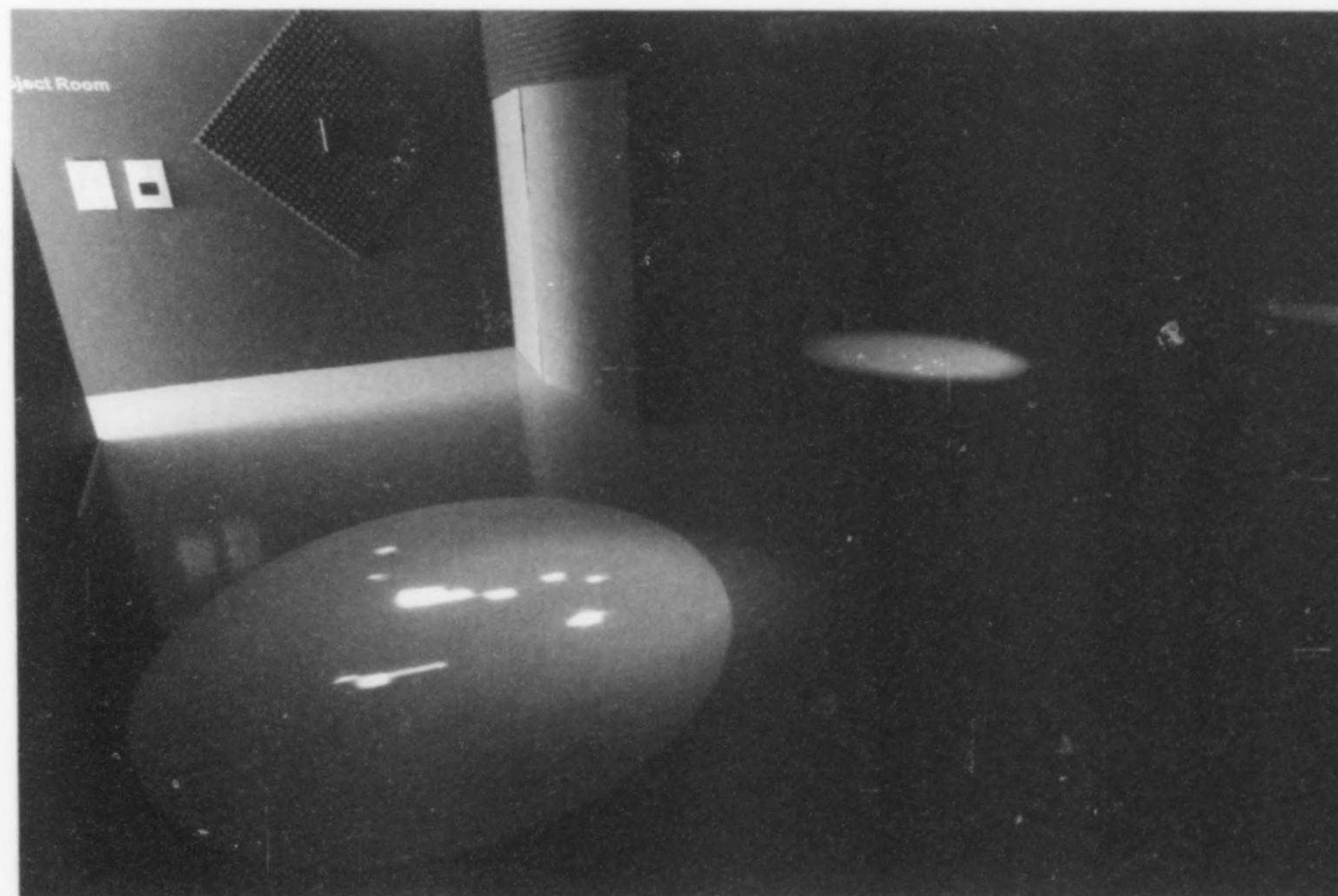
It could start almost anywhere, along the Nile or on a radio, as when Mandelbrot's colleagues Richard Voss and John Clarke, channel-surfing A.M. radio in 1975, listening for 12 hours to "musical selections, as well as announcements and commercials," found evidence of flicker-noise patterns and discovered that flicker noise is the wave form most suggestive of

music's laws of structure, memory and variation over time.

Flicker-noise patterns, Voss and Clarke found, were less chaotic-sounding than white noise and less regimented than brown noise. Situated between the two but unlike either one, flicker noise shares music's founding pleasure principle of balance of order, predictability and surprise.

Voss and Clarke obtained their findings by passing recordings by Bach, Scott Joplin, Milton Babbitt, Eliot Carter, Stockhausen and Betsy Jolas through a band-

Fig. 5. *Astro Black Morphologies*, detail of installation at the John Hansard Gallery, Southampton, U.K., 5 April–14 May 2005. (© Flow Motion/Adrian Ward, 2005. Photo: Steve Shrimpton, courtesy of John Hansard Gallery) Generative design-based visualizations of X-ray data from Cygnus X1.



pass filter, squaring the voltages and then "passing the signal through a low pass filter with a cut off frequency of 20 hertz. The resultant low frequency voltage fluctuations were then subjected to an auto-correlation function to determine the relationship of these fluctuations over time" [9].

The story of modern music could be told as a moment in a history of transformations of matter, identity and form, using the technologies of myth, science and sound, a story of morphology and process, in which physicists, as well as radio engineers and musicians, are scientists of sound.

### SOUND ART, SOUND TRANSFORMATION: ASTRO BLACK MORPHOLOGIES

The story of modern music could also be called the Poetics of Space. It could be a story about time and process, about improvisation, the suspension of closure and what they might tell us about our world and the cosmos. This story may have something to do with the discovery in 1976 by Charles Thomas Bolton and a team of scientists of Cygnus X1, a (possible) black hole, in our galaxy, light-years away from Earth.

Cygnus X1 has become the source of a new opening for dialogue between electronic music and astronomy. In 2002 scientists Ian McHardy and Phil Uttley at Southampton University announced that data readings of X-ray detritus from

Cygnus X1 were implicitly musical in structure.

The patterns of variations they observed in the X-ray output of Cygnus X1, detected by NASA's Rossi X-Ray Timing Explorer Satellite, had a direct correspondence with those of super-massive black holes in distant galaxies. Uttley compared this electromagnetic output to improvised music, with short and long time variations analogous to musical notes and bars with transitions from one pattern of variation to another similar to changes in musical style.

Music, mnemonic patterns, correlation in pattern variation, flicker noise: different variants of the same theme, the same ubiquitous phenomena.

This musicalizing of scientific process and the musical nature of its source raised a few questions for us: What could this music sound like? What openings could it suggest for sound art? How could we re-sound this newly discovered music of the cosmos?

We met with Uttley in February 2003, and he gave us some of his research data: thousands of digits representing the "light curve" for Cygnus X1, obtained by recording the X-ray flux in time steps of  $\frac{1}{10}$  of a second: a method of observation with a musical parallel in granular synthesis and its process of subtraction, discontinuation and reconfiguration of sonic matter.

When taken to extremes, granular synthesis creates an expanded sonic picture populated by signal traces and empty spaces, a process of negation not unlike

dub music's process-based technologies and techniques for subtracting, reshaping and re-sounding sound sources.

We collaborated with astrophysicist Tim O'Brien at Jodrell Bank Observatory and converted the data from text into audible phenomena expressed as both intensities and frequency variations. We then used granular synthesis and dub's trace-producing processes as morphological tools for the production of a series of possible re-soundings of Cygnus X1's distant, ancient music. This process provided the basis for our installation and sound art performance, *Astro Black Morphologies/Astro Dub Morphologies* (Figs 1-6, Color Plate A). (The installation and performance has been staged at the John Hansard Gallery, Southampton, U.K., and the Science Museum's Dana Centre, London.)

Granular synthesis suggests that the space around an object is no less rewarding than the object. Dub suggests that the object, a space as much as the space around it, is no more than a trace in the making. The story of modern music could be the story of the engineering of absence into form.

### A UNIVERSAL VIBRATION

If I were not a physicist, I would probably be a musician. I often think in music. I live my daydreams in music. I see my life in terms of music... I get most joy in life out of music.

—Albert Einstein, 1929 [10]

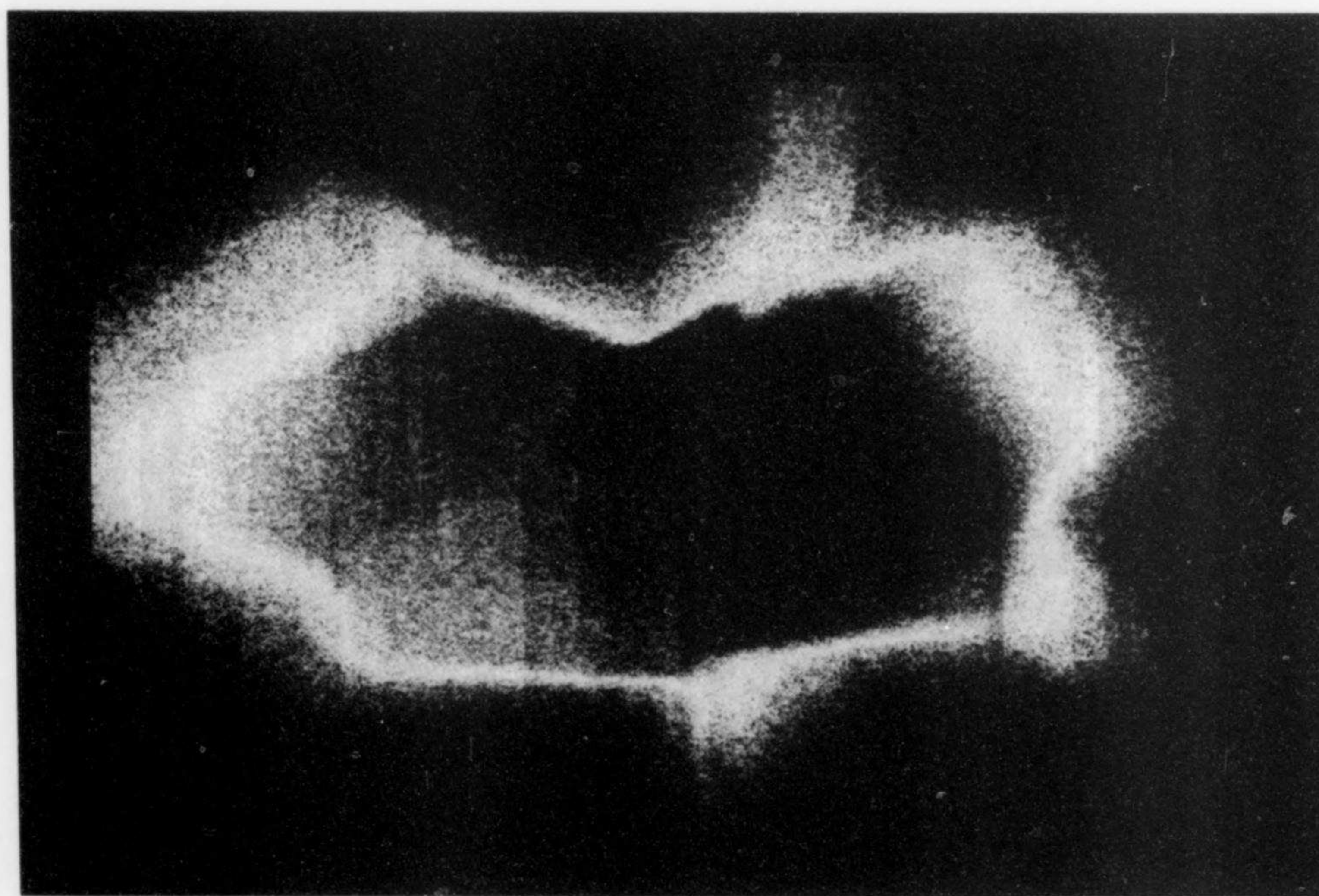
The story of science in music could be that of a universal vibration in the form of a mystery. Thinking about the presence of flicker noise in X-ray output of Cygnus X1, we wondered whether music was ubiquitous in nature.

Not exactly. Uttley explained that "music is a part, an aspect of nature, a process, and flickering type variability is common in nature; because music is an aspect of nature, you see flickering in music as well" [11].

Perhaps the reason, or at least part of the reason, we are drawn to music can be explained by the discovery by Boston University physicist H. Eugene Stanley's research group. In 1992 it showed that flicker noise is also discernible in human DNA: something of the cosmos and its music, inscribed in the body at the cellular level.

The problem is that scientists have not developed a reliable model to account for the wide-ranging presence of flicker noise, from black holes to DNA, from the

Fig. 6. *Astro Black Morphologies*, screenshot of generative design-based visualizations of X-ray data from Cygnus X1. (© Flow Motion/Adrian Ward, 2005)



music of Stockhausen to the body of Sun Ra. The reason for the ubiquity of flicker noise remains a mystery. As Stanley put it to *Scientific American*, "There is some magical phenomenon going that we just do not understand" [12].

To compound the mystery, flicker noise has also been found in recent studies of human behavior. Psychologists Eric-Jan Wagenmakers, Simon Farrell and Roger Ratcliff at the University of Amsterdam have discovered that "recent analyses of serial correlations in cognitive tasks have provided preliminary evidence for the presence of long range serial dependence known as flicker noise" [13]. They also tell us that to this date, no general explanation for the universality of flicker noise has been widely accepted.

Nonetheless, it seems safe to say that music presents in its sound an intimate part of ourselves, which we also find in the cosmos, to which we are in turn connected by music. Flicker noise seems to be a universal vibration that connects mu-

sic, science, the body and the cosmos in an ever-expanding loop extending from the here and now to thousands of light-years into the past and whose feedback produces endless proliferations of music and relations of musicality between musicians, artists and scientists, and new, cosmic openings for sound-art practice.

#### References

1. Quoted in J.C. Thomas, *Chasin' the Trane* (New York: Da Capo Press, 1975) p. 188.
2. The Original Five Blind Boys of Alabama, "I'll Fly Away," *The Sermon, Fantasy/Specialty* SPCD-7041-2 (1993).
3. Lee "Scratch" Perry & the Dub Syndicate, "Blinkers," from *Time Boom X De Devil Dead*, EMI 5300262 (2001).
4. Karlheinz Stockhausen, *Mantra*, Wergo, WER62672 (1995).
5. Thomas [1] p. 188.
6. Robert D. Rusch, *Jazztalk* (Secaucus, NJ: Lyle Stuart Inc., 1984), quoted in David A. Martinelli, "The Cosmic-Myth Equations of Sun Ra" (1991) <[www.ethnomusic.ucla.edu/staff/martinelli/Sun%20Ra.htm](http://www.ethnomusic.ucla.edu/staff/martinelli/Sun%20Ra.htm)>.
7. Sun Ra, "Astro Black," *Astro Black*, Impulse AS-9255 (1973).
8. Benoit Mandelbrot, interview with Jeffrey Goldsmith, *Wired* 2, No. 8 (August 1994) p. 93.
9. R.F. Voss and J. Clarke, "1/f Noise in Music and Speech," *Nature* 258 (November 1975) pp. 317-318.
10. "What Life Means to Einstein: An Interview by George Sylvester Viereck," *The Saturday Evening Post* (26 October 1929).
11. Phil Uttley, interview with Flow Motion, 2003.
12. Philip Yam, "Noisy Nucleotides," *Scientific American* 267, No. 3, 23-27 (September 1992).
13. E.J. Wagenmakers, S. Farrell and R. Ratcliff, "Estimation and Interpretation of 1/f Noise in Human Cognition," *Northwestern University, Amsterdam, Psychonomic Bulletin & Review* 11 (2004) pp. 579-615.

*Flow Motion* are London-based artists Anna Piva and Eddie George. Their work has been exhibited and performed at the Barcelona Museum of Contemporary Art; the Pompidou Centre, Paris; the International Institute of Visual Art; the Steirischer Herbst Arts Festival in Austria; the Yuri Gagarin Cosmonaut's Club, Moscow; Sadlers Wells's Lilian Baylis Theatre; the John Hansard Gallery, Southampton; and the Science Museum Dana Centre, London.

CALL FOR PAPERS

***Leonardo Celebrates Leonardo da Vinci***  
**Special Section of *Leonardo*, 2007–2008**

In celebration of *Leonardo* journal's 40th anniversary, we are calling for essays related to Leonardo da Vinci and his concerns regarding the relationship between art and science. We are interested in submissions in which Leonardo's own concerns serve as a springboard for looking toward the present. What, building upon Leonardo's ways of thinking, can artists and scientists tell each other today? We also seek original accounts of his visual art, of his achievements as a proto-scientist and of the relation between his concerns with science and with visual art.

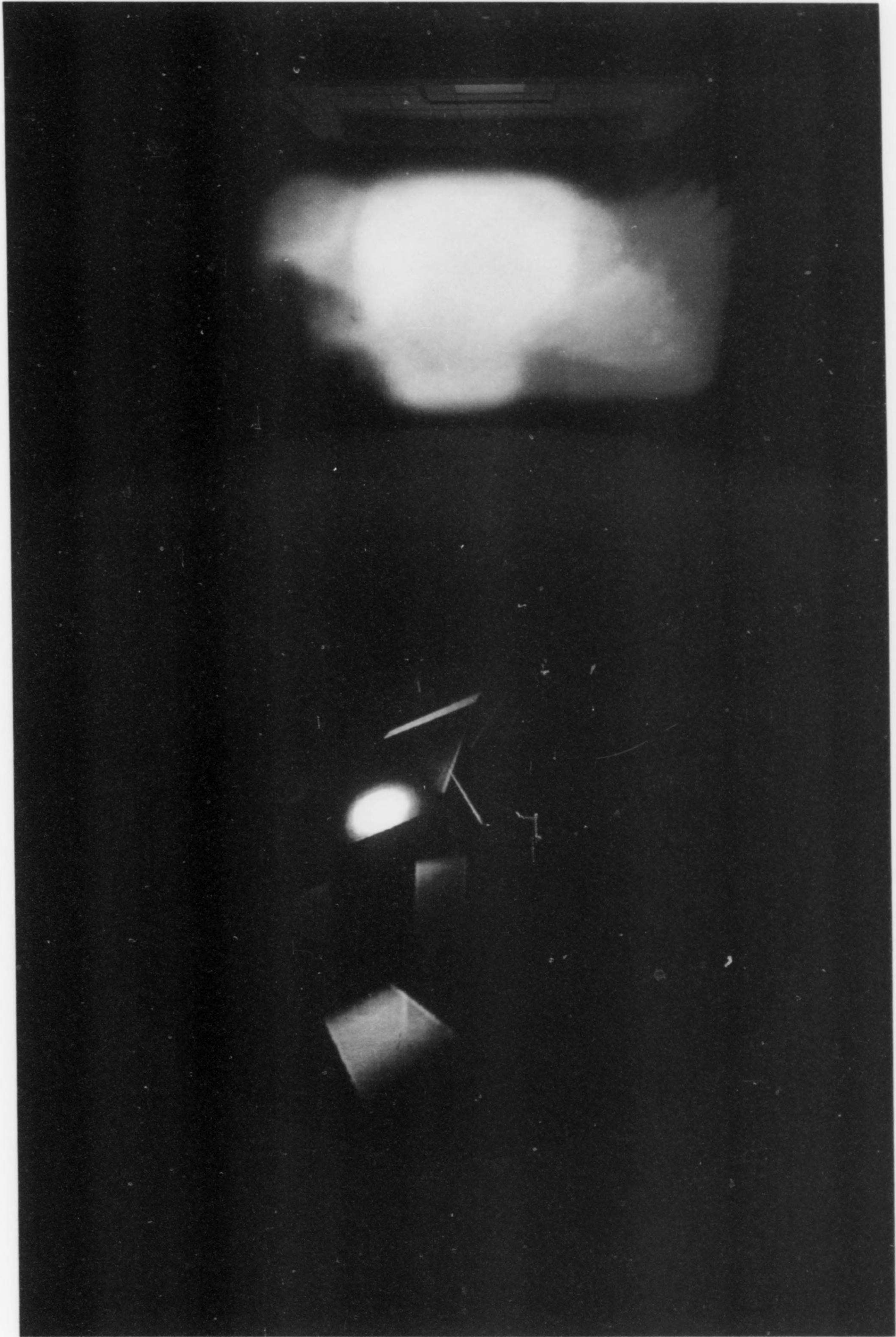
Recommended length: 2,500–3,500 words

Illustrations per essay: 5–8 black-and-white images; possibly one color image.

Prospective authors are encouraged to review the Leonardo Author Guidelines on the Web: [www.leonardo.info](http://www.leonardo.info). (Follow the links: Publications—Information for Authors—Leonardo Print Journals—Editorial and Illustration Guidelines.)

All papers will be peer-reviewed prior to acceptance for publication.

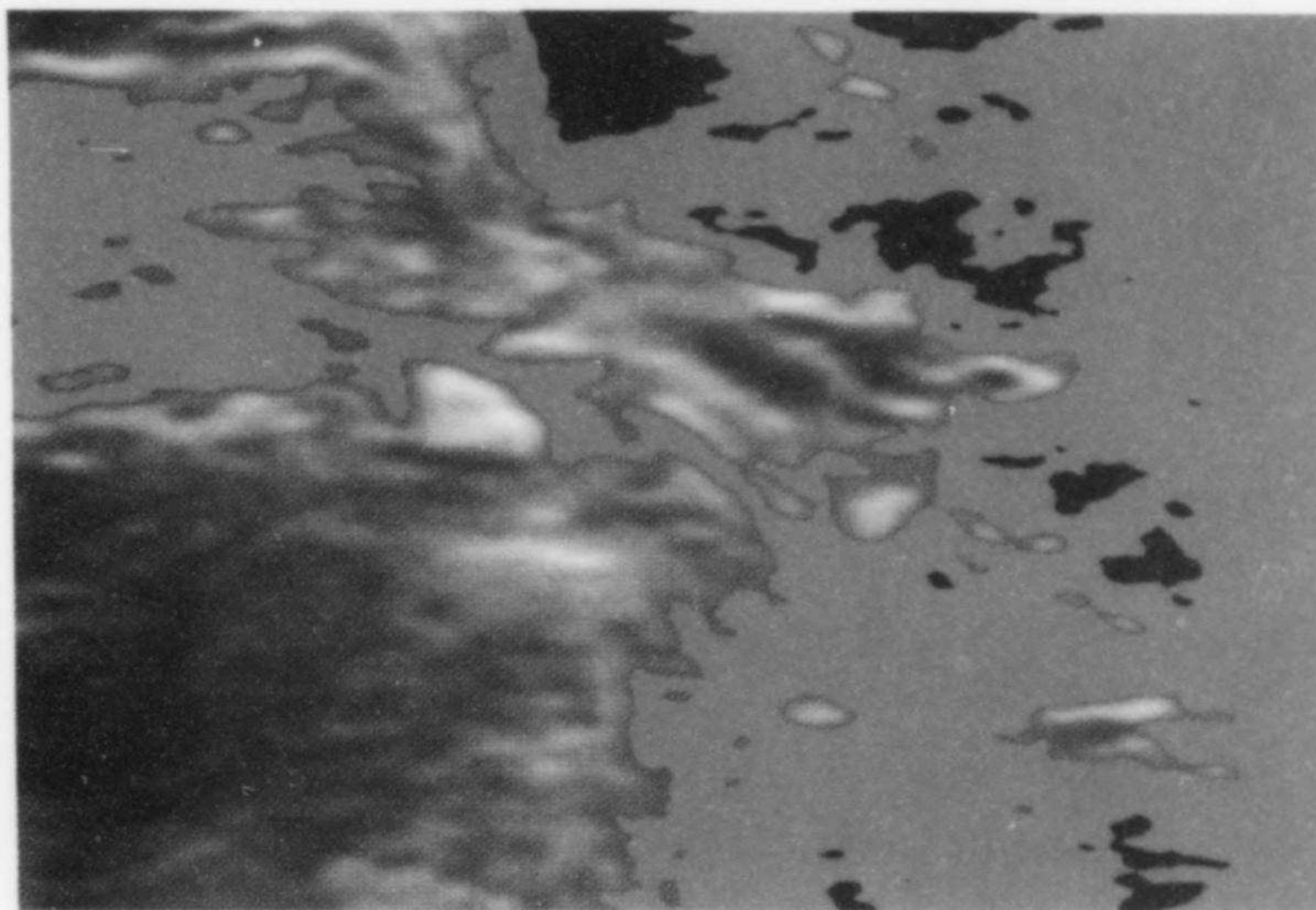
Please send inquiries and submissions to Guest Editor David Carrier, Department of Art History and Art, Case Western Reserve University, Cleveland, Ohio 44106, U.S.A. E-mail: <[dx89@po.cwru.edu](mailto:dx89@po.cwru.edu)>.



Flow Motion/Adrian Ward, *Astro Black Morphologies*, detail of installation at the John Hansard Gallery, Southampton, U.K., 5 April–14 May 2005. (© Flow Motion/Signwave, 2005. Photo: Steve Shrimpton, courtesy of John Hansard Gallery) Generative design-based visualizations of X-ray data from Cygnus X1.



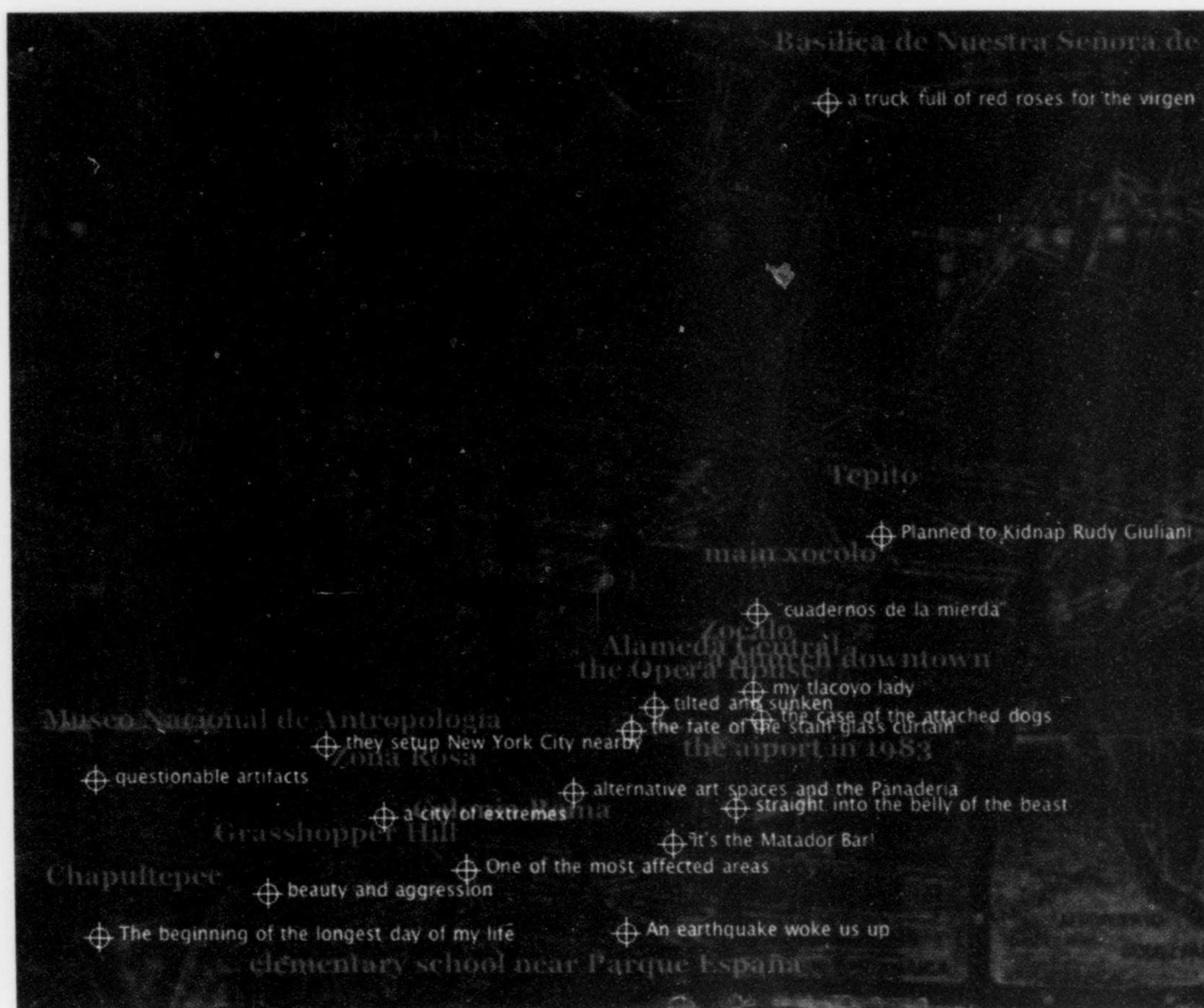
Haus-Rucker-Co, *Connexion Skin*, 1967–1968. (© Haus-Rucker-Co) An example of 1960s neo-avant garde architecture that surpassed the limits of physical construction and became a medium for conceptions of the exploration of space. (See article by Michael Punt, Martha Blassnigg and David Surman.)



No. 1. Claudia Reiche and Helene von Oldenburg, *The High Reality Machine or HRM\_1.0n*, appearance: camouflage. (© Claudia Reiche and Helene von Oldenburg) HRM\_1.0n installs sculptures, Internet relay chats, kinetic objects, art-and-media theories, science-fiction literature, telepresence systems, videos, sound installations, manifestos, web art, etc. on the Mars Exhibition Site via teleportation.

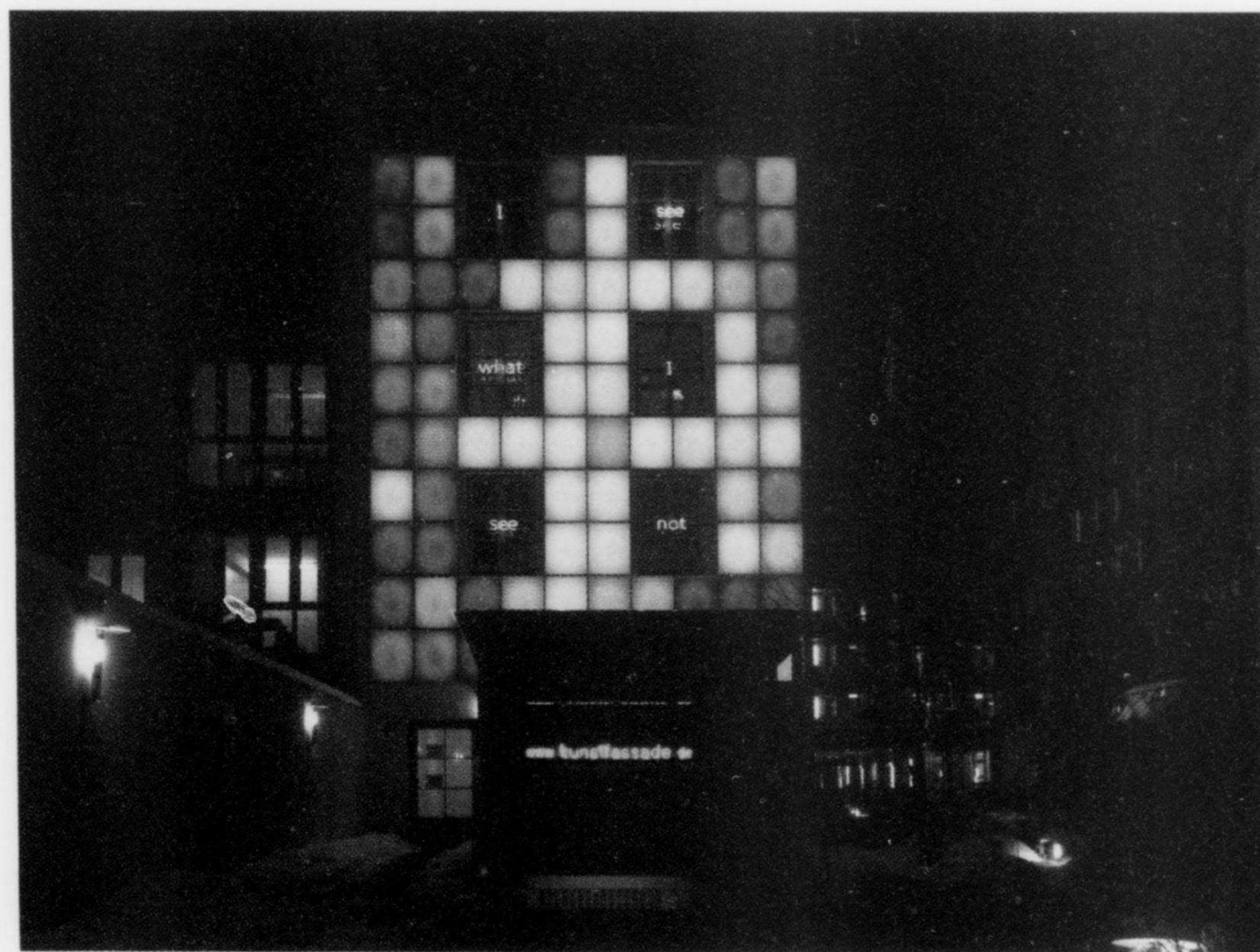
No. 2. Fatima Lasay, *Mga Awit mula sa Gimokud/Chansons de mes deux âmes*, 2004. (© Fatima Lasay) One of two structures made of grape branches, representing the left-hand *gimokud* or soul, emitting synthesized sound.





No. 1. Kathleen Quillian and Gilbert Guerrero, *The International Transient Cartographic Project* (on-line map detail), 2003–2004. (© Gilbert Guerrero and Kathleen Quillian). While in Mexico City, the artists used information from an interactive, on-line map, which consisted of the experiences of friends, family and acquaintances who had previously traveled or lived in Mexico City, as a point of reference to help guide them through the city.

No. 2. Tim Otto Roth, *I See What I See Not*, cosmic particle shower live at the art façade in Munich, 76 RGB neon light elements controllable via Internet, 9 × 6 m, 700 square feet, 23 February 2005. (© Tim Otto Roth) The KASCADE experiment, with its cosmic particle events from the hadron-kalorimetre detector at the Forschungszentrum Karlsruhe, Germany, was one of the cooperating projects from astro- and particle physics providing near real-time images for *I See What I See Not* during winter 2004–2005.

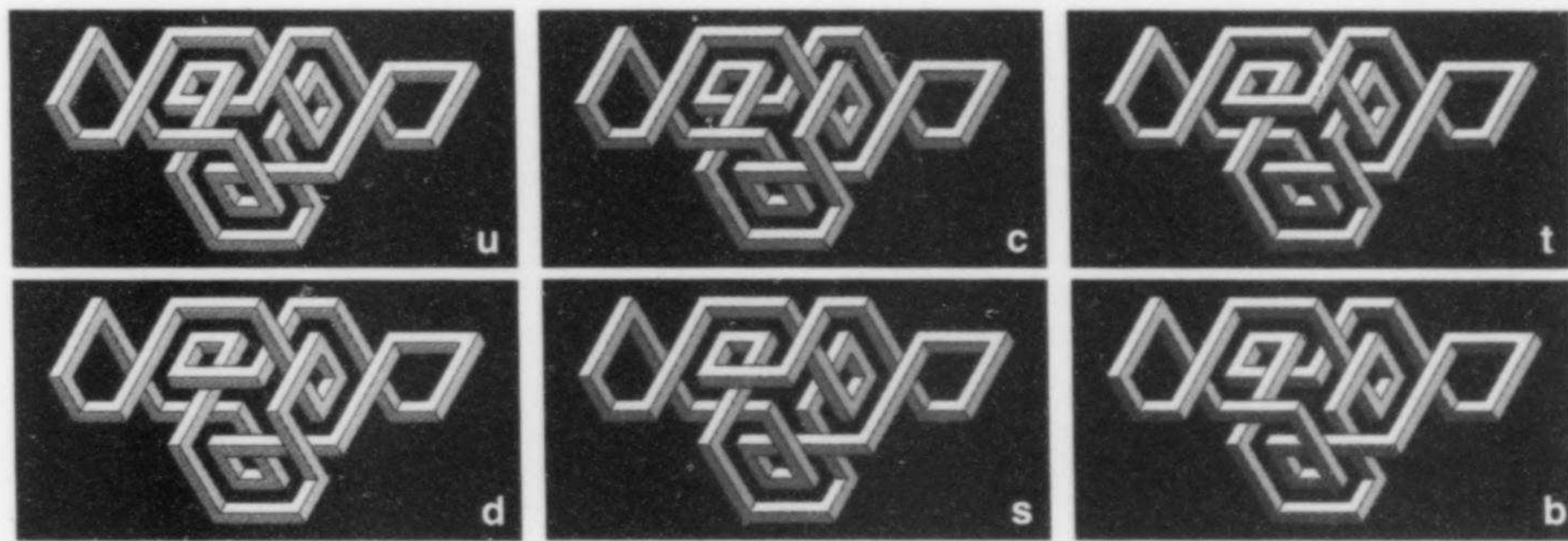




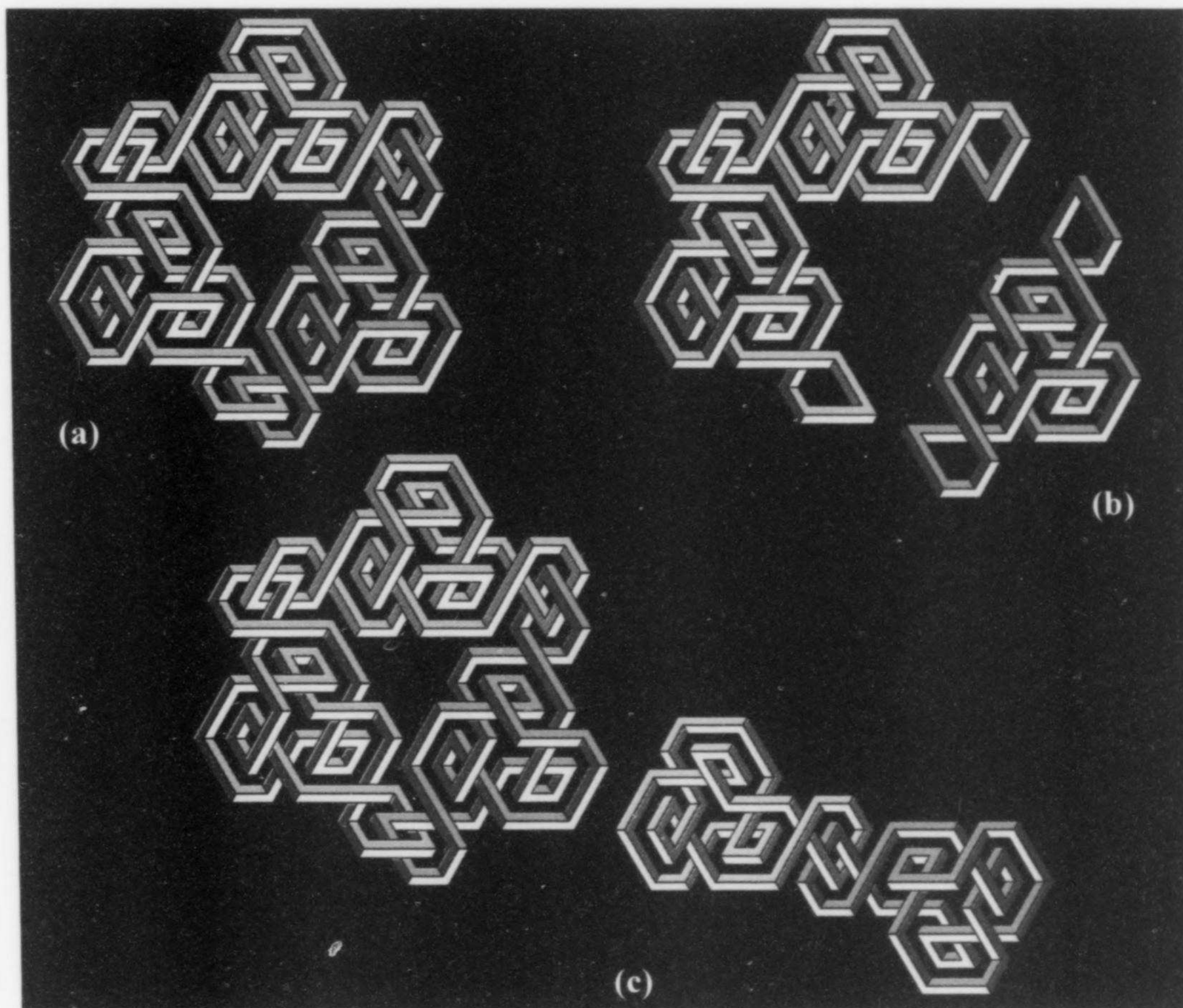
Philip Van Loocke, top contour of initial tree, bent tree with enveloping flower and bent tree with flower canopy. (© Philip Van Loocke) The latter were generated in accordance with the bit-pattern at the bottom.



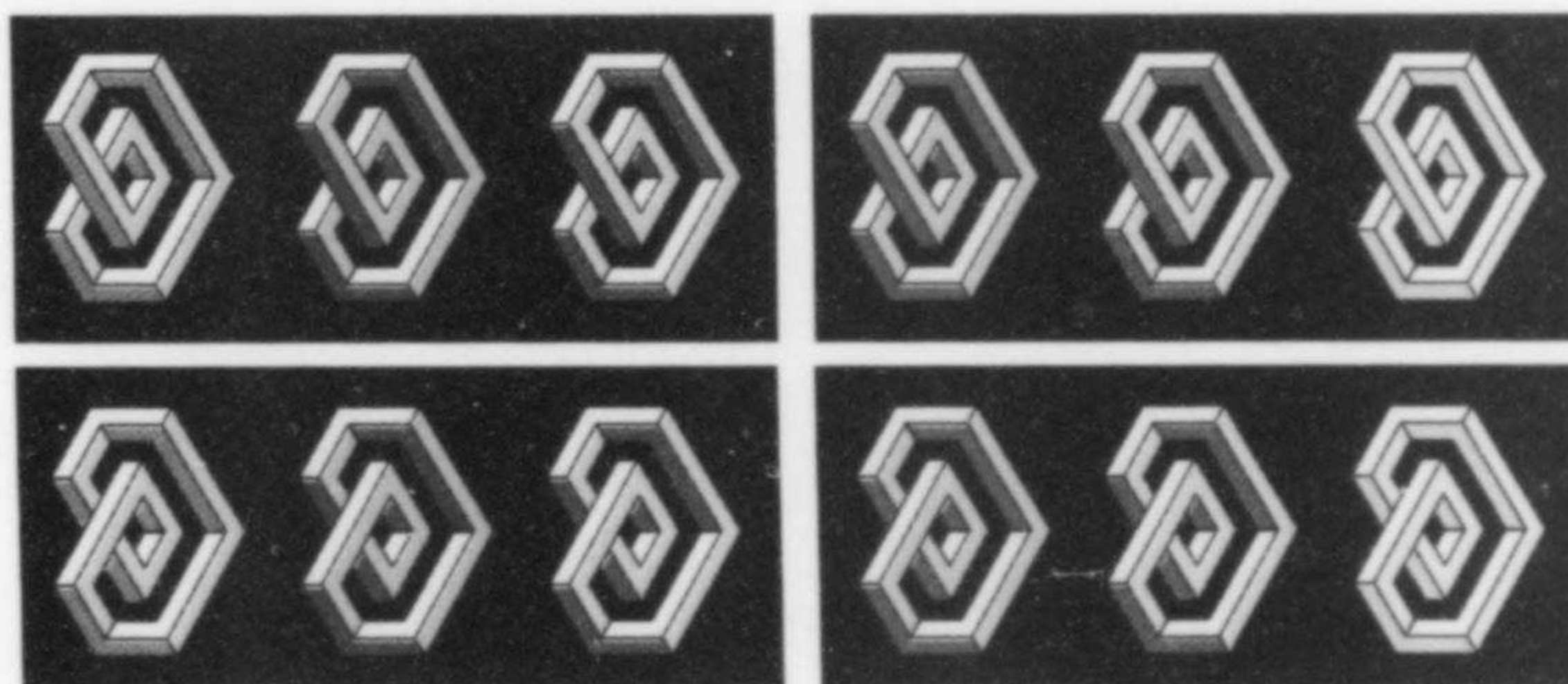
Reynald Drouhin, *Spiderman/Red*, 2005. (© Reynald Drouhin) Mosaic-image generated by *Des\_Frags*, an on-line artwork. *Des\_Frags* was created by the artist in collaboration with a computer programmer. (See article by Jean-Paul Fourmentraux.)



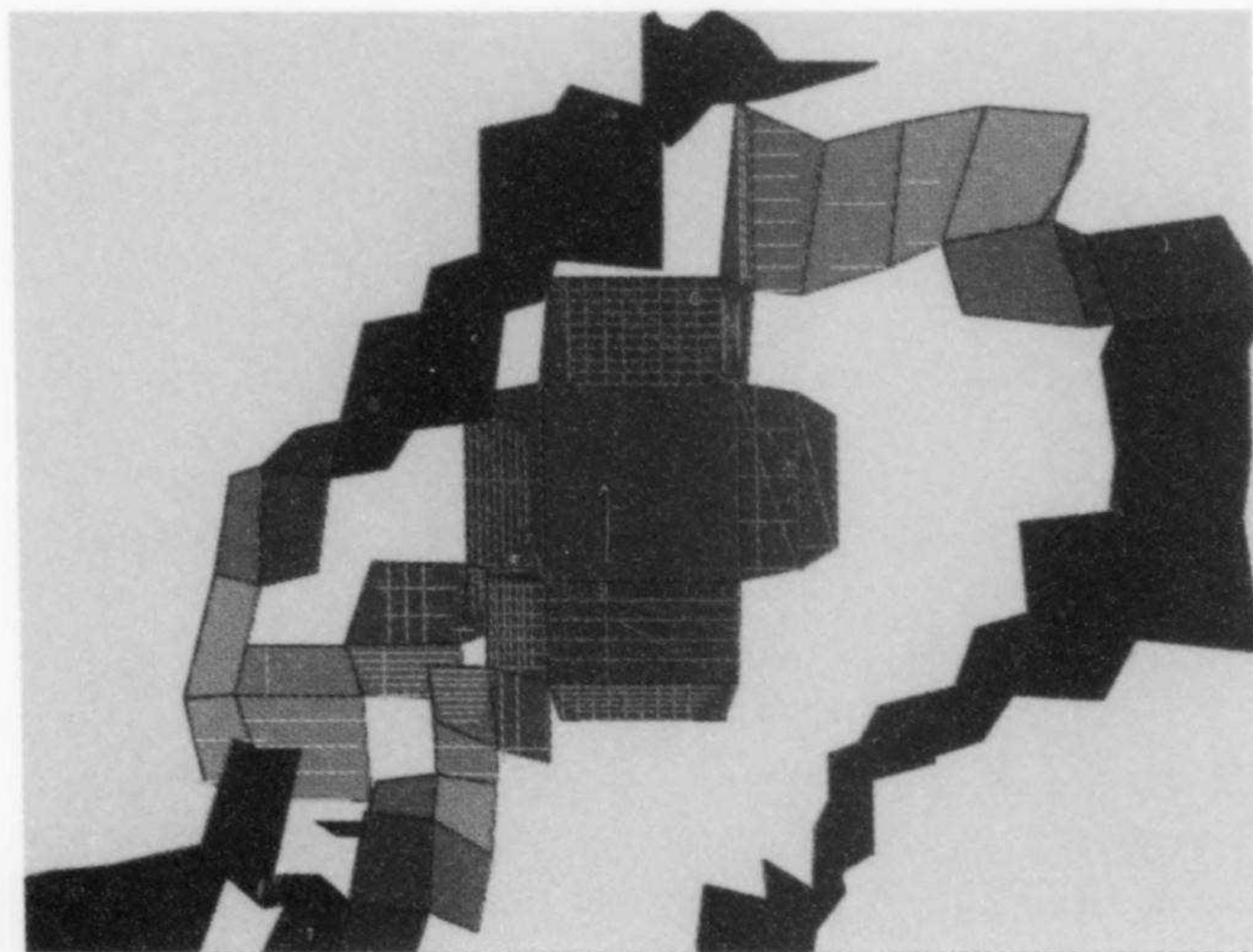
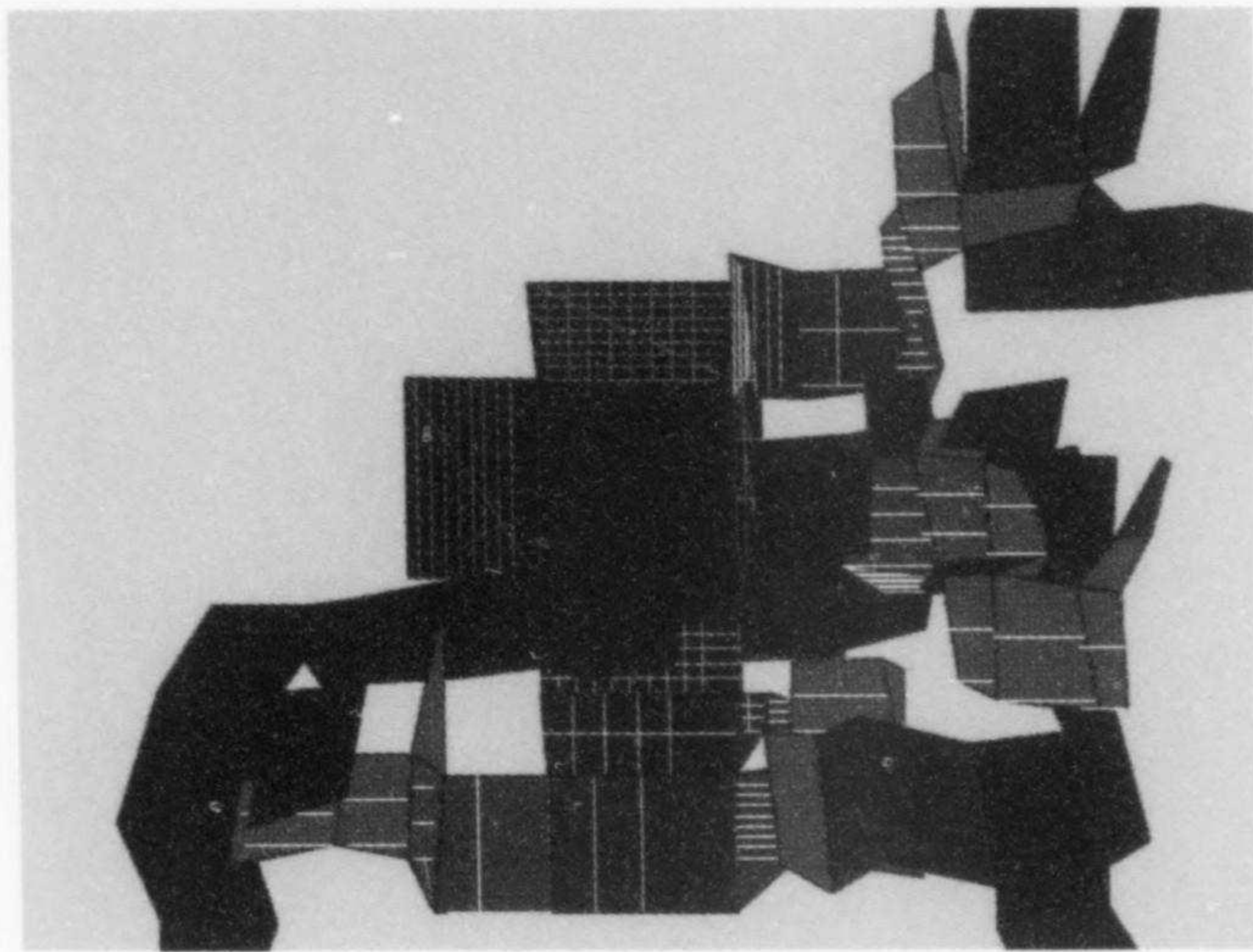
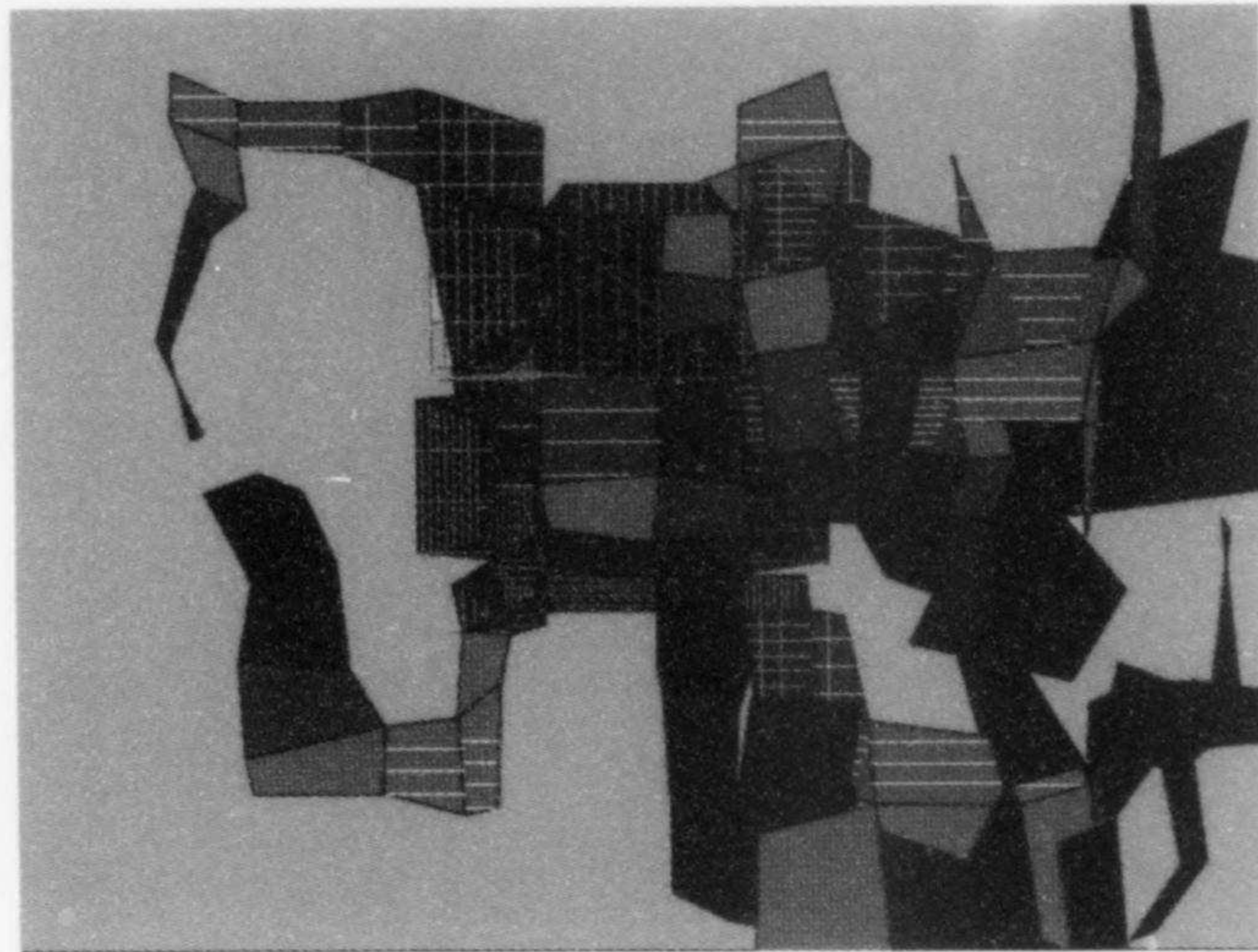
No. 1. Tamás F. Farkas, bound quarks. Upper row: The 3 possible pairs of clips attached to the *LRL* quarks. Lower row: The 3 possible pairs of clips attached to the *RLR* quarks. (© Tamás F. Farkas) (See Table 1, in György Darvas and Tamás F. Farkas, "An Artist's Works through the Eyes of a Physicist," pp. 51-57.)



No. 2. Tamás F. Farkas, the transformation of a proton into a neutron. (© Tamás F. Farkas) A *u* quark is detached from the proton (a-b) and there appears a *d* quark-antiquark pair. The *u* quark-*d* antiquark pair forms a  $\pi^+$  meson, while the *d* quark together with the rest of the former proton forms a neutron (c).



No. 3. Tamás F. Farkas, rishons. Upper left: The *L* (masculine) rishons in all 3 colors. Upper right: The *L* (masculine) anti-rishons in all 3 colors. (© Tamás F. Farkas) Lower left: The *R* (feminine) rishons in all 3 colors. Lower right: The *R* (feminine) anti-rishons in all 3 colors. (© Tamás F. Farkas)



John F. Simon Jr., 3 frames, *Unfolding Object*, 2002.  
(© John F. Simon Jr.) The infinite iterations of the book that are enfolded in *Unfolding Object's* software must be unfolded socially, by the people who engage with the work on-line. (See article by Laura U. Marks.)

# Infinity and Accident: Strategies of Enfoldment in Islamic Art and Computer Art

Laura U. Marks

An aniconic turn is stirring the contemporary visual and media arts. Less and less is present to perception; more and more is latent, in quiet surfaces that seem to be "hiding something in the image" [1]. The latent image waits to be "unfolded," either subjectively, by the viewer, or by the force of its interior logic. Figural images are increasingly being subordinated to information, performativity, communication and other relatively nonvisual contents. This contemporary aniconic tendency, which is a general movement in the arts of information societies, occurs particularly with computer-based art. One of the origins of this aniconic tendency in contemporary art is the influence of Islamic art and thought on Western modernism.

Fascinating subject though it is, the Islamic genealogy of Western modernism is not my focus in the present essay. It does, however, inform my claim here that the parallels between tendencies in contemporary computer art and tendencies in classical Islamic art are not happenstance but the manifestation of historical connections. In turn, this Islamic genealogy of Western modernism should make it possible to examine contemporary computer-based art in light of the impressive variety of philosophical questions and aesthetic solutions found in the varied works of Islamic art of past centuries. Without suggesting that Islamic art is a monolith, I want to apply historical findings on Islamic art to questions about contemporary visual and media arts [2]. I intend to reveal a genealogical connection that has lain more or less latent since the wave of transmission of Islamic knowledge to Europe in the 12th century.

Invention, refinement and lively debate characterize the intellectual golden age of Islam, which may be dated from the establishment of the Abbasid caliphate in what is now Iraq (for convenience, I will continue to refer to the region as Iraq in this paper) in 750 to the Mongol invasion in 1258. In the new capital of Baghdad, the caliph Al Ma'mun (reign 813–833) founded the *Beit al-hikmeh* (House of Wisdom), a massive library and center for translation and scholarship. Especially in the first two centuries of this period, philosophers and theologians intensely argued such issues as the nature of matter, the relationship between cause and effect, and the comprehensibility of the will of God. Their arguments, while ultimately subject to the political interests of the states they served, are literally set in stone in the great Islamic monuments of their time and later eras—works that raise questions about image and latency.

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## ABSTRACT

Computer art and Islamic art, the two largest bodies of aniconic art, share a surprising number of formal properties, two of which are explored here. The common properties of computer art and classical Islamic art can be understood in light of moments in the history of Islamic philosophy. In these two cases, Islamic Neoplatonism and Mu'tazili atomism are shown to parallel, respectively, the logic of relations between one and infinity, and the basic pixel structure, that inform some historical monuments of Islamic art as well as some contemporary works of computer art. It is suggested that these parallels are in part a result of Islamic influences on Western modernism and thus that the genealogy of computer art includes classical Islamic art and the philosophies that informed it.

Contemporary aniconic art is built not around the image, nor even the rejection of the image (it is not iconoclastic), but around an implicit set of information (for example, the database and the algorithm). The image is a selective unfolding of implicit information, and information is in turn a selective unfolding of implicit experience [3]. By the latter I mean that all information is a selective actualization of historical events—statistics reflect a selective arrangement of material experience; software reflects the la-

Fig. 1. Mihrab, Mosque of Sultan Hassan, Cairo.  
(Photo © Alfred Molon)



bor of programmers; the evening news on television is a selective presentation of certain events; even poetry is the actualization in words of a swath of material and psychic experience, the rest of which remains virtual. It may be added that what is unfolded into information or image can be considered actual, while what remains enfolded remains virtual [4]. Enfoldment-unfoldment implies that the relation between two elements, such as soul and matter, particle and wave, image and information, or information and experience, is one not of dichotomy but of implicit relation [5].

In computer art, the image is the mere skin of an artwork whose underlying structure and *raison d'être* lie elsewhere: in its algorithm and database. Similarly in Islamic aesthetics, generally speaking, the visual image is an expression of a divine "logic" that may or may not be made perceptible. Both are characterized by their variety of strategies for unfolding the perceptible image from the imperceptible elements that drive it [6].

Several formal and structural properties common to both classical Islamic art and computer art can be identified. Fundamental to them all is:

1. A logic of enfoldment and unfoldment. From it follow, though not always obviously,
2. Aniconism: a tendency against privileging the representational image.
3. Latency: a tendency for the work's underlying structure to remain invisible or latent, perhaps to be manifested over time or to be teased out by the attention of observers.
4. Algorithmic structure: a structure based on a series of instructions that manipulate information to produce actions or images.
5. An emphasis on performativity rather than representation: the work of art plays out in time, unfolding image from information and information from experience,

in the carrying out of algorithms and/or the attentive recognition of observers.

6. An ease of translation among media. Because the perceptible image is animated by underlying information, the image may show up in a variety of media (e.g. in Islamic art: stone, wood or paper; in computer art: 2D images, sound or commands to motors).
7. An emphasis, in seeming contrast to the logic of enfoldment and unfoldment, on the discreteness and discontinuity of information: Works that emphasize their own image or other manifest qualities may disavow awareness of the information source of these qualities.

Not all these properties can coexist. Nor are all the beliefs that underlie them compatible.

### MULTIPLICITY ENFOLDED IN UNITY

A basic premise of Islam, shared by all believers, is *Tawhid*, or the absolute unity of God. The world's multiplicity exists only as a function of the One. This basic doctrine is stated in the Qur'an and was initially developed by Islamic philosophers in a synthesis with Greek, Syriac and Byzantine thought.

How can art indicate this relationship between the unknowable Infinite and the multiplicity of the palpable world? I believe it can be demonstrated that each of the various theological tendencies in Islam holds a different position on the form of mediation between the unified and unknowable God and God's perceptible creation; and that to each of these positions in turn corresponds a different practice of Islamic art, which is in turn historically variable. For example, a belief that one may rationally inquire into the nature of God may be reflected in artworks that emphasize the way image un-

folds from information, such as the floriated Kufic writing of the Sh'ite Fatimids of 12th-century Egypt [7]. On the other hand, a belief that the relationship between the worldly and the Divine cannot be understood rationally but can be apprehended mystically may give rise to fantastical figurative painting, as in the courts of 16th-century Persia, with their Sufi-inflected Sunni orthodoxy [8].

In the intellectual hotbed of the Abbasid caliphate in 8th- to 10th-century Iraq, several radically different philosophies clashed and interwove, with implications for the entire subsequent history of Islam. These include, among others, the Greek-influenced Neoplatonism of the *falasifa* and the atomism sharply debated between the Mu'tazili rationalists and the Ash'ari dogmatists (known as such after the Mu'tazili reformer Abu'l Hassan al-Ash'ari, d. 935) [9]. All these tendencies variously struggled and thrived in the intellectual climate of translation, synthesis and Islamization of received knowledge that was vigorously cultivated by the Abbasid caliphs. These arguments had direct implications for politics and were inherited, institutionalized and transformed by later thinkers and the political powers behind them.

Islamic art does not exhibit a unified discourse; its styles reflect historical changes, both gradual and abrupt, in politics, theology and technology. Therefore, the examples I use cannot be taken as emblematic of all Islamic art, nor of direct correspondences between belief and material form. Some Islamic monuments clearly index the theological and philosophical leanings to which their patrons or society adhered. For example, the Almohads of 12th-century North Africa, whose name derived from *al-muwahhidun*, "confessors of the unity of God," viewed the suggestion that God has attributes as blasphemous. This theological view was reflected in their austere and (rare in Islamic history) iconoclastic art and architecture. Almohad art tends to prune away all attributes in order to approach the (unattainable) Divine Essence. Ibn Tūmart (reign 1080–1130), the Almohads' ascetic and bellicose leader, adopted a severe version of Ash'ari theology, led military campaigns in Spain and North Africa and cracked down on all forms of sensual pleasure. The Almohads destroyed the ornaments with which their predecessors had decorated their mosques and whitewashed their polychrome decoration. The Great Mosque in Ibn Tūmart's birthplace of Tinmal, Morocco (1035), is a fortress-like structure whose only ornament, other than the *mihrab*

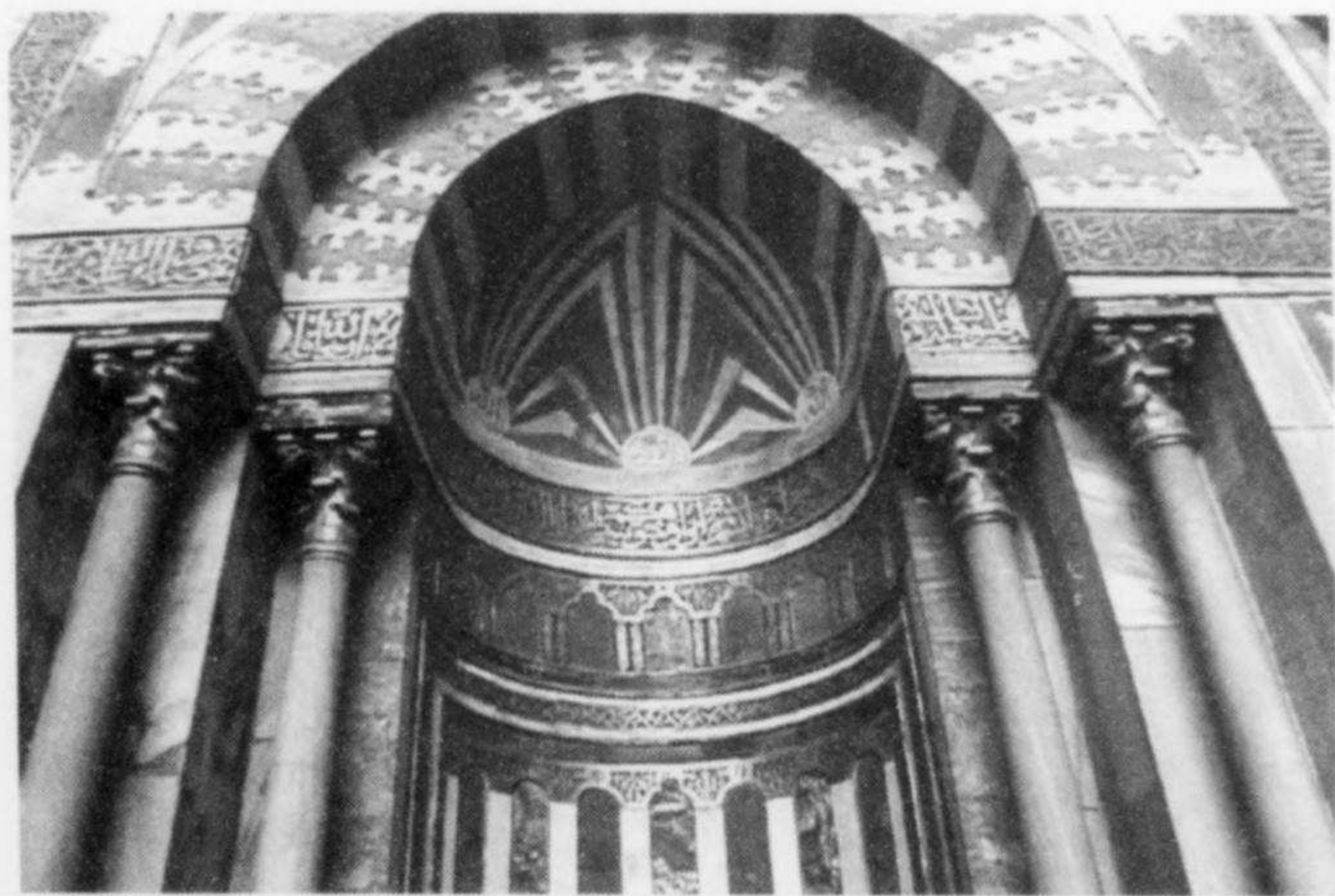


Fig. 2. External mihrab, Mosque of Sultan Hassan, Cairo. (Photo © Samirah Alkassim)

(the prayer niche on the *qibla* wall, the wall facing Mecca) consists in the pointed arches in the outer courtyard and multi-lobed arches in front of the *qibla* wall. The absence of visual or tactile diversions eases the visitor into a contemplative state.

I note that similar radical aniconism characterizes some works of computer art that abjure the graphical interface in favor of a visually ultra-minimal index page. One example is a program produced by the artist-hacker organization 0100101110101101.org, known for introducing a benign computer virus as a work of art at the 49th Venice Biennale in 2001. Their recent project, *life\_sharing*, makes the artists' entire hard drive, from texts to private e-mail, open to any on-line visitor. Using a free Linux-based operating system and a list of directories, but without a single image interface, the visitor enters the guts of 0100's computer. This project attempts to strip away all interfaces in order to confront the user with the infinitely extensive plane of digital memory.

Other examples of Islamic art can be given in which ideology and aesthetics are closely aligned. Yet in most Islamic works of art, historical styles commingle, serving local political purposes yet not necessarily evincing a single unalloyed theological view. Neoplatonism and atomism, though in principle opposed, historically coexisted. Similarly, Islamic art often evinces qualities corresponding simultaneously to both of these, and indeed other, philosophies, as do the two late and well-known monuments of classical Islamic architecture that furnish my central examples. The effect is admittedly somewhat ahistorical. The first is the mihrab of the Sultan Hassan Mosque, from 14th-century Mamluk Cairo; the second, the dome of the Hall of the Two Sisters from the Alhambra in Granada of 14th-century Nasrid Andalusia.

### ISLAMIC NEOPLATONISM: ∞ IS ENFOLDED IN 1

Absolute unity is also a Neoplatonist doctrine, associated especially with Plotinus, who argued that the One generates the universe through emanation of the light of reason. Abu Yusuf Ya'qub al-Kindi (d. 866), Islam's first systematic philosopher, adapted Plotinian thought to monotheism by replacing the principle of emanation with divine creation *ex nihilo*, in which God is outside time but creation is finite [10]. Abu Nasr al-Farabi (d. 950), by contrast, developed an emanationist theory of the structure of being, whereby

God, the First Being, by thinking about Himself, gives rise to a Second Being and First Intellect, which in turn generates a third, until a tenth, Active Intellect mediates between the celestial and earthly realms [11]. A logic whereby the multiplicity of creation unfolds from the infinite unity of God also characterizes the thought of the Ikhwan al-Safa (Brethren of Purity), a Neopythagorean secret society in 10th-century Basra that authored a popular pamphlet. In the mathematical universe of the Brethren of Purity, God is the First Principle of all things just as 1 is the first principle of all numbers. Thus the relationship God:Universe equals the relationship of 1 (indivisible unity) to other numbers (multiplicity).

Most Muslim thinkers did not advocate trying to come face to face with the Divine. Rather they held that beauty is engendered in the sophisticated, dialectical relationship between unity and multiplicity. The Baghdadi literary theorist Abu Bakr 'Abd al-Qahir al-Jurjani (d. 1078) wrote that in all arts and crafts, "the more widely differed the shape and appearance of their parts are and then the more perfect the harmony achieved between these parts is," the more "fascinating" and praiseworthy the resulting work will be [12]. The best art invites a meditation upon the subtle relationships between unity and multiplicity. For art, as for philosophy, by this criterion there is no compulsion to collapse the infinity of forms to 1 but rather a desire to demonstrate the sophisticated relationship between them. The influence of Neoplatonism on some Islamic monuments has been noted by Gülrü Necipoglu in her authoritative work *The Topkapi Scroll* and also by Asli Gocer [13].

In Islam, God is not represented by an icon but indicated through a trajectory. The holiest place in a mosque is the mihrab. It functions both like a compass, indicating the direction of divine presence, and like a lens, focusing the energy

of prayer in that direction. Mats spread for prayers at home act as needles drawn toward the magnetic presence of God. Prayer in Islam, in short, performs the presence of the One Infinite God as the beckoning absence that directs prayer in physical, temporal, directional space.

The mihrab of the much-admired Sultan Hassan mosque in Cairo, completed in 1356, spectacularly enacts the relationship between that unknowable, infinite One and the multiplicity that strives toward it (Figs 1-3). At the base of the spandrel supporting the dome of the niche, a very modest "Allah" is inscribed in black letters. From this vanishing point radiate rays of colored marble, black, white, green, red and yellow. As their distance from the word "God" increases, these marble stripes metamorphose fractally, the border of each tangling with the adjacent one. It is a virtuosic rendering of a typical application of Mamluk marble encrustation. At the edge of the mihrab the rays resolve into an exceedingly ornate pattern of oblongs and roundels of precious marble and inscriptions in gold. As from the deceptively simple word for God at the center spring ever-more elaborate forms, the Sultan Hassan mihrab *performs* the relationship between 1 and infinity. The infinite multiplicity of the world unfolds from the infinite unity of God, and, as a viewer's eye travels back to the navel of the niche, unity re-enfolds multiplicity. The pleasure, both spiritual and aesthetic, of contemplating it lies in the marvelous inventiveness by which multiplicity is shown to spring from unity.

It must be said that patronage as much as theological inspiration informs the dazzling effects of the decoration of the Sultan Hassan mosque. In Mamluk Cairo, as Yasser Tabbaa writes, skilled stonemasons (often from Syria) competed with one another to achieve ever-more-dazzling effects with polychrome inlay, and the effect would have been to glorify



Fig. 3. Close-up, external mihrab, Mosque of Sultan Hassan, Cairo. (Photo © Samirah Alkassim)

the sultan, as well as the Divine, in the eyes of worshippers [14]. Moreover, by this time Egypt was under the sway of Sunni religious beliefs, which included the outright denunciation of the principle of emanation as polytheistic (as, if all Being is an emanation of God, this implies that God is somehow plural) [15]. Nevertheless, given the popularization of Neoplatonist thinking and its inextricable admixture with more orthodox theology, the Sultan Hassan mosque both mystifies and reflects the relationship of the Divine with the world.

Good computer art, by the Neoplatonist criterion I am proposing here, similarly exploits the complexity of unfolding-enfolding relations. It does not immediately collapse the perceptible image to its numeric basis in database and algorithm. Nor, of course, does it remain statically at the level of image. Rather it invites the perceiver to marvel at the richness with which the perceptible image unfolds from the numeric base. John Simon's web work *Unfolding Object* [16] (Color Plate H) initially presents a face as impassive as Malevich's black square or the name of God in the Sultan Hassan mihrab. Its initial page shows a colored square on a colored background. The user clicks the square to "unfold" successive "pages," which are simply animated to appear to open in three dimensions. Darker color and creases (suggested by lines across the page) indicate that previous visitors have unfolded these pages. Those never altered unfold into a bright new page. The process creates an increasingly complex, impossibly dimensional object, looking sometimes like a mauled chrysanthemum, sometimes like the kinky-pipes screensaver of vintage PCs.

Interestingly, the infinite iterations of the book that are enfolded in *Unfolding Object's* software must be unfolded socially, by the people who engage with the work on-line. Simon writes, "To realize this object in software was a great joy for me because all the potential for the object is contained in a very few lines of writing. When the code is activated—there are more ways to unfold it than we have time in our lives to explore" [17]. It is not necessary for users to be on-line at the same time: The *Object* encodes actions carried out upon it in a rudimentary form of communal memory. *Unfolding Object's* potential is contained in its source code and unfolded by the user. The longer one engages with it, the more complexity, logical depth and social extension the simple shape reveals. The work's title refers to quantum physicist David Bohm's the-

ory of the implicate order, or an imperceptible latent order by which apparently disparate perceptible events are connected [18]. The similarity to Neoplatonist Islamic thought is evident.

What I find most interesting about the comparison between the Sultan Hassan mihrab and *Unfolding Object*, however, is that infinity is already there in the object, waiting to be discovered by users. The two works of art evoke the difference between a fathomable infinity—that encoded in Simon's software—and an unfathomable infinity, that of the Deity to whose unknowable presence the mihrab points. It is here that the parallels between a sacred and a secular work diverge. A work such as *Unfolding Object* invites a wonder before the infinite that ultimately converges on the material (the experience of the programmer) or the conceptual (the creative speculation to which the work gives rise), but not the divine.

### MU'TAZILI ATOMISM: INDEPENDENCE OF PIXELS

The Neoplatonist understanding of Tawhid or divine unity emphasizes the interconnectedness of the universe as a manifestation of the One God. Another current in the intellectual debates of Abbasid Iraq places less emphasis on God's inconceivable unity and more on God's inconceivable power. This is the thought of the Mu'tazili atomists. While the Neoplatonist universe is highly structured, the atomist universe is held together by the will of God alone. It is striking that, while the falasifa emphasized that matter is an emanation from God, the contemporaneous atomist movement emphasized the complexity and ultimate unknowability of the relationship between God and matter.

The Mu'tazili were Islamic theologians who, like the falasifa, were devoted to vigorous rational debate, but they relied less upon Greek philosophy than did the falasifa and more upon Qur'anic sources. For a brief period in the 9th century, their argument that humans could use rationality to understand God's justice was official doctrine in the Abbasid caliphate; it then fell precipitously from favor.

In their attempt to explain God's reasoning, the Mu'tazili developed a sophisticated ontology that would permit understandings of the causal relations between invisible and visible, divine and earthly. Using logic rather than mysticism, they cultivated a notion of virtuality that makes it possible to contemplate things that do not exist—which seems strikingly similar to the contemporary vo-

cabulary of virtuality surrounding new media. This approach was derived from the Qur'an's distinction between the perceptible (*shahada*) and the unseen (*ghayb*), which includes not only divine being but also all that is in the past or the future [19]. The Mu'tazili of Basra maintained that nonexistent objects (*ma'dum*) are "things" and thus objects of knowledge. For those things that do exist, the Mu'tazili developed a complex realism in which all things that have acquired existence (unlike God, who has always existed) can be categorized as either atoms or "accidents": indivisible particles of matter, or the qualities, such as color and movement, that accrue to them. According to the Basrian Mu'tazili, atoms occupy space, form larger units additively, measure space by occupying it, and prevent other atoms from occupying the same space [20].

The Mu'tazili passionately debated relationships between atom and accident. In a radical version of Mu'tazili atomism, absolute occasionalism, Ibrahim al-Nazzam (d. 845) of the Basrian school argued that both motions and bodies last only a moment and are continually recreated (or not) by God. Things exist because God commands, *Kun!* ("Continue to exist!") [21]. The opposite of continued existence is *fana'*, ceasing to exist. Only by God's grace do we continue to exist at every moment.

In some cases, and ultimately, the rationalism of the Mu'tazili atomists gave way to mysticism, a reluctance to ascribe causality to the unknowable ways of God. Al-Ash'ari insisted that it was dualistic to inquire how God's attributes inhered in God, and polytheist to claim that humans had free will, that is, were the authors of their own actions. While the rational tradition struggled against rising conservative religious pressure [22], Ash'ari Mu'tazili thought gained power. It was modified by conservative anti-rationalist thinkers, chiefly al-Ghazali (d. 1111). Humility and awe in the face of the omnipotent were called for.

Yasser Tabbaa correlates the development of a uniquely Islamic architectural form with Mu'tazili atomistic theory, especially the moderate occasionalism of Ibn al-Baqillani (d. 1013) [23]. This form is the *muqarnas* dome, which seems to have first appeared on mausoleums in Iraq and Upper Egypt in the 11th century. Built from thousands of tiny, repeated cells called *muqarnas*, it emphasizes not underlying unity but infinitesimal parts—like the atoms of the Mu'tazili. In most of its iterations, the *muqarnas* dome disavows the rational re-

relationship between parts and conceals the structure of the dome, making it look insubstantial. A famous example is the muqarnas dome in the Hall of the Two Sisters at the Alhambra, that late flower of Umayyad princely architecture (Fig. 4). Subdivided into thousands of stalactite-like forms, admitting myriad points of sunlight, the dome is a dizzying dance of light and shade. If the concentric decoration of the Sultan Hassan mihrab invites contemplation of the relationship between God and the created universe, the muqarnas dome argues that we cannot know what that relationship is. (Again, historical conscience requires me to caution that the Alhambra is by no means a "typical" atomist monument.)

A hypothetical Mu'tazili atomist cinema is described by Jalal Toufic, who suggests that film's frame-by-frame structure supports an aesthetic of appearance-disappearance [24]. What really "sutures" the viewer into a film, Toufic provocatively suggests, is not the image but the jump cut, which "alerts him or her to his or her substitution by another, similar entity, and his or her annihilation into the one and only Subject." Subsumption into a larger entity and incomprehension of one's relation to that powerful other except through submission: these describe both the Ash'arite philosophy and a certain relationship to mechanical image-making media.

Atomism emphasizes the level of information while not presuming to know how it is related to (unfolded from) the level of experience. It demands faith. In computer-based art, the expression of image by information is even more arbitrary than in cinema. The universe of computers is composed of units of information. There is no necessary relationship between the "friendly" interface, a skin of myriad pixels, and the underlying software and hardware. Thus many users approach computers with an attitude not of understanding (of how the visible part relates to the concealed calculations) but of wonder, mystification and sometimes fear.

A state of awe or blissful annihilation is courted by some artworks that crash computers. Others wrest control of the interface away from the user or collapse it into an enfolded state. The standard-bearer of *fana'* in the digital age is Jodi.org, whose complex programming renders opaque the (supposed) transparency of standard graphical user interfaces [25]. Privileging the independence of pixels juddering on the desktop, programmers Joan Heemskerk and Dirk Paesmans insist on the non-necessity of a

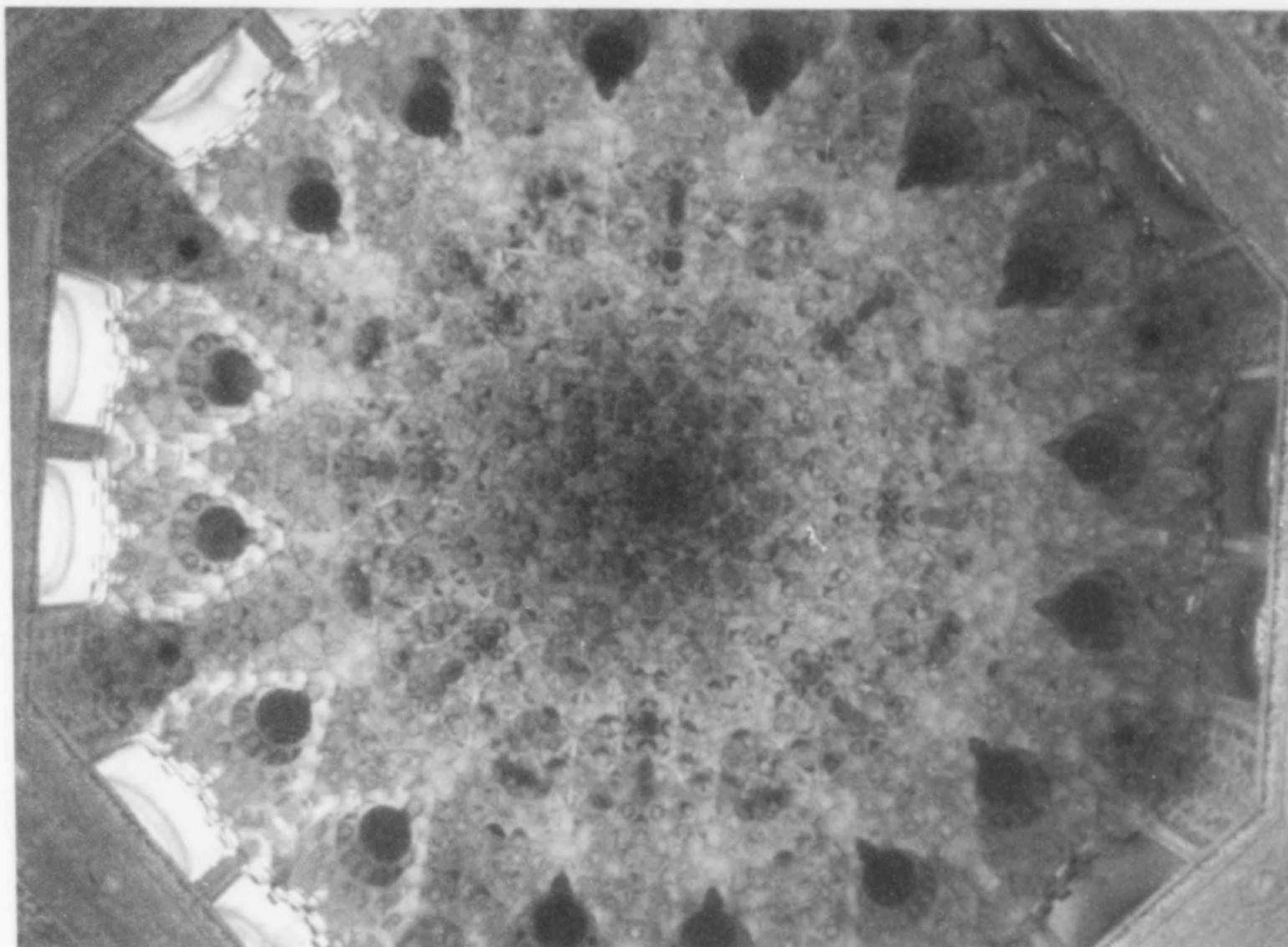


Fig. 4. Muqarnas dome, Hall of the Two Sisters, Alhambra. (Photo © Hazem Ismail Sayed. Courtesy of Aga Khan Visual Archives, Massachusetts Institute of Technology)

correlation between perceptible forms and the software that gives rise to them.

For the Islamic atomist philosophers, the ontological separation between God and the palpable world could either occasion a sophisticated inquiry into the possible relationship between them or discourage rational explanation. Historically in Islamic philosophy there was a shift from the first approach to the second. For Jodi (and similar works, such as the controversial *m9ndfuck.com*, Emmanuel Lamotte's interface art at *erational.com*, and Antoni Abad's *1.000.000*), what first engenders wonder, awe or the sublime experience of believing that one's files have been destroyed gives way to a critical understanding of the relationship between software and its effects. Stressing the lack of necessary relation between the interface and the underlying information, "atomist" computer artworks critique the mystification of the "friendly" interface deployed by conventional computer media.

### HISTORICAL ENFOLDMENTS

History too exists in relations of enfoldment. What people know of the past at a given moment is the merest surface of enfolded events, which they have managed to unfold [26]. Islamic knowledge is inextricably enfolded in European philosophy, science, technology and culture. These connections are only known selectively, and most will never be known. Some of these connections are only recently coming to light in the West,

because Western intellectual historians have disavowed Arab/Muslim links or dismissed their importance. Historians of mathematics and science, including George Saliba and Roshdi Rashed, demonstrate that Arabic scholars critiqued and significantly developed Greek works, producing a specifically Arabic body of thought, and that these works were known, translated and taken up by European scholars. Even after the Crusades and the expulsion of Muslims and Jews from Spain in 1492 (many stayed on and concealed their faith), Arab and Islamic scholars and artists were invited to work in European courts. Italian scholars traveled to the Islamic world to study Arabic during the Renaissance [27]. The massive work of translation of Arabic texts into Latin continued throughout the Middle Ages and as late as the 17th century. The Latin word *algebra* enfolds the Arabic *al-jabr* (restoration), from the title of Mohammad Ibn Musa Al-Khwarizmi's (d. 850) treatise on practical arithmetic, *Kitab al-jabr w'al-muqabala*, which was translated by Robert of Ketton in the multicultural scholarly center of Toledo in the 1140s [28]. Thus did Al-Khwarizmi, mathematician and chief librarian of the Beit al-hikmah, give his name to the Latin word *algorithm*.

In the arts, as in philosophy, mathematics and science, Islamic plastic expression deeply informed European artistic innovation from the Renaissance to modernism. Many of these connections have also been disavowed. However, especially with the rise of abstract,

haptic and subjectivist practices in European art from the late 19th century, Islamic art had an undeniable impact on Western artists. Undoubtedly the many techniques of abstraction, algorithmic construction, tactile surface qualities, meditative repetition and other qualities found in various Islamic arts influenced the rise of Western modernism [29].

Why should scholars and artists now try to unfold another aspect of the history of Islam? We are at a point where the Islamic heritage latent in Western modernism can inform contemporary efforts to make information culture meaningful and responsive. In this secular and multi-confessional age, the ultimate source of experience differs from the divine source to which Islamic art refers. In addition, the information unfolded in our contemporary images tends to encode power (state information, corporate information, financial information) in a way that requires combative discernment more than calm contemplation. The richness, however, with which Islamic art, in all its historical variants, invites a contemplation of the relationships between the perceptible and the imperceptible can push us to make and want images whose seeming aniconism conceals an enfolded experience that is worth seeking out.

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#### References and Notes

- Gilles Deleuze, *Cinema 2: The Time Image*, Hugh Tomlinson and Robert Galeta, trans. (Minneapolis, MN: University of Minnesota Press, 1989) p. 45.
- This essay concentrates on contemporary works of art made with and reflecting on computer software. However, many of the principles I propose here extend to other relatively aniconic arts, as well as to works made without computers that are nonetheless informed by the culture of information.
- The triadic philosophy of Charles Sanders Peirce informs this model of implication-explication or enfolding-unfolding between three levels, Experience (or Reality), Information and Image, which I developed in an attempt to analyze the status of images in the information age. For a more detailed discussion, please see my essay "Invisible Media," in Anna Everett and John T. Caldwell, eds., *New Media: Theories and Practices of Digitextuality* (London and New York: Routledge, 2003). On triadic thought, see Charles Sanders Peirce, "The Architecture of Theories" and "The Law of Mind," in Justus Buchler, ed., *Philosophical Writings of Peirce* (New York: Dover, 1955) pp. 315–323, 339–353.
- Deleuze succinctly describes the relationship between actual and virtual, as informed by the thought of Leibniz and Bergson, in Gilles Deleuze and Claire Parnet, "L'actuel et le virtuel," in Gilles Deleuze and Claire Parnet, *Dialogues* (Paris: Flammarion, 1996) pp. 179–184. Deleuze's model of what can be actualized in a given historical moment is informed by Foucault's archaeology of knowledge; see Gilles Deleuze, *Foucault*, Séan Hand, trans. (Minneapolis, MN: University of Minnesota Press, 1988).
- I derive the term *enfoldment* from a reading of David Bohm and Basil J. Hiley, *The Undivided Universe: An Ontological Interpretation of Quantum Theory* (London and New York: Routledge, 1993) and Gilles Deleuze, *Le Pli: Leibniz et le Baroque* (Paris: Minuit, 1988).
- Another scholar who is pursuing the parallel between Islamic art and computer art is Simon Yuill; see his essay "Ibn al-Bawwab and the Bastard Codes" (2003) at <www.lipparosa.org>. Yuill points out that Islamic art is a precedent for computer art in its use of notational or programmatic media, specifically in the case of calligraphy. His observations corroborate the shared qualities in Islamic and computer art of algorithmic structure and intermedial translation.
- Gülür Necipoglu points out that the persistence of floriated Kufic, from whose letters spring leaves, vines, and even animals, was one of the signs of Fatimid resistance to the Sunni revival until the 12th century. Gülür Necipoglu, *The Topkapi Scroll: Geometry and Ornament in Islamic Architecture* (Santa Monica, CA: Getty Center for the History of Art and Architecture in the Humanities, 1995) p. 103.
- See Sheila R. Canby, *The Rebellious Reformer: The Drawings and Paintings of Riza-yi Abbasi of Isfahan* (London: Azimuth, 1996), and Anthony Welch, "Worldly and Otherworldly Love in Safavi Painting," in Robert Hillenbrand, ed., *Persian Painting from the Mongols to the Qajars* (London: I.B. Tauris, 2000) pp. 301–317.
- The term *falasifa* is borrowed from the Greek. The term *mu'talifa*, or Islamic rational philosopher, designates those who withdrew (*ʿiṣāʾal*) from factions formed during the first Muslim civil war.
- Majid Fakhry, *Islamic Philosophy, Theology, and Mysticism* (Oxford, U.K.: Oneworld, 1997) p. 25.
- Oliver Leaman, *An Introduction to Classical Islamic Philosophy*, 2nd Ed. (Oxford, U.K.: Oxford Univ. Press, 2002) p. 18.
- Necipoglu [7] p. 189.
- Necipoglu [7] pp. 185–189; Asli Gocer, "A Hypothesis Concerning the Character of Islamic Art," *Journal of the History of Ideas* 60, No. 4 (1999) pp. 683–692.
- Yasser Tabbaa, "The Muqarnas Dome: Its Origin and Meaning," *Muqarnas* 3 (1985) pp. 68–69.
- Necipoglu [7] p. 192.
- See <unfoldingobject.guggenheim.org>.
- John Simon, e-mail communication to the author, 8 January 2003.
- See David Bohm, *Wholeness and the Implicate Order* (New York: Routledge, 2002).
- Tilman Nagel, *The History of Islamic Theology: From Muhammad to the Present*, Thomas Thornton, trans. (Princeton, NJ: Princeton Univ. Press; Markus Wiener Publishers, 2000) pp. 115–116.
- Alnoor Dhahani, *The Physical Theory of Kalam: Atoms, Space, and Void in Basrian Muʿtazili Cosmology* (Leiden, the Netherlands; New York; and Cologne, Germany: E.J. Brill, 1994) p. 61; Yasser Tabbaa, "The Muqarnas Dome: Its Origin and Meaning," *Muqarnas* 3 (1985) pp. 68–69.
- Dhahani [20] p. 45.
- The famous "closing of the doors of *ijihad*," or pronunciation that the Qur'an needed no further interpretation—at least among Sunni Muslims—was more or less achieved by the beginning of the 13th century.
- Tabbaa [14] p. 69. Tabbaa argues that the arabesque, overall star patterns and the increasing subdivision of music similarly reflect the dominant philosophy of Ash'ari atomism.
- Jalal Toufic, "Middle Eastern Films before the Gaze Returns to Thee—in Less than 1/24 of a Second," in Jalal Toufic, *Forthcoming* (Berkeley, CA: Aelos, 1999) pp. 115–136.
- Readers unfamiliar with Jodi may visit <www.jodi.org>. See Tilman Baumgartel, "Interview with Jodi," *Rhizome* (19 May 2001) <http://rhizome.org/thread.rhiz?thread=1770&text=2550#2550>.
- This is a version of Michel Foucault's archaeology of knowledge that understands discontinuities between discursive entities in history as deep folds rather than ruptures. See Michel Foucault, *The Archaeology of Knowledge*, A.M. Sheridan Smith, trans. (New York: Pantheon, 1972).
- See, for example, Roshdi Rashed, *The Development of Arabic Mathematics: Between Arithmetic and Algebra* (Dordrecht, the Netherlands: Kluwer, 1994); George Saliba, "Rethinking the Roots of Modern Science: Arabic Scientific Manuscripts in European Libraries," Occasional paper (Washington, D.C.: Center for Contemporary Arabic Studies, Georgetown University, 1999).
- María Rosa Menocal, *The Ornament of the World: How Muslims, Jews, and Christians Created a Culture of Tolerance in Medieval Spain* (Boston: Little, Brown and Company, 2002) pp. 179–180.
- See, for example, Philippe Büttner, "In the Beginning Was the Ornament—From the Arabesque to Modernism's Abstract Line" (pp. 86–105) and other debates on the influence of Arabic calligraphy and the "arabesque" on European painting in Markus Bröderlin, ed., *Ornament and Abstraction: The Dialogue between Non-Western, Modern, and Contemporary Art* (Basel: Fondation Beyeler, 2001). I explore the relationship between the theories of perception of Ibn Al-Haytham (and others) and the transmission of Islamic aesthetics to Europe in another paper, "Islamic Aesthetics, Modern Attention, and the Abstract Line," two versions of which are forthcoming in the proceedings of "Sense and Sensations: On the Performativity of Perception" (Frei Universität Berlin, November 2004), and in Christina Lammer, Cathrin Pichler and Kim Sawchuk, eds., *Verkörperungen (Patient Embodiment)*.

Manuscript received 2 September 2004.

## ISEA2006 Symposium

*5–13 August 2006, San Jose, California*

The ISEA2006 Symposium is being held in conjunction with the first biennial ZeroOne San Jose Global Festival for Art on the Edge in San Jose, California, 5–13 August 2006. The themes for the symposium and festival are: Interactive City, Community Domain, Pacific Rim and Transvergence.

The symposium and festival will be located primarily in numerous venues in San Jose's downtown core, including the San Jose McEnery Convention Center, the Martin Luther King Jr. Library, the Tech Museum of Innovation and the San Jose Museum of Art, which will convert its café into an interactive café with extended hours during the festival. The main exhibition will include the work of over 100 artists.

San Jose State University will host a pre-conference Pacific Rim New Media Summit and provide low-cost artist housing during the festival. Plaza de Cesar E. Chavez will be a central site for open-air installations and performances, including a "container culture" exhibition and a nomadic architecture camp. In addition, there will be projects throughout the city of San Jose as part of the conference's Interactive City and Community Domain themes.

See <<http://isea2006.sjsu.edu/index.html>> for more details.

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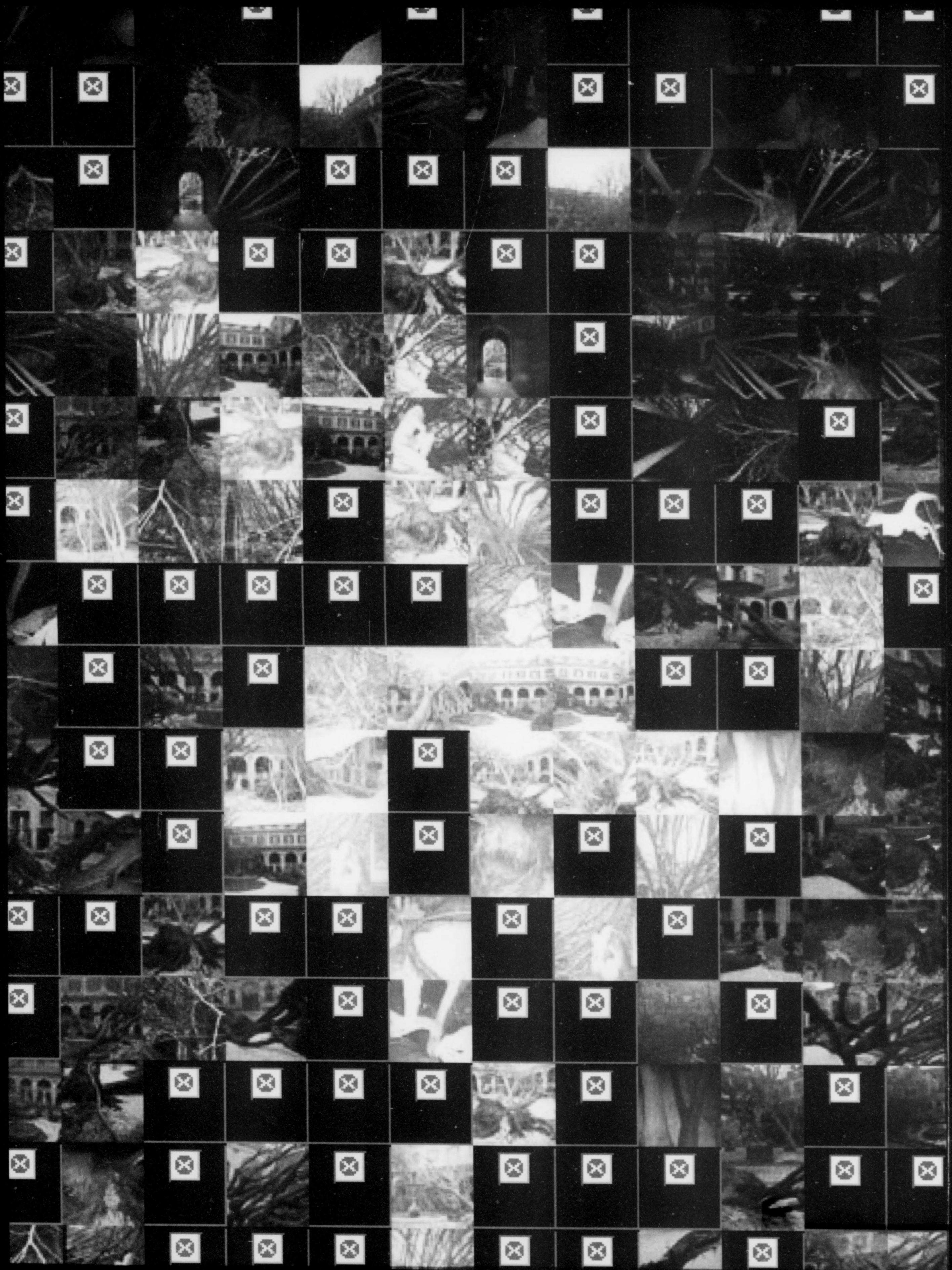
## The Pacific Rim New Media Summit A Pre-Symposium to ISEA2006

*7–8 August 2006, San Jose, California*

The political and economic space of the Pacific Rim represents a dynamic context for innovation and creativity. Experimentation in art, science, architecture, engineering, design, literature, theater and music is resulting in the emergence of new forms of cultural production and experience unique to the region. The complex relations and diversity of Pacific Rim nations are exemplified throughout the hybridized communities that compose Silicon Valley.

As part of the ISEA2006 Symposium, the CADRE Laboratory for New Media at San Jose State University will host a 2-day pre-symposium entitled the Pacific Rim New Media Summit, co-sponsored by Leonardo. With a purview encompassing all states and nations that border the Pacific Ocean, the summit is intended to explore and build interpretive bridges between institutional, corporate, social and cultural enterprises, with an emphasis on the emergence of new media arts programs in seven areas: Creative Community, Curatorial, Education, Directory, Eco-Social Activism, Mobile Computing and Urbanity, and Latin American—Pacific/Asia New Media. This trans-disciplinary event will have a specific focus on educational methodologies and practices.

For more information, visit <<http://isea2006.sjsu.edu/prnms.html>>.



# Internet Artworks, Artists and Computer Programmers: Sharing the Creative Process

Jean-Paul Fourmentraux

**C**ollaborative situations between artists and important "extra personnel," composed of all those who, in various ways, contribute to the realization of the work, are numerous in the history of artistic practice. Although these artworks are the results of collective activity, the different contributions to production are often hidden to benefit the mythical figure of the singular author, the final guarantor for "the cardinal activity of art" [1]. In the case of Net Art, the interactivity postulated as a technical imperative of the work requires computing skills that the artist does not always possess. Computer programmers are needed for the algorithmic programming of the artistic *dispositiv* [2]. Observation of the spaces of mediation, translation and negotiation enables a better understanding of the ways in which a plan begun through individual initiative can evolve into a shared work. From this point of view, the digital arts involve a simultaneous redefining of an artwork's localization (i.e. where or what exactly is the artwork?) and of the responsibilities of its authors. Certain questions arise:

- What is it that makes us consider a work of Net Art to be an artwork? How do the perspectives of the artist and the computer programmer differ in terms of what constitutes the artwork?
- How do these different partners proceed to share the activities of conception? What are the tasks attributed to each one at the beginning of the plan? What are the tasks that each one is in charge of in practice? Who is responsible for what? Who is the author?

The following analysis deals with the conception and realization of *Des\_Frags* [3], a project by artist Reynald Drouhin [4] made in association with computer programmer Sebastien Courvoisier at the French International Center of Video Creation (CICV) [5]. The ethnographic observations of the artwork's conception were conducted primarily through three periods of residential research at CICV. The materials from which these observations are drawn include: an observation report; computer models, diagrams, interfaces and specification notebooks used by different actors; a series of interviews with the artist and the computer programmer; and all the e-mail conversations that guided the activity of conception. This

survey, an unpublished research report, is part of a research contract financed by the Plastics Arts Delegation of the French Ministry of Culture and Communication, from the Contemporary Art and Scientific Culture program.

*Des\_Frags* is an on-line software program that allows users to link a keyword with an image from their hard drive or the Internet. After a period of time, they receive an e-mail containing a mosaic image that is a recomposition of the original image but composed of images found on-line that are related to the user's chosen word (Article Frontispiece and Color Plate F). A study of *Des\_Frags* offers a better understanding of the specificities of flow: The artist returns to the collaborative conditions of the work's conception and installs, rather than actualizes, a software system. This study focuses on the conception and design of this artwork and on the distribution of roles, allocation of tasks and different perspectives [6] of the work held by the various participants. I take a close look at the role of communication tools in this process, the various technical mediations [7] and intermediary objects [8] mobilized by the different partners to translate their individual interests to their common purpose. These media aids for communication and action can become negotiation partners. They influence the conception process through their anticipation and description values, and also affect the control and authentication of the plan. In order to get closer to these "translation" and "negotiation" processes [9], I have chosen, in this text, to restrict my study to observation of the shared conception of the user interface. Computer programming, ergonomic development, aesthetic coherence and design are concurrently called for in this work of technical and aesthetic production. The sociological aim here is to consider the technical problems and the social contexts together, and to produce both an analysis of aesthetic and/or technical debates and a sociological analysis of the implied actors [10].

## BETWEEN PROSCENIUM AND BACKSTAGE: THE DISPOSITIV OF NET ART

*Des\_Frags* proposes a *dispositiv for, by and with* the Internet, one that can only exist and unfurl on-line. This *dispositiv* is unique to Net Art and requires the use of preexisting elements on the Web (in this case, still images) to compose a mosaic-image.

## ABSTRACT

Internet artwork no longer refers to the concept of a finalized object, but rather to a dynamic process, a collective, open and interactive device. Due to the increasing sophistication of tools, the design of an Internet artwork now requires hybrid skills. The necessary cooperation with computer specialists in order to create suitable programs thus changes the status of the artwork and its author. This paper presents an ethnographic case study of cooperation between a computer programmer and an artist. It examines the processes of shared design, negotiated authorship and artwork appropriation. From an analysis of the means of communication, various technical media and "intermediary tools," the author focuses on role allocation, task sharing and artwork appropriation as the artwork is modified throughout the creative process.

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*Des\_Frags* functions by asking an Internet user to select an initial static image, either from the Internet or from his/her own archives. This original image provides the pattern upon which other images scavenged from the Web are displayed. With the help of a search engine designed for this purpose, the user, or "internaut," is then asked to collect a large number of other images by using no more than three keywords. These thumbnail images are then incorporated into the final mosaic. The pragmatic conditions under which this process of artistic creation occurs (as well as the strategies and conventions of its design, application and circulation) work to renew the systems, existence and expression of the work of art. What is the artwork in this context? What are its characteristics? Between proscenium and backstage, how is the artwork simultaneously recognized, perceived and activated?

The role of the CICV in this collaboration focused on the development of a computer program to gather different, preexisting fragments of Internet applications, and on the conception of the user interface. The interface needed to enable both the search for mosaic images and the submission of the image matrix. This process entails three main stages: (1) The expert evaluation of the artistic plan (its conceptualization); (2) The technical development of the work, encompassing both technical and aesthetic solutions to programming requirements; (3) The valuation/exhibition of the work (its final aim). Each of these stages went through numerous mediations—technical, human, institutional—and indicated a progression in the collaborative process.


### Institutional Enrollment in the Project

Drouhin met with the CICV staff before beginning work with Courvoisier alone. This first encounter between the artist and the CICV staff was particularly rich because its main purpose was to make the artist specify the characteristics of a plan that was still being formulated. Little by little, a situation of give-and-take took place between the different partners. On several occasions during the course of the evaluation, the artist was asked to reframe his plan and to make choices that would aid its technical development, just as the artist waited for the computer programmers to tell him the possible options. The artist was compelled, even as he was asking for more information, to come to a decision on various options, to the point that the interactions between artist and programmers became so en-

## des frags reynald drouhin


**defragmentation of the internet** #  
follow steps # 1 to # 9 to defragment the internet with images... or just # 9 to generate an image which is randomly fragmented.  
# ▼

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**key word(s)** <sup>01</sup> pictures search engine 

▼

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**image source** <sup>02</sup> 440 pixels (pg, gif, png, bmp) 

aucun fichier selectionné

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**size of mosaics** <sup>03</sup> in pixel

width (20-200) =  height (20-200) =

---

**repetition of the same mosaics** <sup>04</sup>




a little  a lot  not at all

---

**transparency of mosaics** <sup>05</sup>

a little  a lot  not at all

---

**title** <sup>06</sup>  **signature** <sup>07</sup>

---

**e-mail** <sup>08</sup>   
CC

▲   \*  <sup>09</sup>

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[des frags](#) [reactions](#) [contractions](#) [information](#) [credits](#) [contacts](#)

Fig. 1. Screenshot of the third and final interface of *Des\_Frags*. (© Reynald Drouhin)

tangled as to raise questions about who exactly formulated, refined, transformed and/or abandoned the options.

The CICV roots collaborations in an institutional context that contributes to the structuring of activities and thus, by putting the different actors in clearly distinct roles, tends to limit the possible ambiguity of positions. This system defines the identities and roles of each person, makes expectations and purposes clear and highlights potential difficulties. When an entangled web of problems and options (aesthetic, institutional, ethical, technical, etc.) is encountered, resolution in the name of a common purpose is undertaken by some of the actors according to their assigned roles. Not just anybody can ask any question, just as not just anybody can answer any question.

The technical partners are "in the service" of the artist's plan; the artist is the sole designer and legitimate initiator. The different knowledge sets and practices of the various actors are thus inscribed in a history of specialties: art history, and more precisely aesthetic sense, on the one hand and the history of discoveries and technical innovation on the other hand. However, the boundaries between these knowledge sets and practices that appear to be stable and clearly defined are susceptible to contagions in the apparent "immediacy" of concrete collaborations.

### The Intermediary Space of the Collaboration

All of these transactions fall within the scope of a shared work space that revolves

around an art/technical axis. The transfer of competencies and the translations of knowledge sets and practices occur at the junction of these two domains. Therefore, it was often difficult to separate what were strictly the computer programmer's concerns from those of the artist. The two partners tried to create an intermediary space of exchange, a territory "in between" where the confrontation of interests and work methods could take place. Even though the institutional context of the exchange acted as a stabilizing influence by separating the expertise and tasks of the collaborators, these same collaborators had to battle with objects and technical devices that nevertheless affected the relationships between collaborators. The interface constituted the support and the medium from which the shared conception went forward. This technical object is here viewed as an "analyzer"—support and mediator—of the conceiving action. In this way the interface acted as a bridge to link the opposing actors and help them.

As design of the interface was the final stage of the project's conception, its necessary anticipation led the artist and the computer programmer to successively outline intermediary steps. Indeed, as the technical choices were collectively evaluated, kept or dismissed, anticipation of the interface's uses prompted a listing and definition of its formal parameters and technical options. There was an ongoing negotiation throughout the conception process with regard to the interface's appearance and the technical requirements of its functions. Two preliminary attempts at designing the interface preceded its final form. The first, initiated by the artist, was strictly functional and clearly imperfect as far as its formal appearance was concerned. This initial model turned out to be too technical and abstract for a novice user. The second attempt was the result of the computer programmer's work, which redesigned the interface with the double aim of technical experimentation and testing its functionality. This redesign attempted to give a visual illustration for each of the interactive parameters, so that the user could see an example of the possible results of each interface function.

Courvoisier: There was a moment when a lot of people at the heart of CICV did not really understand the use and meaning of the interface functions and options. It was at that time that I settled on small images, little icons that tried to show, in the easiest possible way, the results that this could give according to the different parameters. Reynald told me that it was something he hadn't thought

about and he's going to integrate it in the final interface. So there maybe, there's an influence.

Courvoisier's initiative went far beyond the strictly technical responsibilities assumed to be those of the computer programmer. His contribution gave not only a technical meaning to the whole interactive process, but also a plastic and visual form that influenced, in an important way, the design of the final interface. However, though the artist seemed receptive to the readability offered by the addition of the illustrative vignettes, he was nevertheless hesitant to use the icons, which he judged too descriptive for each of the functions.

Drouhin: The way the options are set... I don't think that I'll present them this way when I redo the interface. He [Courvoisier] didn't have the vocation either to present things or to draw the interface... What's funny is that he did not put it crudely... He put red characters on a black background... and even if it's sure that we won't keep any of these elements, it's interesting that he presented it this way... It's ugly. It's not a value judgment but... It's presented as a technician would do it, there's no vocation to be aesthetic here.

Drouhin was naturally inclined to retain control of those elements that he perceived as belonging to the field of his own competences. The third and defini-

#### information artistic

Defragmentation of the Internet by Images: With the aid of one or several "key words": to determine the images that will be researched (mosaic modules) to recompose the image that you have submitted (the matrix). "Des frags" is a project using the resources available on the Net and to put them to a different purpose than that for which they were originally designed. For this, the project is, in appearance, very simple: using existing tools available on the web to create the final work (from/by and with the Net). "Des frags" is the defragmentation of the Internet... A multitude of information is available on the web, and this project allows all this information to coexist together in the one final image: a matrix that will serve as a global reference point of the different elements of which it is composed.

"Des frags" is also a "blow" (a murder for players of video games)... meaning a "hold-up" of existing images on the Net: the appropriation of a raw material present on the web and reactivation of this "dead", archived memory into a live, ephemeral memory.

#### information technical

Defragmentation of the Internet: creating the positive association of autonomous, specific and dispersed resources: diverting contingent functions to channel them towards an open finality: going beyond the discordant multiplicity of languages and types of information to make a "melting pot" with a new coherence.

It all comes down to the creation of an ensemble of mutualist applications (in PHP and MySQL) allowing for the transparent circulation of the information from one pre-existing tool to another: the web based text translation engine of SystranSoft (for the automatic translation of key words from French to English), the "Yahoo" web-engine for the research of images (for the recuperation of mosaics), the "Metapixel" photomosaic composition programme (for the final rendition), a collection of image processing programmes from ImageMagick (for the degradation of the "contradictions") ... all this through a simple HTML interface.

"Des frags" also uses system processing (Linux) which is brutally dissociated from its parent, with the information extracted by breaking certain "web windows" — a continuous breakage whose splinters, far-away and indeterminate, are recomposed into a familiar image.

Fig. 2. Screenshot of the *Des\_Frags* artistic and technical information. (© Reynald Drouhin)

tive version of the interface was undertaken solely by Drouhin. Its visual design is minimal and sober, consisting of black characters on a white background. The artist conceived each of the menus. The different options are referred to by simple terms, with no descriptive or explanatory overstatement. Nevertheless, the path from the first model to the final version of the interface was the result of a long process of borrowings and shared suggestions, readable through the final, hybrid and collective design (Fig. 1).

The collaborative realization of the artistic and technical interface, both as artwork and tool, led to multiple collective and individual appropriations of the different dimensions of the plan. The different negotiations focused alternately on the aesthetic and technical stakes of the artwork and of the software program; the realization of the interface in its plastic (formal) and technical (functional) dimension; its appearance, ergonomics, options; and finally on the appropriation and signature of the dispositif. During this conception, in the "in-between" of the exchange, the artwork was truly an unlimited "everything," invested as much by the artist as by the computer programmer. At the boundaries of the cooperation, interests and motivations were intertwined. The artist became the initiator and discoverer of computer

solutions. The computer programmer claimed his creative sense and intervened in aesthetic choices and in the artistic appraisal of the plan and its interface. The compromises negotiated between the artist and the computer programmer were governed by two opposite logics: one of coherence with the artistic plan, its aesthetic concept and visual form, and one of adaptation to technical constraints, feasibility and technical implications.

## RECONSTRUCTION OF STATUS AND ROLES

If these boundaries of action were crossed during the shared activity of conception, they reappeared in an intensified form in interviews with the artist and the computer programmer post-conception. At the plan's close, desires and often frustrations reemerged, encouraged by the demand of reflexiveness inherent in an interview format. So, in the "information" column of the *Des\_Frags* site, the status of the collaborators reemerged as delimited and reinforced by a separation and confrontation of points of view (Fig. 2).

The artistic information roots the work in art history and artistic practice. The technical information inscribes the dispositiv development in technical innovation and in the history of computer

programming. As a result, the various contributions appear more from the angle of complementarity than from one of possible hybridization. This discrepancy of points of view finds its equivalent in differentiated modes of designation of the dispositiv. *Des\_Frags*, following the example of digital creations on the Internet, does not constitute one artwork but several works superimposed upon one another with limited points of interaction. On a first level is the initial concept, where creative intention is translated into the technological substructure through a hidden computer program. On another level the artwork, perceptible as such, is seen through the interface but even more it is lived and performed in its displayed form on-line. On a third level, there is the work as it is acted or perceived as the result of the device implementation via the interface. This multiple and fragmented character of the work promoted different levels of reappropriation by the artist and the computer programmer, various appropriations for each of the multiple dimensions of the device. From the artist's point of view, the artwork was within this "everything" that makes it possible: not only the idea, the concept, the interface, the engine, but also what the user sends, and the results of this are part and

parcel of what the artist calls the plastic plan in its wholeness. Courvoisier, the computer programmer, agreed with the artist about the idea of the work's plural existence, but he was perhaps more concerned about isolating his own contribution.

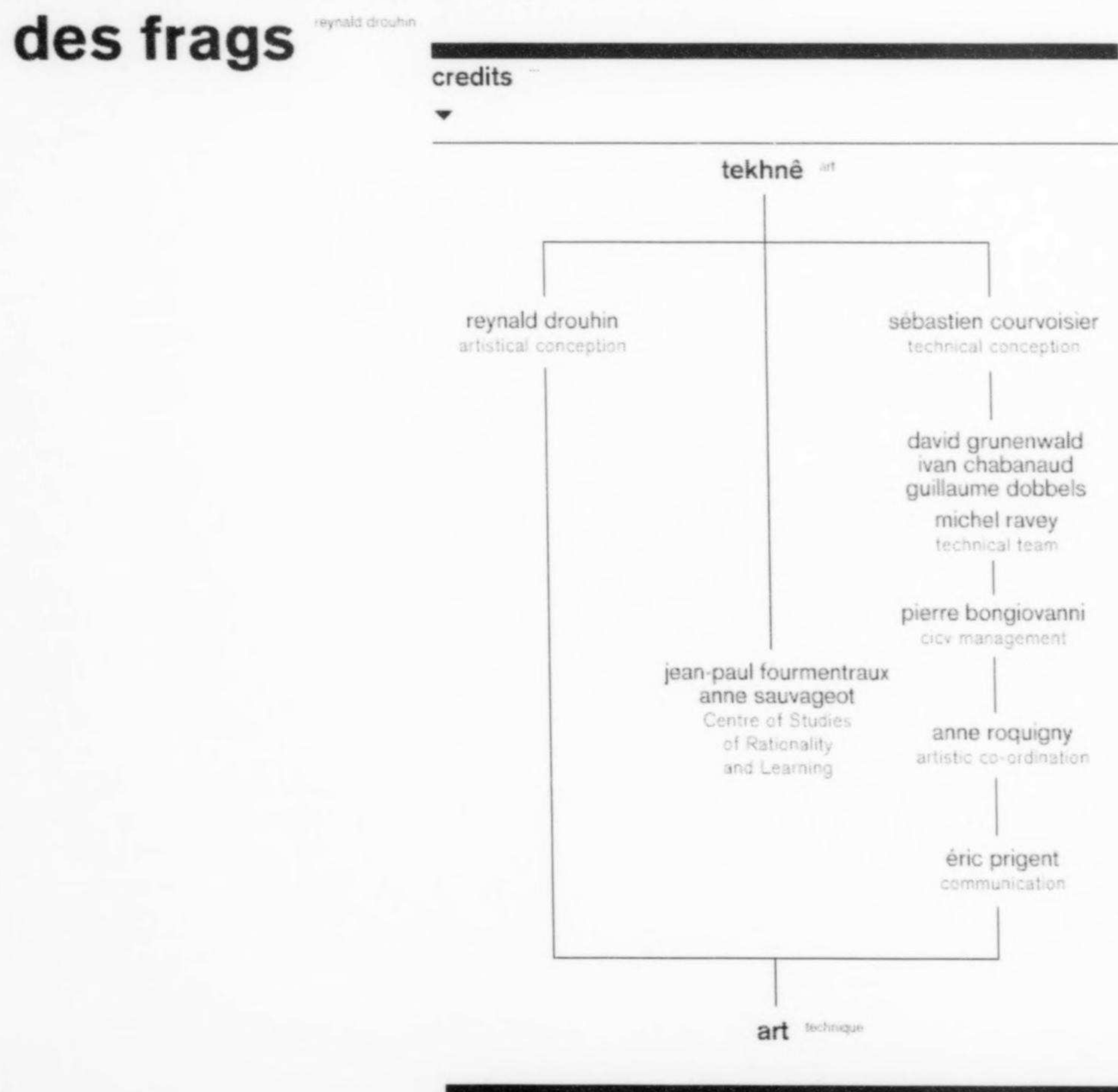
Courvoisier: That's the problem because, in a certain way, we can say we work in an equal way. The work would not exist without the concept that aroused it, but the work would also not exist without the technical equipment that is set to realize it. When you know that it's the concept that comes before the artwork. . . . At this level we can say that whatever happens, the artist is always the real creator of the work. . . . Even if sometimes we can wonder if finally the work is related more to what I did or what he wanted to do?

In other respects, even Courvoisier recognizes Drouhin as the artwork's initiator, and if he experienced the feeling of producing a program in the service of a work of art, he nevertheless conceived this program from a perspective of autonomy and openness. For the programmer, the program's requirements of modularity and autonomy are liable to separate the tool from the artwork. The realization of the *Des\_Frags* plan thus promoted both the production of a plastic creation and a computer application, a software tool that could be used again in a different context. The problem of appropriation, implicit throughout the plan's development, became inescapable when the question of authorship of the artwork intervened at the project's close. What can the artist claim as his property? If the work is this "everything" that constitutes the whole dispositiv, can the artist, for all that, remain the master of it?

Drouhin: I cannot say that he is a "co-artist" because that's not his function. He does not present himself this way either. I don't know how to say it. It's true that there's a problem here. If I know what to ask him, I don't know how to define his position. . . . But I'm going to put myself above him in the credits, sure, because I initiated the plan and then, at the end, the form it takes. But perhaps I'll put Sebastien [Courvoisier] above the CICV, I don't know, or on the same level. . . . Earlier I didn't know how to name him because I didn't want to say "technician." It doesn't please me at all. It's true that it's rather simplistic and reductionistic in light of the work he's doing, but we give a greater importance to the one who has the idea and that's obvious. But as far as the implications and exchanges we have are concerned, he enters the plan here, he gives ideas.

Drouhin's solution to these questions of authorship was to distribute the different actors and their contributions to

Fig. 3. Screenshot of the *Des\_Frags* credits. (© Reynald Drouhin)



the collective conception of the *Des\_Frags* dispositiv along a "tekné/art" axis (Fig. 3). As in film credits, the whole "additional staff" who contributed to the artwork's realization is mentioned: from the direct actors of the artistic and technical conception to the institutional partners, communication agents and even to me, the sociological researcher, and my research supervisor. In contrast to film credits, the "crew" listings are not meant to be hierarchical but instead are shared on the vertical axis that goes from "tekné (art)," which refers to the practices in which artistic conception and technical skills are put on the same level, to the "art (technique)," which refers to the "rules of art," wherein artistic recognition occurs.

### THE WORK OF ART BEYOND THE INTERFACE

This article attempts to highlight changes created by the "virtual" and "fragmented" regime unique to information technology and the effects of these changes on the traditional notion of the "work of art." The *Des\_Frags* project exemplifies how, in this context, the work of art no longer presents the spectator with an ontological entity "already-there," within which artistic or technical talent and intention have crystallized. As a result, it is clear that, even though the interface is at the center of the artistic creation, it participates in the arrangement and composition of the artwork with the same status as the other elements. The interface functions to create a situation and embodies one of the elements that is part of a wider relationship with other elements such as the artist and the visitor, the computer and its peripherals (screen, keyboard, mouse), the programming algorithm, the source code, and the content's evolution (the material made available by the artist, brought by the visitor, generated by the machine or the network [11]). In other words, the interface can be regarded as a "body of work" shared by the artist, the machine and the Internet users. The existence of *Des\_Frags* stems from the configuration of different fragments set in a dispositiv that includes a proscenium (the interface), a stage (the matrices, the thumbnails, the ephemeral gallery) as well as a backstage (not only the program, the fragments of preexisting applications, image stocks and search engines, but also the indefinite whole made up of potential images from the network that may be integrated into the system [12]). The concept of artistic dis-

positiv allows us to think about the superimposition of the different levels of this artwork. Moreover, its heuristic quality comes from its capacity to show the inclination of these various parts to function autonomously. In this respect, the layout "disposition" refers to the act of arranging the various elements that compose *Des\_Frags* in a certain order; it also designates the result of this action. Understood as a machine and a mechanism, the dispositiv subsumes both the artistic act and its manifestation and, as a result, includes the possibilities of yet other approaches. On-line artworks simultaneously engage an aesthetic of code, an interface design and an art of the (ephemeral) archive. All on-line digital art will conjugate these three enunciative regimes and render available an "applied art" to the public.

This retrospective loop institutes a fully symmetrical distribution of roles for its three partners: the artist and programmer (who initiate and react to the process), the visitor (who actualizes the different versions of the dispositiv), and finally the work of art itself (which unfurls and manifests itself when in contact with the multiple "holds" [13], intentional or automatic). The dispositiv of Net Art contribute to the erasure of the barrier that separates the distinct entities of the producer and the consumer of an artwork. Neither truly rational, nor prohibitively determined, the viewer actively develops possible "holds" into the image and the artwork that he/she will be able to undo or redo. Potentially, this is only visible when actualized or, to use the language of the initiated, "performed." And in the course of this symmetrical process, the artwork, jointly activated by the program (the machine) and the actors of the interactive process (artist, programmer and user), finds itself capable of new functionalities. This type of artwork embodies the medium, the source of information and the environment where its "interactivities" and "interactions" spread and weave the relationships between the "agents" involved in the creative process.

### References and Notes

1. H. Becker, *Art Worlds* (Berkeley, CA: University of California Press, 1982).
2. In the original French text this word is "dispositif," meaning, literally, "mechanism" or "device." Long mistranslated as "apparatus" in the field of film theory, this term would be better defined as a holistic phenomenon that encompasses both the cinematic apparatus, or mechanism, and the subject or viewer implicated in its functioning. Melita Zajc explores the question of this common mistranslation in her essay, "The Concept of Dispositiv: Studying Technology in Terms of Its Use. Because of

the All Yet-to-Be-Written User Manuals" (available on-line at <<http://www.iwm.at/p-jvfcon.htm>>). Zajc invented the term "dispositiv" to avoid this problem of mistranslation. In this text, I also translate this term "dispositif" as "dispositiv," in order to avoid confusion.

3. Reynald Drouhin, *Des\_Frags* <<http://desfrags.cicv.fr>>.
4. Reynald Drouhin immersed himself in the Internet in 1995. Artworks such as *Alteration*, *Metaorigines* and *Des\_Frags* divert software, disrupt images and incorporate Internet errors and other intrigues. Drouhin's works often overlap and respond to one another. He is considered a major figure of French-speaking Net Art.
5. CICV provides artists' residencies in electronic arts and organizes the International Festival of Multimedia Urban Arts, in Belfort, France <[www.interferences.org](http://www.interferences.org)>. This multimedia and digital art festival is funded by the French Ministry of Culture.
6. C. Bessy and F. Chateauraynaud, *Experts et faussaires. Pour une sociologie de la perception* (Paris: Métailié, 1995).
7. A. Hennion and C. Méadel, "The Artisans of Desire: The Mediation of Advertising between the Product and the Consumer," *Sociological Theory* 7, No. 2, 191-209 (1989); A. Hennion, *La passion musicale. Une sociologie de la médiation* (Paris: Métailié, 1993).
8. S-L. Star and J. Griesemer, "Institutional Ecology, 'Translation,' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39," *Social Studies of Science* 19 (1989) pp. 387-420; "Les objets dans l'action. De la maison au laboratoire," in B. Conein, N. Dodier and L. Thévenot, eds., *Raisons pratiques* 4 (Paris: EHESS, 1994); M. Akrich, "Essay of Technosociology: A Gasogene in Costa Rica," in P. Lemonnier, ed., *Technological Choices: Transformation in Material Cultures since the Neolithic* (London: Routledge, 1993) pp. 289-337; M. Callon and J. Law, "Agency and the Hybrid 'Collectif,'" *South Atlantic Quarterly* 94, No. 2, 481-508 (1995).
9. A. Strauss, *Negotiations: Varieties, Processes, Contexts, and Social Order* (San Francisco: Jossey-Bass, 1978); M. Callon, "Struggles and Negotiations to Define What Is Problematic and What Is Not: the Socio-Logics of Translation," in K. Knorr, ed., *The Social Process of Scientific Investigation*, Vol. 4 (Dordrecht, the Netherlands: Reidel Publishing Company, 1980) pp. 197-219; M. Callon, "Some Elements for a Sociology of Translation: Domestication of the Scallops and the Fishermen of St-Brieuc Bay," in J. Law, ed., *Power, Action and Belief: a New Sociology of Knowledge?* (London: Routledge, 1986) pp. 196-229.
10. This study succeeds previous works: J. Adler, *Artists in Offices* (New Brunswick, NJ: Transaction Inc, 1978); H. Collins and M. Kush, *The Shape of Actions: What Humans and Machines Can Do* (Cambridge, MA: MIT Press, 1998); N. Dodier, "Les appuis conventionnels de l'action. Éléments pour une pragmatique sociologique," *Réseaux* 62 (1993); N. Dodier, *Les hommes et les machines. La conscience collective dans les sociétés technicisées* (Paris: Métailié, 1995); B. Latour and S. Woolgar, *Laboratory Life: The Construction of Scientific Facts* (Princeton, NJ: Princeton Univ. Press, 1986); B. Latour, *Science in Action: How to Follow Scientists and Engineers through Society* (Cambridge, MA: Harvard Univ. Press, 1987); B. Latour, "Drawing Things Together," in M. Lynch and S. Woolgar, eds., *Representation in Scientific Practice* (Cambridge, MA: MIT Press, 1990) pp. 19-68; D. Norman, *The Design of Everyday Things* (New York: Doubleday Currency, 1990); S. Shapin, "The Invisible Technician," *American Scientist* 77 (1979); S-L. Star, "Working Together: Symbolic Interactionism, Activity Theory, and Information Systems," in D. Middleton and Y. Engeström, eds., *Cognition and Communication at Work* (Cambridge, UK: Cambridge Univ. Press, 1997).
11. In this respect the experiments of Net Art build on the research of experimental cinema or video art

by questioning what constitutes a work of art and violently shakes up the roles and functions attached to experimental cinema and video art.

12. In this process, the proscenium is the zone of action where the work can either be "played" or "undisplayed" via the interface: it is the visible element that operates the translation of the dispositif. The stage then becomes the place of performance, shared by the artist and the "audience," where periodic and circumstantial manifestations of the work occur. The backstage area is reserved for the author-trio embodied by the machine, the artist and the computer programmer. Others have examined these new relations between artists and computer programmers: P-M. Menger, *Les laboratoires de la création musicale*

(Paris: La Documentation française, 1989); P-M. Menger, "Artists as Workers: Theoretical and Methodological Challenges," *Poetics* 28 (2001) pp. 241-254; C. Harris, *Art and Innovation: The Xerox Parc Artists-in-Residence Program* (Cambridge, MA: MIT Press, 1999); G. Hutzler, B. Gortais and A. Drogoul, "The Garden of Chances: A Virtual Ecosystem," *Leonardo* 33, No. 2, 101-107 (2000); J. Campbell, "Delusions of Dialogue: Control and Choice in Interactive Art," *Leonardo* 33, No. 2, 133-140 (2000); J. Hamilton, *Fields of Influence: Conjunctions of Artists and Scientists* (Birmingham, U.K.: University of Birmingham Press, 2001).

13. In rock climbing, "holds" create an environment and are at the same time a result of action. Here it

is also meant in reference to the "sociology of perception," or the "sociology of holds" explored in Bessy and Chateaurayand [6].

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## CALL FOR PAPERS

### LMJ 17: My Favorite Things: The Joy of the Gizmo

If, as Marshall McLuhan so famously suggested, the medium is the message, then the gizmo must be the one-liner. From baroque violinists to laptopers, sound artists have long fetishized the tools of their trade, the mere naming of which can provoke an instant reaction: Shout "LA-2A," "TR-808," "JTM45" or "Tube Screamer" in a room full of musicians, and you will notice the eyes brighten, the breath shorten and the anecdotes pour forth. But only to a point: Many a "secret weapon" is held close to the chest.

This is the chance to get that secret off your chest: LMJ 17 will address the significance of *physical objects* in music and sound art in a time of increasing emphasis on software and file exchange. We are soliciting papers (2,000-5,000 words) and briefer artists' statements (500-1,000 words) on the role of purchased or homemade instruments, effects boxes, pieces of studio gear, "bent" toys, self-built circuits, and so on, in your work as a composer, performer, artist, producer, recording engineer, etc. Wherever possible, please include photographs of your subjects (300 ppi TIFFs preferred).

#### DEADLINES

**1 October 2006:** Brief proposals sent to Nicolas Collins <ncollins@artic.edu>.

**1 January 2007:** Final texts and all materials to the LMJ Editorial Office.

Contact Nicolas Collins <ncollins@artic.edu> with any questions.

# An Artist's Works through the Eyes of a Physicist: Graphic Illustration of Particle Symmetries

György Darvas  
and Tamás F. Farkas

**T**amás Farkas has developed a series of sets of graphic units that can be used to model the different properties of physical particles. One of the sets is demonstrated in this paper, which is the result of years of collaboration between a physicist and a graphic artist.

The inner structure of atoms and the classification of quarks and their properties are not easy subjects to understand. This difficulty stems from the impossibility of real visualization of quarks, which closes the doors before the imagination. Physics education struggles with this problem of visualization, since all visualizations are schematic and are unable to show all sides and details of a physical model. Although physics education is attempting to resolve the problem, so too does Farkas's work.

Below is the artist's statement on the significance of his work for both physicists and laypeople, followed by a physics-based discussion of the properties of quarks and how their properties can be seen as modeled in Farkas's work.

## TAMÁS F. FARKAS: INSIGHT INTO THE PROCESS OF VISUALIZATION

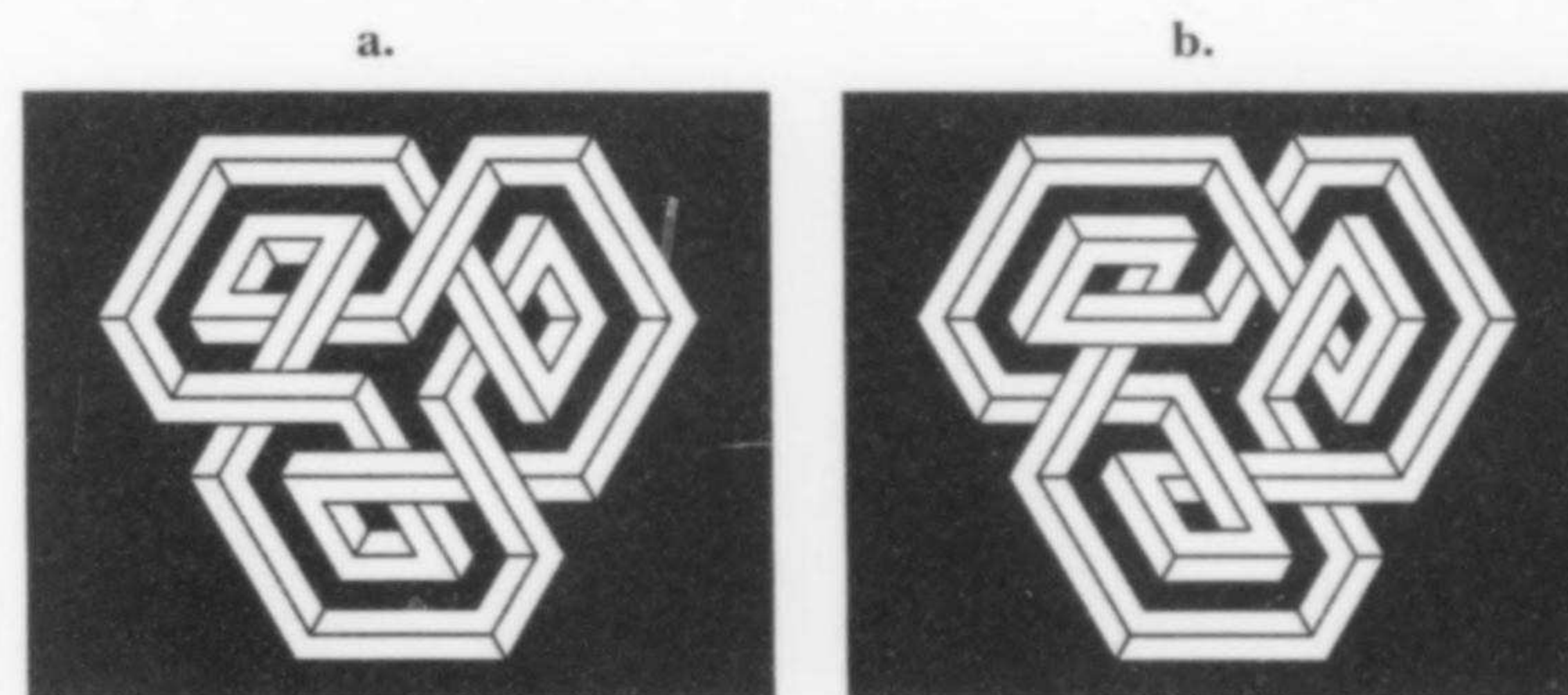
My works have opened new insight into an impossible world and free vistas for artistic imagination [1], partly in higher dimensions and partly in geometric structures not realizable even in higher dimensions. Making visible spaces that are non-Euclidean, beyond traditional geometries, multidimensional and not realizable in the real world, these are also works that attract the interest of physicists studying the structure of matter. Application of *colors* and *color-shades* in the visualization may multiply the manifold of mutually perpendicular—or, through the use of straight lines, at least apparently perpendicular—(abstract) spatial dimensions.

Moreover, these works make these conceptions visible and perceivable for those observers who are unfamiliar with abstract physical structures. Figures drawn by physicists are schematic, suitable only for illustrating dry physical facts. The world of sub-elementary particles is often too complex and difficult for non-physicist observers to grasp. *Flavors, colors* and other physical properties of the sub-elementary particles [2]

can be interpreted only in multidimensional abstract fields (abstract even for physicists). These abstract fields themselves have complex, multidimensional structures. Therefore, physicists strive to represent the objects manifested in these fields with the simplest symbols possible (such as dots, arrows or wavy lines directed toward a given spatial axis).

According to common belief, this world is too complicated to be represented simply, not even to attribute an internal structure to the represented objects. My pictorial world breaks this taboo. For three decades I have been investigating how to make visible the spatial world not perceivable by the everyday senses. The roots of my graphical world are partly in the arts and partly in the sciences (e.g. multidimensional geometry and the world of abstract symmetries). My graphical research into scientific profundities strives to create a harmony rooted in the Renaissance way of thinking; my works represent the joint beauty of human thought and manual creativity. This *graphical world* is not a simple play with forms and colors. Thorough examination of the illustrations of this paper allows one to observe a series of graphical orders and regularities developed and implemented with rigorous consistency. The shape is partly a self-imposed visual delimitation, a self-chosen basic unit of a set of symbols. It partly determines the nearly infinite abundance of regularities, which I depict on the plane—perpendicular in pairs or triplets to each other in multiple dimensions—within and beyond the limits of traditional geometry.

Fig. 1. Graphical unit representing a quark. (© Tamás F. Farkas) (a) *Spin-up* and (b) *spin-down* quarks.



## ABSTRACT

The paper presents remarks by a physicist and a graphic artist on an artwork series produced by the artist. They associate the colors and twists represented in these graphics with the properties of subatomic particles—their structures and connections. The authors use graphical representation to visualize the inner structure of atoms, the classification of quarks and the metaphorical names of abstract physical properties. No textbooks that make visible these basic properties by means of art are currently available. Artistic visualization brings these “mysterious” physical objects closer to the understanding of students and the general public and leaves physicists better able to discover new secrets of the internal structure of quarks and their properties.

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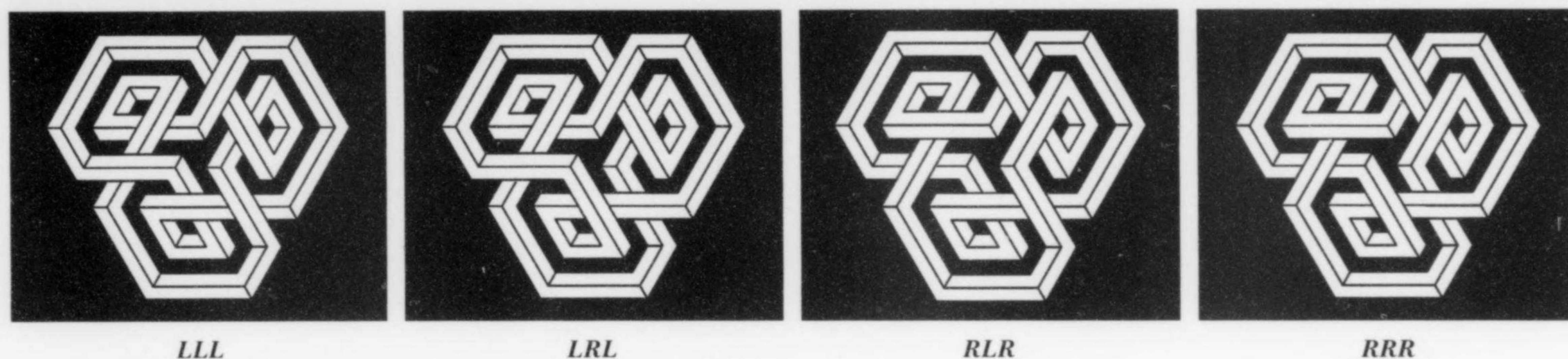


Fig. 2. The four possible *scint* permutations in a graphical unit. (© Tamás F. Farkas)

This *form-world* is composed of one or more continuous, closed quadratic prism lines woven into themselves, each *returning into itself*. These lines, woven also into each other, compose a system characterized by an internal regularity. Applying the regularities I have developed, I create more and more complicated structures within the limits of representation in two dimensions. At the same time, these forms seem to emerge from the plane into the space before the spectator's eyes. These complicated structures retain their perspicuity and can easily be surveyed by the general observer because order and symmetry prevail in them. I most often apply the 2-, 3-, 4- and 6-fold rotational symmetries, and in certain cases mirror-symmetry from among the geometrical symmetry transformations.

Systematic investigations based on symmetry considerations created an open, endlessly rich world of symbols, in which impossible spatial structures, as well as those only realizable in higher dimensions, appear projected onto the 2D plane. In many cases, what seems real in these graphics turns out to be impossible if one attempts to realize them. In other cases, what is impossible in 2 or 3 di-

mensions may be "real" in a higher-dimension world.

Both simpler and more complicated internal structures and line tracings make themselves apparent in these graphics. This form-world is open to both those spectators with a broad imagination as well as those preferring simplicity in their space-view. One can choose either simpler or more revealing, more complicated structures from my set of symbols for the unit of the model-family, according to one's individual visual imagination. The series presented with this paper is only a selection from among the spatial variations of my graphical units, which are suitable to represent the flavor and color worlds of the quarks.

The different graphics, hyperspace structures constructed by line tracing, allow various interpretations. We have chosen a single topic from among the many possible for the purposes of a representation of the physical model of quantum chromodynamics.

My graphics—via the representation of multiplied planes—became appropriate for more than the mere demonstration of the abundance, flavor, color and interlinking structure of the sub-

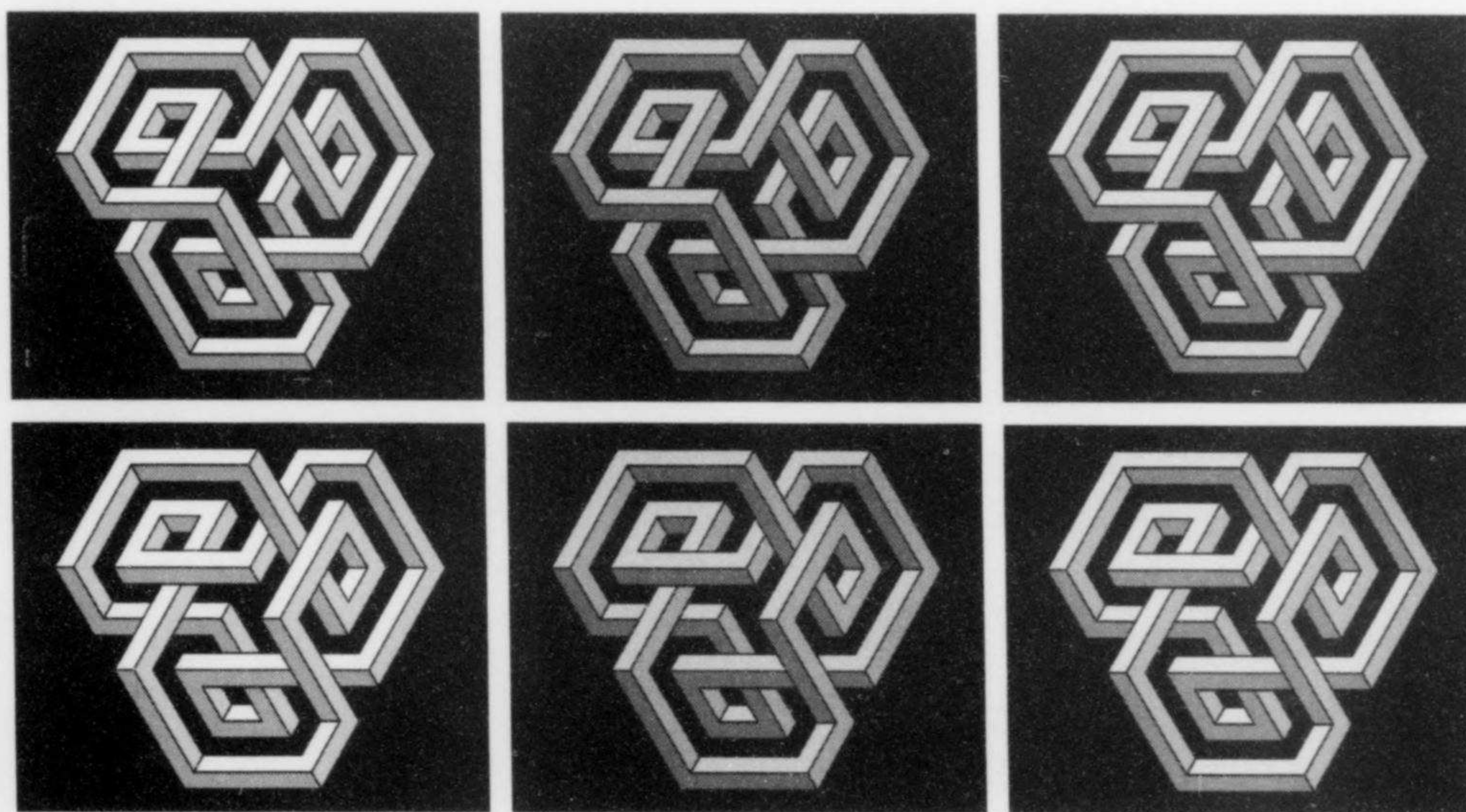
elementary particles by their breaks of lines in well-defined angles expressing dimensional change, directions of rotation, colors and color shades. They are more than illustrations for an imaginary physics textbook. They attribute an aesthetics-carrying internal structure to the individual subatomic particles. According to our present knowledge, several attributes of this internal structure do not correspond to any physical property. Therefore, our imagination is left free to develop its own idea of their beautiful representation. These graphics express the idea that the subatomic particles, at least potentially, may have an internal structure.

While physicists represent a particle as a dot or arrow, we replace these simple symbols with a complex unit possessing internal structure. Thus our images preserve openness for new developments in science. They evoke associations in the mind. They generate thoughts in laypeople and inspire ideas in physicist spectators. At the same time, they express our deep belief that the as-yet-unknown properties of matter are arranged in accordance with symmetry and beauty. They provide us with the illusion that we understand something of physics, although we are "only" enjoying art. This beauty, painted on canvas, has been admired in many individual and collective exhibitions both in Hungary and worldwide, from Washington, D.C., to Israel and from Japan to Italy.

#### DARVAS AND FARKAS: A MODEL OF QUANTUM CHROMODYNAMICS

Atoms consist of electrons, protons and neutrons. Protons and neutrons consist of quarks. Quarks are invisible. So too are their properties. To enable physicists and the public to visually perceive quantum properties, we turn to graphical representations. Since (according to our current knowledge) their symmetries, flavors and colors are among the most important

Fig. 3. Single quarks. Upper row: The *LRL* quark in all 3 colors. Lower row: The *RLR* quark in all 3 colors. (© Tamás F. Farkas) (Colors are indicated by different shades of gray.)



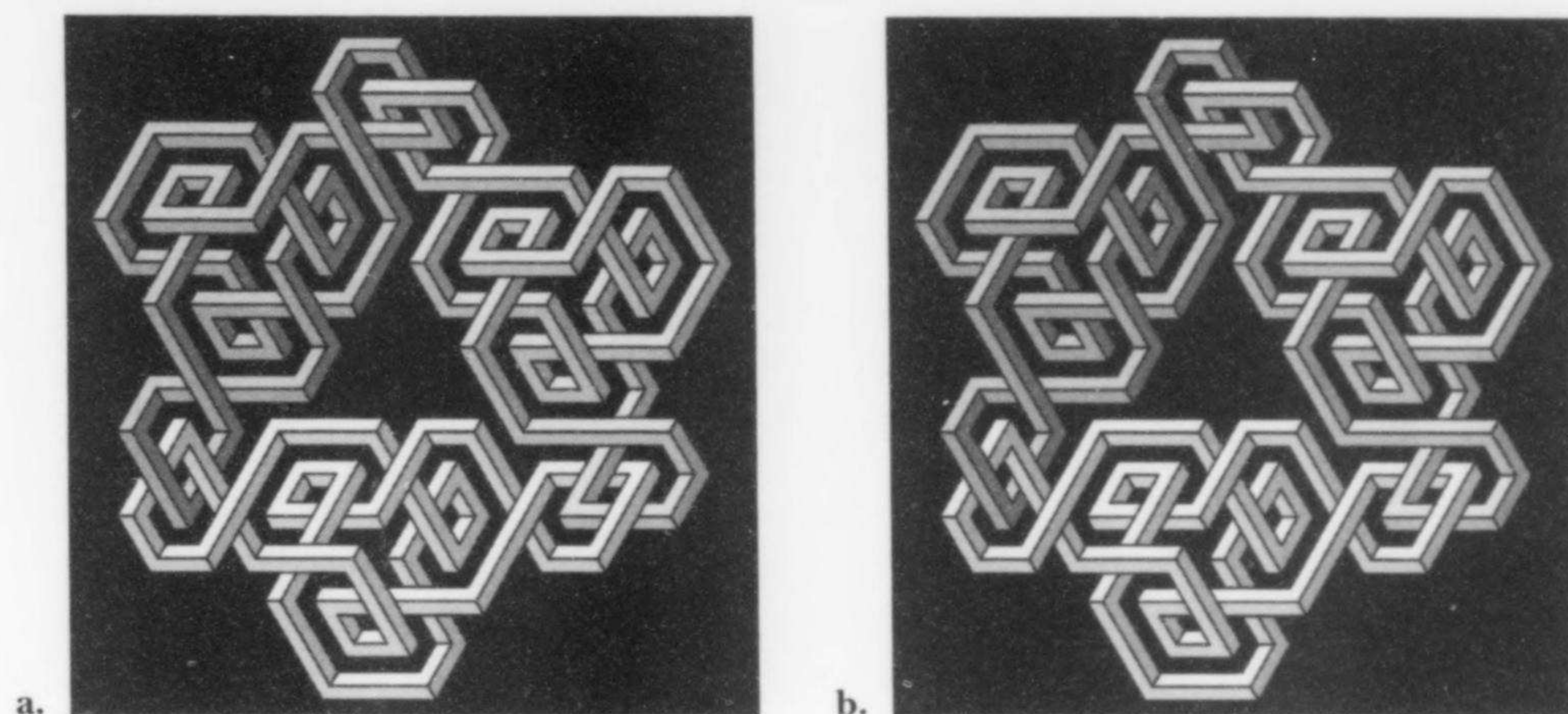


Fig. 4. (a) The proton (*udu*). (b) The neutron (*dud*). (© Tamás F. Farkas)  
(Colors are marked by different shades of gray.)

properties of quarks, these properties should be central to their graphical representation. This can be achieved in a purely schematic way (as in current textbooks), or through the application of art. Darvas, a physicist, realized that a few of Farkas's paintings could serve as graphical representations of certain properties attributed to physical particles.

This paper attempts to lead the reader through the world of quarks via graphical units, colors, shades and screws [3]. Artistic visualization brings these "mysterious" physical objects closer to the understanding of students and the general public. For physicists, the artistic repre-

sentation of quarks and their symmetries, flavors and colors gains its importance through its predictive force. That is, artistic representation makes physicists able to reveal new secrets of the internal structure of quarks and their properties. It opens their minds to new associations. Mathematical and physical connections among the quarks and their properties can be made visible [4].

## THE PLEASURE OF QUARKS

### Quarks

Although quarks never appear in nature unbound to other quarks, we have to start

with single quarks to explain their representation. According to the Standard Model of physics, the structure of matter is made up of quarks.

### The Shape: The Scent of Quarks

Darvas recognized a model for a single quark in the graphical unit shown in Fig. 1a. This work was not intentionally designed as such a model; rather, the association was born in Darvas's mind. We have chosen that graphical unit to represent a single quark in our present visualization. The unit (a shape formed by a line, composed of quadratic prisms, returning into itself) has a three-fold rotational symmetry. It has an internal structure. One can find three twisted loops within this graphical unit. For the sake of illustration, let us assign the twists the property *scent* (this is our coinage; no such property has been conceived in physics). All three twisted loops, that is, scents, are left-handed in Fig. 1a and right-handed in Fig. 1b. (Left-handedness means here that the line forming a loop crosses beneath itself after three right-angled left turns. Right-handedness refers to a similar cross after three right turns.) Scent may then take one of two values: It can be either left-handed or right-handed. Let us call the left-handed scent *masculine* and the right-handed scent *feminine* (these names are also ours). The three twists, i.e. scents, in the representation of a quark are perpendicular to each other (like three adjoining faces of a cube). They form a convex quadratic angle in relation to the plane of the paper. We designate this convex angle a "spin-up" state (Fig. 1a).

### The Spin of Quarks

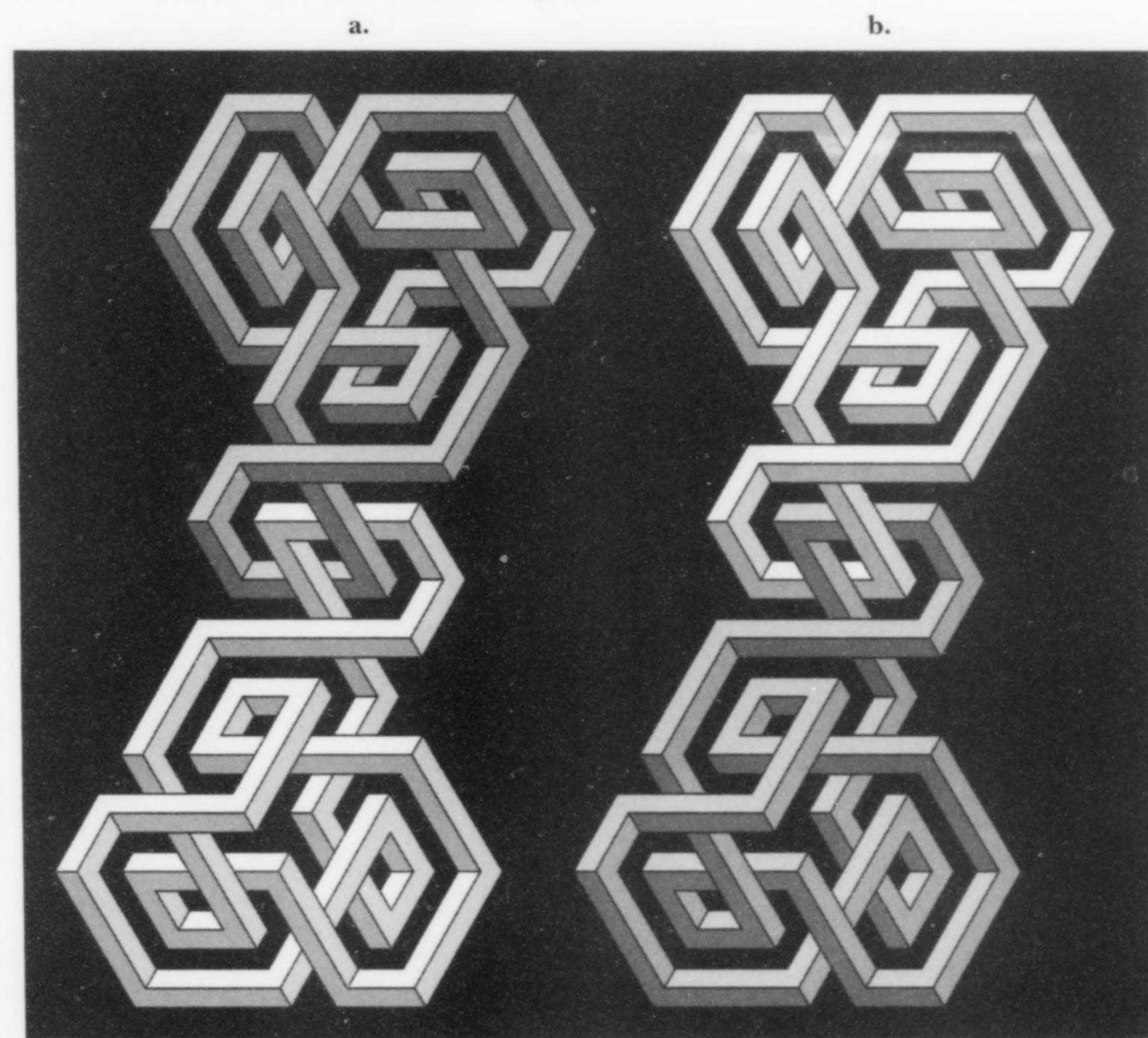
Two quarks are represented in Fig. 1: one spin-up and one spin-down. A spin-down quark is represented by a concave graphical unit (like the opposite three adjacent faces of a cube).

The three loop twists in the graphical representation of a quark can each be left- (*L*) or right-handed (*R*). One unit can geometrically consist of 0, 1, 2 or 3 left-handed (i.e. masculine), and 3, 2, 1 or 0 right-handed (i.e. feminine) scents (Fig. 2). No other permutations can be distinguished from each other. All four permutations of scents may appear both in spin-up and spin-down quarks, respectively. For simplicity, we deal below only with the spin-up states of quarks.

### The Colors of Quarks

According to Pauli's principle, in quantum physics no more than two identical fermions (half-integer spin particles) can

Fig. 5. (a)  $\pi^+$  meson. (b)  $\pi^-$  meson. (© Tamás F. Farkas)  
(Colors are marked by different shades of gray.)



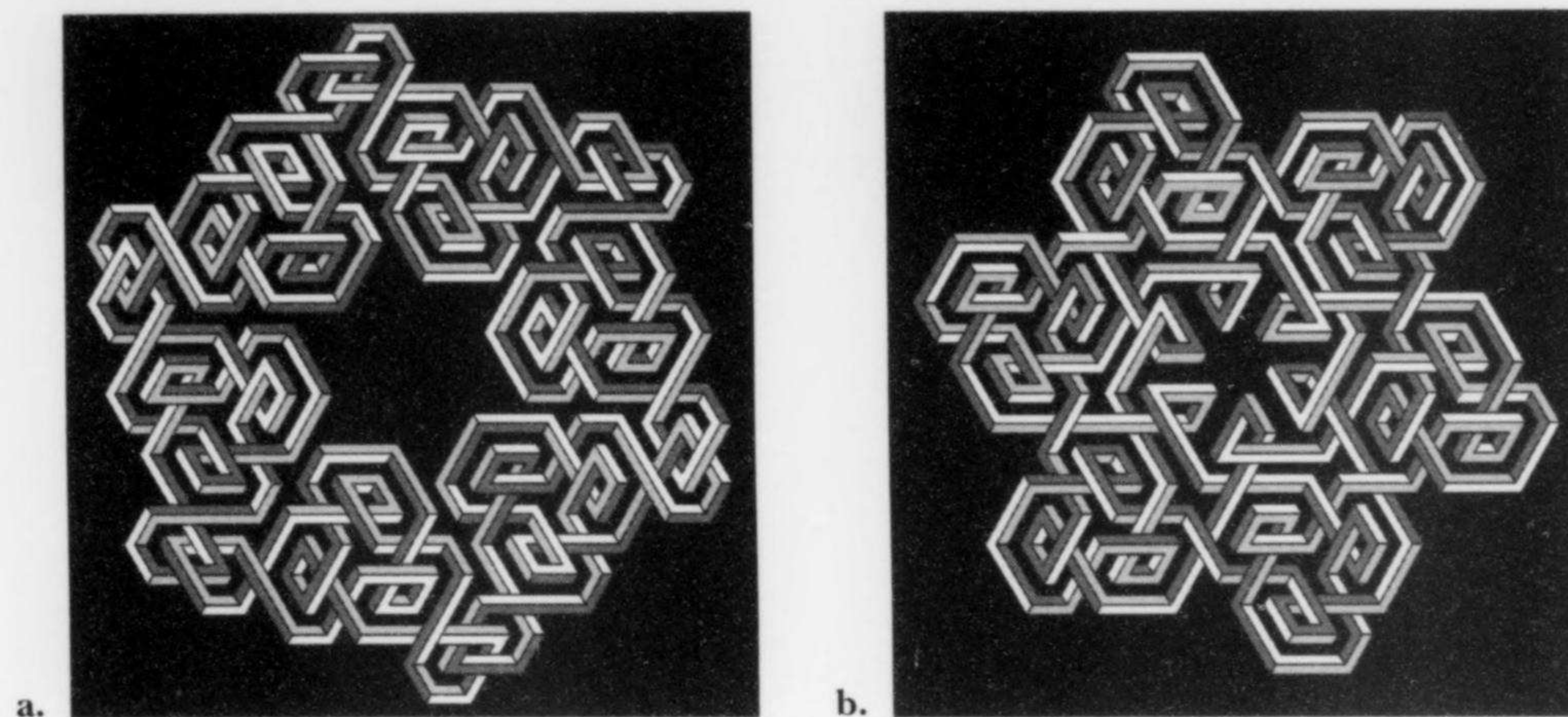


Fig. 6. (a) Nucleus of the deuterium atom. (b) A more sophisticated model of the deuterium nucleus. (© Tamás F. Farkas) (Colors are marked by different shades of gray.)

take part in a single structural unit (and even those two must be in opposite states). This rule must also be applied to scents. Thus the *LLL* and the *RRR* graphical units (the geometrically most symmetrical) cannot represent real physical particles. There remain two physically possible graphical units (*LRL* and *RLR*) (Fig. 3). (Because of the rotational symmetry of the graphical unit, the *LRL*, *LLR* and *RLL* permutations are indistinguishable.) According to our model, they represent quarks. Nevertheless, these two can each appear in three different states of a property, called *colors*. Physicists have named the three values of this property *red*, *green* and *blue*. These are metaphoric names; we apply the corresponding real colors for their representation, however (see Table 1).

### Bound (Real) Quarks

According to our present knowledge, in natural (nonextreme) physical conditions, nature produces only bound quarks. Baryons are always composed of only three quarks, and mesons are always composed of solely a quark and an anti-quark.

When a rotationally symmetrical quark (or the graphical unit representing it) enters into a bond with two others to form a baryon, it loses certain of its symmetry

properties. Note that this is a more general geometric principle of nature, valid not only for quarks: a solitary object has more symmetry properties than it would as part of a system (however, there may appear new symmetry properties in the more complex systems).

### Flavors of Quarks

In the case of our quark model, the individual quarks join to each other via graphical clips (see Fig. 4, Table 1 and Color Plate G No. 1). The binding clip can be joined to two of the three scents. As one can choose two of the three scents in three different ways, the number of possible permutations triples (yielding six different units, each in three colors). We based the correspondence on a classification of the clips, more precisely of which scent-pairs the clips join. We carried out the classification by investigating to which two of the possible three scents the clips joined. For example, in the *LRL* case (Table 1, top), there are three permutations: The clips can join to the two *L*s, which case we call *u*, they can join to an *L* and an *R*, which we call *c*, and they can join to an *R* and an *L*, which we call *t*.

Quarks are graphically joined to other quarks by clips connected to two of their

constituting units. It is not easy to recognize; therefore we draw it to readers' attention that the 6 quarks differ from one another in the permutation of the left-handed and right-handed twists (masculine and feminine scents) to which their clips are attached. For the sake of an easier survey, we represent each in Color Plate G No. 1 in one color only.

Physicists call the property of quarks that distinguishes them from one another their *flavor*. In these terms, one can speak of quarks of the six different listed flavors (up, charm, truth; down, strange and beauty). Let us assume that nature prefers their symmetric (i.e. *-LRL-* and *-RLR-*) junction, so that the up and down quarks appear most frequently in ordinary matter.

### The Structure of Matter

The world is basically composed of *quarks* and *leptons*. According to our present knowledge, these basic building blocks include 6 quarks (more precisely, quarks in 6 flavors) and 6 corresponding anti-quarks. Each of the 6 flavors may be present in 3 colors. Therefore we have 18 quarks (and 18 anti-quarks) altogether.

### The Charges of Quarks

Particles are also characterized by further properties, e.g. electrical charge. The charge of the quarks, consisting of two masculine scents and a feminine one (namely *u*, *c* and *t*) is equal to  $+(2/3)$  in units of electron charge. The charge of the quarks consisting of two feminine scents and one masculine (namely *d*, *s* and *b*) is equal to  $-(1/3)$ . We demonstrate the charges visually, using the scents, from which the charges can be calculated as described below.

### Baryons

According to the Standard Model of physics, a quark never appears in nature alone, only in a triplet or pair. Three quarks form a *baryon*. (The pairing of a quark and an anti-quark forms a *meson*.)

Table 1.

3 possible pairs of clips attached to the *LRL* quarks (each represented in one color only in Color Plate G No. 1)

(green)	(red)	(blue)	(flavor)
-LRL-	-LRL-	-LRL-	= u (up)
-LLR-	-LLR-	-LLR-	= c (charm)
-RLL-	-RLL-	-RLL-	= t (top or truth)

3 possible pairs of clips attached to the *RLR* quarks (each represented in one color only in Color Plate G, No. 1)

(green)	(red)	(blue)	(flavor)
-RLR-	-RLR-	-RLR-	= d (down)
-RRL-	-RRL-	-RRL-	= s (strange)
-LRR-	-LRR-	-LRR-	= b (bottom or beauty)

Mesons transmit the mutual interactions between baryons.) Baryons and mesons together are called hadrons. Quarks exist confined in hadrons. According to our model, if we could observe a hypothetical "single" quark, we could "see" it only in two states (not in six) because the permutations of the junctions, which distinguish from each other the flavors ( $u$ ,  $c$  and  $t$ ) and ( $d$ ,  $s$  and  $b$ ), would vanish in the absence of binding. At the same time, both could appear in all 3 colors separately.

The quarks within an individual baryon are always of different colors. Moreover, according to the Standard Model, they change their colors continually at a very rapid pace. The color of the quarks is not an observable property. A quark emits a so-called gluon, which another absorbs. This process changes the colors of both. The latter quark also emits a gluon and changes color with the third, and so on. This mechanism ensures not only the permanent color change of the individual quarks, but also that all three have different colors simultaneously. Thus the observer always detects equal proportions of the different colors; therefore, the quarks are seen from the outside as "white," that is, colorless.

Any three of the quark flavors may form a baryon. All the constituent quarks are of different colors (red, green and blue). The most common form of matter is that of two baryons: protons and neutrons (Fig. 4).

Darvas saw in Fig. 4a the model of a *proton*. In a proton, two  $u$  quarks and a  $d$  quark are bound together. The colors of the individual quarks in the image are chosen randomly, and all three change their colors with great frequency. Note that the red, blue and green graphical units are not identical. (See Color Plate G No. 2a. Figure 4 distinguishes the colors by different shades of gray.) The  $u$  and the  $d$  quarks within the proton can be distinguished by their binding scents. The  $u$  quarks are joined to their partners next to their two left-handed twists, and the  $d$  quark next to its two right-handed twists. In other words, the  $u$  quarks have no joining clip connected to their right-handed twist, and the  $d$  quark has no joining clip connected to its left-handed twist. (Note also that although one of the two  $u$  quarks has a down spin—concave in our system of symbols—for aesthetic reasons we draw here only convex—spin-up—quarks to represent all three quarks, thus the second  $u$  quark too.)

Darvas saw in Fig. 4b the model of a *neutron*. In a neutron two  $d$  quarks and a  $u$  quark are bound together. The color of

the individual quarks in the image is chosen randomly (see Color Plate G No. 2c, left-hand object), and all three change their colors with high frequency. (Note again that for aesthetic reasons we did not draw a spin-down quark to represent the second  $d$  quark.)

### Anti-Quarks

"Anti"-particles are those with a charge of opposite sign to that of a given particle. Anti-quarks have charges of  $-(2/3)$  and  $+(1/3)$ . Anti-quarks are represented in this model by their complementary colors. In accordance with quantum chromodynamics, anti-quarks are represented (graphically) in a way identical to the corresponding quarks; however, their colors are the colors complementary to the respective quarks. (The inverse of the hexadecimal number or numeric code for a color denotes the code of the complementary color of the original.)

### Mesons

Mesons are pairings of a quark and an anti-quark. Darvas saw in Fig. 5 models for mesons. When forming a meson, a quark is bound to only one other entity (called an anti-quark); thus they join to the anti-quarks next to that scent that does not take part in binding into a baryon (e.g. a  $u$  quark joins to two quarks next to its two left-handed twists and to an anti-quark next to its right-handed twist).

The  $\pi^+$  meson (Fig. 5a; see also Color Plate G No. 2c, right) consists of a  $u$  quark (red; dark gray in Fig. 5a) and an anti- $d$  ( $\bar{d}$ ) quark (cyan; light gray in Fig. 5a). A  $u$  quark is coupled with another to form a meson through its right-handed twist, while a  $d$  or  $\bar{d}$  quark is coupled through its left-handed twist. The charge of a  $\pi^+$  meson is equal to  $+1 [(2/3) + (1/3)]$ .

Let us set out the model of the  $\pi$  meson (Fig. 5b). The  $\pi^-$  meson consists of an anti- $u$  ( $\bar{u}$ ) quark and a  $d$  quark. If the  $d$  quark (similar to the above  $u$ ) takes the

color red (dark in Fig. 5b), the anti- $u$  ( $\bar{u}$ ) quark takes the complementary color, which we mark as cyan (light gray in Fig. 5b). The charge of a  $\pi^-$  meson is equal to  $-1 [(-1/3) + (-2/3)]$ .

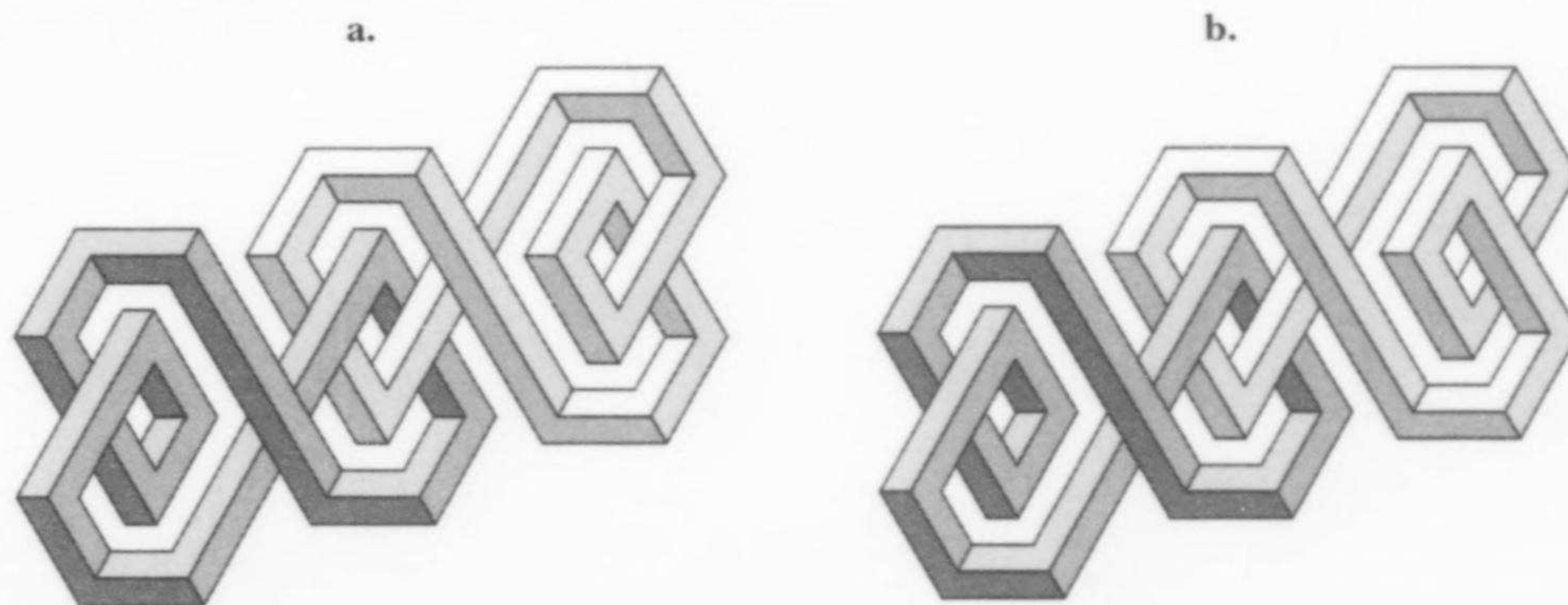
How does a physicist visualize the transformations of the particles into each other through these graphics? For example, a proton's transformation into a neutron (plus a positive pi meson:  $p \rightarrow n + \pi^+$ ) can be graphically described as in Color Plate G No. 2. A  $u$  quark is drawn out of a proton, while the connecting "string" is broken (Color Plate G No. 2b). At the broken ends a quark and anti-quark pair ( $d - \bar{d}$ ) appears: The  $d$  quark replaces the  $u$  quark in the baryon, thus forming a neutron instead of the former proton, and the  $\bar{d}$  quark forms a  $u - \bar{d}$  pair, that is a  $\pi^+$  meson, with the  $u$  quark (drawn out of the proton) (Color Plate G No. 2c). (Note the shift of the joining clip of the  $u$  quark from the two left-handed twists when bound in a baryon to the right-handed twist when bound in a meson, as well as the different joinings of the  $d$  and the  $\bar{d}$  quarks in the baryon and the meson, respectively.) All meson-mediated baryon transformations, that is, all particle reactions, can be graphically demonstrated in a similar way.

### Nuclei

Protons and neutrons form the nuclei of atoms. The nucleus of the simplest atom, that of hydrogen, is a single proton. The next simplest nucleus is that of deuterium.

The nucleus of the deuterium atom (Fig. 6a) consists of a proton ( $udu$ ) and a neutron ( $dud$ ). Thus the deuterium nucleus consists of 3  $u$  and 3  $d$  quarks. Note certain symmetries of the model: Both the  $u$  and the  $d$  quarks appear in all 3 colors, and the identically colored quarks appear in opposite-spin (convex and concave) states. (This model does not fully coincide with the experimental evidence found by nuclear physicists, since in ac-

Fig. 7. (a) The electron ( $e^-$ ). (b) The positron ( $e^+$ ) (© Tamás F. Farkas) (Colors are marked by different shades of gray.)



tual experiments the two centers—the proton and the neutron—within a deuterium can be separately observed.)

The model can be extended. For example, we can imagine that quarks within baryons and nuclei are more intermingled than is shown in Fig. 6a, where they can be visually separated. The applied graphic representation of the quark model makes it possible to represent a more complex intermingling of the quarks within a baryon and a nucleon. Although this representation can be used to represent more detailed physical models, its complexity demands a more sophisticated view by the reader. Nevertheless, it demonstrates that the model is open to further developments of the physical theory.

## PREDICTIVE FORCE OF THE MODEL

### Rishons

When looking at the graphical constituents of quarks, what do we see? The model can predict properties not yet or only partially conceived of in physics. These are assumptions not yet proven. One can observe that the three scents constituting a quark can be represented as individual units. A physical model introduced by Harari [5] advanced a hypothesis that all physical particles could be constructed with the help of two primary components. He called these components *rishons*. According to his model, there would be two rishons (called by him *Tohu* and *Vohu*), with electric charges ( $-\frac{1}{3}$ ) and 0 (the anti-rishons would have the charges 0 and  $\frac{1}{3}$ ).

We draw a similar model. Our model, however, paints a picture of the rishons somewhat different from Harari's. The quarks in our model are composed of the two rishons (and their anti-rishons) as represented in Color Plate G No. 3, and we want to compose the electric charges

of the quarks from the charges of our rishons to be  $\frac{2}{3}$  for (*u, c, t*) and  $\frac{1}{3}$  for (*d, s, b*), as in the Standard Model.

All the quarks represented in our model can be composed using the two graphical units seen in the upper and the lower rows of Color Plate G No. 3. Masculine scent is represented by a left-handed twisted rishon; feminine scent is represented by a right-handed twisted rishon. The *u, c* and *t* quarks (charge  $+\frac{2}{3}$ ) are composed of two left-handed-twist rishons and one right-handed (having two masculine scents and one feminine). The *d, s* and *b* quarks (charge  $-\frac{1}{3}$ ) are composed of two right-handed twists and a left-handed twist, or in other words, two feminine-scent rishons and one masculine.

This combination demands that the electric charge of the masculine-scent rishon be  $\frac{5}{9}$  and the electric charge of the feminine-scent rishon be  $-\frac{4}{9}$ .

Observe that these graphical units are asymmetric. Their peculiarity is that one can compose visually symmetric units (quarks; see Fig. 1) from three individually asymmetric components (rishons). This asymmetry predicted that one could not expect symmetric properties devoted to these primary components (cf. their electric charges,  $+\frac{5}{9}$  and  $-\frac{4}{9}$  respectively).

### Leptons

The rishon model read from Farkas's graphics is suitable to represent leptons as well. Let us represent the members of the electron family using red and anti-red (cyan) colors.

An electron (Fig. 7a) can be composed of a feminine and an anti-masculine-scent rishon ( $\bar{L}R$ ) [6]. Its charge is  $-1$  [ $(-\frac{5}{9}) + (-\frac{4}{9})$ ].

A positron (Fig. 7b) can be composed of a masculine and an anti-feminine-scent rishon ( $R\bar{L}$ ). Its charge is  $+1$  ( $\frac{4}{9} + \frac{5}{9}$ ).

A neutrino (Fig. 8a) can be composed of a feminine and anti-feminine-scent rishon pair ( $R\bar{R}$ ). Its charge is 0.

Similarly, an anti-neutrino (Fig. 8b) can be composed of a masculine and anti-masculine rishon pair ( $L\bar{L}$ ). Its charge is also 0.

This model, like Harari's theory, is also unable to give an account of the masses of the leptons. Regarding the colors, quarks can be made only of equally colored rishons (the model cannot give an explanation for the reasons), and leptons can be made only of complementarily colored rishons. This method properly represents the leptons as colorless. Perhaps the *muon* and *tau* lepton families could be represented by the other two colors (green and blue) and their complementary colors, but this is as yet only an assumption.

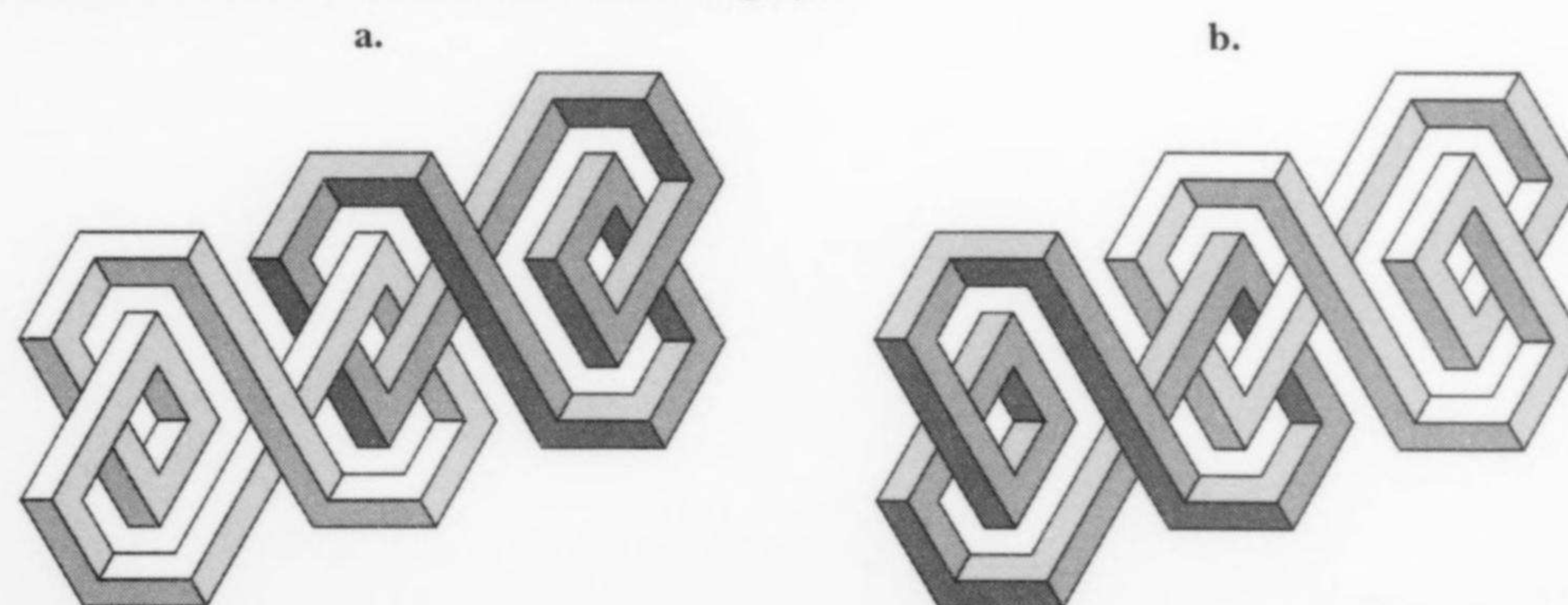
## CONCLUSIONS

We emphasize again that this paper does not describe a physical theory. It presents a graphic artwork series accompanied by the comments of a physicist on what he sees in systematically studying them. The paper shows that a physical theory—namely the Standard Model of quantum chromodynamics—can be demonstrated in graphic artworks. There is one physical novelty in the model, a new prediction on the charges of the rishons. Here we should make two remarks. First, according to contemporary physics, rishon theory seems to depart from the mainstream of the development of physics. Second, a graphic representation cannot serve as a physical proof of the value of a physical property. The emphasis is on the artworks, which are original and mentally stimulating. These artworks (which were painted in oil on large-scale canvases) contain geometrically new "impossible" constructions, new "space views." A physicist saw in them a certain similarity to the system by which subatomic particles have been classified.

## References and Notes

1. P. Erdi and F.T. Farkas, "Impossible Forms," *Leonardo* 18, No. 3, 179–183 (1985).
2. Note that the properties of quarks referred to as colors, etc., are only metaphorical and not identical to colors perceived with our eyes, flavors perceived with our tongues, etc. These metaphors are applied in the process of visualization.
3. These screws can be found in the center of each detail, and are chirally twisted right-handed or left-handed, to which point we attribute fundamental symbolic properties, as will be shown further on in the text.
4. See note [2].

Fig. 8. (a) The neutrino ( $\nu$ ) (b) The anti-neutrino ( $\bar{\nu}$ ) (© Tamás F. Farkas) (Colors are marked by different shades of gray.)



5. H. Harari, "A Schematic Model of Quarks and Leptons," *Physics Letters B* 86 (1979) pp. 83–86.

6. Graphically it is composed of a feminine scent (i.e. an R-twisted [Color Plate G No. 3, lower left]) rishon and a masculine scent (i.e. an L-twisted anti-colored [Color Plate G No. 3, upper right]) anti-rishon, joined to each other by the above-mentioned clips in the center of the graphic. A color and an anti-color neutralize each other, so that the lepton will not show an observable color from outside).

### Bibliography

Darvas, G.; Nagy, D.; and Pardavi-Horvath, M., eds. *Symmetry: Natural and Artificial* (Budapest: Symmetrion, 1995), 734 pp.

Darvas, G., ed. *Ars (Dis)Symmetrica '99; Science Reflected in the Arts—Art in the Sciences* (satellite art program series accompanying the UNESCO-ICSU World Conference on Science, "Science for the Twenty-First Century: A New Commitment," 1999) (Budapest: Institute for Research Organisation Hungarian Academy of Sciences; and Symmetrion, 1999), 144 pp.

Farkas, F.T. "Imaginary Symmetries," *Symmetry: Culture and Science* 3, No. 1, 83–100 (1992).

Greiner, W., et al. *Quantum Chromodynamics*, 2nd Ed. (Heidelberg, Germany, and New York: Springer Verlag, 2001), 428 pp.

Ne'eman, Y., and Kirsh, Y. *The Particle Hunters* (Cambridge, U.K.: Cambridge Univ. Press, 1986), 272 pp.

Suganuma, H., et al., eds. *Quantum Chromodynamics & Color Confinement* (Singapore: World Scientific, 2001), 424 pp.

Zee, A. *Fearful Symmetry: The Search for Beauty in Modern Physics* (New York: Macmillan, 1986), xiv + 322 pp.

### Glossary

**anti-particle**—particle with an electric charge of opposite sign to that of a given particle.

**baryon**—half-integer spin particle affected by the strong force.

**fermion**—half-integer spin particle.

**flavor, color**—see *quark*.

**gluon**—integer spin particle intermedating color changes between quarks.

**hadron**—a general term that denotes both baryons and mesons.

**lepton**—half-spin particle unaffected by the strong force (electron, muon, tau and their neutrinos).

**meson**—quark-antiquark pair; integer spin particle intermedating strong interactions between baryons.

**neutrino**—particle affected solely by weak force.

**positron**—anti-particle of the electron.

**quantum chromodynamics**—physical theory of the strong interaction, describing the properties of quarks (such as flavors and colors).

**quark**—constituents of physical particles; three quarks form a baryon (e.g. a proton or neutron) and a quark-antiquark pair forms a meson; quarks are classified by metaphorically named properties: they appear in six *flavors* and each flavor in three *colors*.

**rishon**—hypothetical particle, three of which constitute a quark.

**scent**—hypothetical property attributed to quarks in this paper.

**spin**—a particle's own angular momentum of rotation around its axis (which is additional to its angular momentum calculated from its rotation around its axis).

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Special Section

# Colloquium on Art/Science/ Spirituality Reconnections within Emerging Planetary Cultures

*Guest Editor: Julien Knebusch*

Selected papers from the Colloquium on Art/Science/Spirituality Reconnections within Emerging Planetary Cultures, part of the First Melilla Festival for the 5 Cultures, Melilla, Spain, 18–20 July 2004.

This colloquium, co-sponsored by Al Andalus Foundation, UNESCO DIGI-ARTS, the Leonardo Global Crossings Project and the Ford and Rockefeller foundations, focused on the different cultural groups living within the city of Melilla: Jews, Spaniards, Moroccans, Tziganes and Indians. Melilla is well situated for international dialogue. It sits at the periphery of Europe as one of the few Spanish cities still existing in Morocco. The city is encircled by a militarized wall, similar to the wall dividing Israel from Palestinian territories, to prevent African immigrants from entering this “door” to Europe.

The content and progress of a colloquium is much dependent on its location. This colloquium, with 20 participating artists, scientists and philosophers, was intended to provide a listening post, an opportunity for intercultural dialogue and a specific step toward the amplification of new emerging planetary cultural developments. Speakers presented specific scientific and artistic work and made explicit the contexts of cultures, philosophies and religions that set a priori conditions and constraints on their approaches and their specific works.

In addition to the intellectual interest of the symposium, the visit to the city and the various, continuous and unforeseen interactions among the participants constituted a deep and rich experience.

# The Philippine Triad and Western Dichotomous Philosophies: A Contest of Traditions in Three Audio-Performance Projects

Fatima Lasay

In this paper, I present three of my audio-performance projects that have helped me shape an analytical position and philosophy based on the tripartite social structure of ancient Philippine society. This social structure consists of three primary roles: the *Datu*, *Pandáy* and *Babaylan*.

The *Datu* (chief or chieftain) is responsible for political affairs, military functions and the economic health of society, commerce and agriculture. The *Pandáy* (blacksmith), who works with metal, is a specialist in making things for domestic, agricultural and military purposes. The *Babaylan* (priest or shaman), considered the most significant in this trinity, is an expert on culture, religion, medicine and theoretical and practical knowledge of natural and spiritual phenomena; he or she is a kind of proto-scientist with skills for mediating between god/s and humans [1].

With such triads as their hubs, ancient Philippine communities were physically, economically and politically interlinked through the archipelago's riverine and coastal networks. Political power was dependent on ties among communities, and all power was defined by the people. The triad did not hold absolute authority, nor did it uphold norms or yardsticks of progress or development. The triad society was a fluid, riverine rank society and not a rigid class society [2].

Most importantly, ancient Philippine communities were also psychologically interlinked via the sun rituals of the *Babaylan*. There were many types of rituals, but central among these was that involving the relationship of the *Babaylan* to the sun, and all the *Babaylan* were interconnected in both the modern country itself and in the precolonial region, in which a particular mythology was salient. Ethnolinguistic beliefs and mythologies have a practical aspect expressed in what is called a ritual. The ritual of the *Babaylan* usually consists of observing the sun and its movement—this ritual is the source of dance, theater and all artistic and literary forms.

Rituals are actions or rites that follow a prescribed pattern and are believed to be highly efficacious. The presence of a prescription indicates the connection of a ritual with a tradition, a past or a myth, and the belief that a ritual is efficacious

indicates the power of the ritual to produce specific desired results. Because conditions and needs change in time and place, what is determined to be efficacious also changes according to time and place. Therefore, rituals, although prescribed to some extent, must be living; they must change or evolve.

## A SOUND ARCHAEOLOGY WORKSHOP

In the project *A Sound Archaeology Workshop* (June 2004), I explored both the past and contemporary meaning of ritual with five students from the Ecole Cantonale d'Art du Valais in Sierre, Switzerland.

In the conception of a multicultural computer-art workshop, I decided to take a cultural approach to digital sound editing. In the triad, the exchange of technical knowledge is only one aspect, that of the *Pandáy* or blacksmith. What must take place in a triad is a recovery (unearthing) of internal knowledge. A focus on foreign culture is also not sufficient, because the "otherness" of foreign concepts such as that of the "ritual" can turn into either alienation or exoticization and objectification. What must take place instead is the experience of internal rituals.

In acoustic ecology and the practices of soundwalking and soundscape composition, there is an association with the context of sound. In electroacoustic and acousmatic music and musique concrète, recorded sounds are taken out of their context. In the *Sound Archaeology Workshop*, we moved across and beyond these practices—from an intense listening to a pristine and undisturbed sonic environment, to ritualistic listening and intervention by establishing a dialogue with the cultural environment. Hence we engage a biocultural feedback system within ourselves, the sounds that we produce and the sounds from the natural and cultural environment.

A soundscape composer re-creates or makes a representation of a sonic environment and inspires a dialogue through memories and associations. What kind of dialogue or what kind of sonic memories and associations are recovered and remembered in a ritualistic interaction with the environment? In this workshop, we moved beyond sound expression by employing the ritual acts of birth through death. We investigated

## ABSTRACT

The author's three projects draw upon her analysis of a triumvirate of social roles in ancient Philippine society, especially in connection with the maintenance of ritual in that society. Each project addresses the historical function of ritual as well as how it is carried over into art.

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Based on "Lessons from the Philippine Triad," paper presented at the Colloquium on Art/Science/Spirituality Reconnections within Emerging Planetary Cultures, part of the First Melilla Festival for the 5 Cultures, Melilla, Spain, 18–20 July 2004.



Fig. 1. *Mga Awit mula sa Gimokud/Chansons de mes deux âmes* (Songs from the *Gimokud* or *My Two Souls*), sound installation in Lac Géronde, Sierre, Switzerland, 2004. (© Fatima Lasay)

the corporeal and incorporeal qualities of sound, sound as relic or artifact, and thereafter the digital editing studio as reliquary of sound events.

The inspiration for this sound workshop came from the sound and dance rituals of the Subanen in the Zamboanga Peninsula of the Philippines. In the *soten*, *dumadel* and *pangaliwato* rituals, the shaking of dried fronds calls the attention of the *diwata* (goddess)—the sound of the leaves is the sound most beautiful to the gods' ears.

It is also from the *buklug*, the most elaborate of the Subanen rituals of thanksgiving, that the *Sound Archaeology Workshop* derives. The *buklugan* (ritual site) is prepared by raising a platform or stage 10 to 18 feet above the ground. A beam passes through the middle of the stage, and below stretches a thick log laid on the ground. This log is hollowed out and lies over large earthen jars sunk in the earth, which serve as sound resonators. As in the Subanen epic *Sundayo*, the people dance up and down the stage

to sound out a communal call to the gods and ancestors [3].

In the *Sound Archaeology Workshop*, sounds from the environment and from personal actions or ceremonies of burying a pot or other vessel beneath the ground were recorded. The sound rituals took place in the vineyards of the Château Mercier. I selected a vineyard because it is a site where the cycle of life and death is manifested, and this one was the generations-old site of tradition and culture in the wine-producing city of Sierre.

Our rituals were based on five different contexts, representing the cycle of life: (1) union or marriage, (2) expectation or pregnancy, (3) healing, (4) offering, and (5) death. Each student selected a stage in the cycle of life and performed a personal ritual that related to it. What was common to all the rituals was that they involved the prescribed action of placing ritual objects in a vessel and burying it in the vineyard.

In the *Sound Archaeology Workshop*, we

performed our personal and cultural rituals in the vineyards of Château Mercier; we paid attention to the sounds that we invoked. We recorded these sounds carefully. Collectively, our rituals compose the cycle of life, a cycle remembered in the ancestral vineyards of Sierre. As our rituals were being enacted, recovered or remembered, we received the magnified sounds through the use of powerful stereo microphones and headphones. The sound experience generated the expansion of a universe of ritual and sound; it challenged our familiar understanding of both.

In other words, our experience of the sonic landscape was extended into a foreign situation, a foreign place and culture. In the archaeology of sound, we reassembled the evidence. From the vineyards to the sound studio, from the sound to its contexts, the challenge was how to achieve resonance between the rite and the relic, the composer and the listener. We listened to and manipulated the recorded sounds in a digital sound stu-

dio, seeking to create a balance and resonance between different contexts and sound content. Using differing cultures and languages, how do we learn to hear and understand one another?

Balance and resonance were intrinsic aspects of the ancient Philippine triad society. Composed of clusters of interconnected riverine, coastal and near-coastal communities, ancient Philippine network society maintained a balance of communalism, sovereignty and autonomy under the combined expertise of the Datu and Pandáy with the spiritual and psychic mediation of the Babaylan. A psychic interconnection was also maintained through the communal sun rituals of the Babaylan. This triumvirate balance held together a rank society stratified through water channels and sun rituals.

The triad society, as a rank society, differed from classic slaveholding societies [4]. When Western colonialism arrested the Asiatic development of Philippine society, however, clusters of community were drastically transformed from social into political units, and communal relationships corrupted into relations of exploitation. So as conditions "progressed," the Datu and Pandáy retained their positions, and the Babaylan was bombed, civilized and educated into oblivion. The nature of the ritual as a rite of the Babaylan was destroyed. Spirit degenerated into intellect. Ritual degenerated into "art."

In a society where the Babaylan is endowed with the power to weave the physical, social, spiritual and psychological ties of a community, the art/science and East/West dichotomies have no place. For the extrication of its members from the oppressive relationship with the dangerously bipolar world of present times, the Babaylan's place needs to be renewed. Art could be a powerful means of renewal in this context.

### **THE SOUNDS OF LIFE: A CELEBRATION OF THE GRAPE**

In *The Sounds of Life: A Celebration of the Grape*, I sought to explore how sound could be a medium for "therapy" or the renewal of the integrated Babaylan within ourselves.

*The Sounds of Life* was a sound workshop carried out with four children at the Institut Notre-Dame de Lourdes, a school and clinic for children with developmental disabilities. Mini-disc recorders, stereo headphones and microphones were used in the recording of sounds during a grape-planting ceremony. The chil-

dren wore stereo headphones so they could hear the magnified sounds—digging, watering, chatting and singing—of planting the grape plant. A listening session took place several days after the ceremony.

In *The Sounds of Life*, I used the art of active listening as an exploration of "riverine connections" within a person—interconnecting mind, body and spirit. Art here is not a psychological (therapeutic) bridge between two poles but rather a source of interconnection within human faculties for memory and consciousness. Carl Jung once stated that he wanted to build a bridge of psychological understanding between East and West. He also wrote:

Western consciousness is by no means consciousness in general; it is a historically conditioned and geographically limited factor, representative of only one part of mankind. The widening of our consciousness ought not to proceed at the expense of other kinds of consciousness, but ought to take place through the developments of those elements of our psyche which are analogous to those of the alien psyche, just as the east cannot do without our technology, science, and industry. The European invasion of the east was indeed a violence on a grand scale, and it has left us the duty—noblesse oblige—of understanding the mind of the east. This is perhaps more necessary than we realize at present [5].

What is the relationship of the "technology, science and industry" of the West (which the East "cannot do without") to

Western psychic development through analogy with the eastern psyche? Is Jung's proposal a trivialization of "the mind of the east" as the object of Western "noblesse oblige"?

The binaries of Jung do not make sense to me.

Fulvio and Véronique, my friends and partners in the *Sounds of Life*, told me that this was the first time that year that the children remembered what they had done at the school. They remember planting the grape plant and singing and that I visited them. My work as an artist and as a Filipino has been about recovery and remembrance, and I am deeply moved by the children's remembering the simplicity of the ordinary ritual of planting grapes.

I see the triad as a means of recovering and remembering communalism, sovereignty and autonomy in a country corrupted by foreign imperialism and internal feudalism. To recover art as a ritual is to recover the role of the artist as an intellectual (like the Datu), an activist (like the Pandáy) and a cultural producer (like the Babaylan) in the shaping of culture.

Amid the detritus of capitalist intrusion, colonial Philippine society evolved via struggle and debate into a heightened awareness of the exploitation of the people. Today, I see the ancient heritage of the triad as a precursor of geopolitics and a powerful means of contemplating the binary illusions of the competitive

Fig. 2. Small boats made of grape branches, paper and gold leaf are placed under the sound structures near the lake. (© Fatima Lasay)





Fig. 3. Releasing one of the small boats into the lake may represent either the release of the soul or an offering to the gods. (© Fatima Lasay)

economy. The triad provides an analytical position for unraveling the interactions between the economic base and the political and cultural levels of society. Through the triad, I hope to investigate the relationship between structure and agency, using a political economy approach to understanding and solving the conflicts in our highly polarized world today.

### **MGA AWIT MULA SA GIMOKUD/CHANSONS DE MES DEUX ÂMES**

Out of the need to explore this polarity, dichotomy or duality that persists in Philippine postcolonial life, particularly in the dichotomous relationship between Catholicism and animism, I created a sound installation using experiences and materials gathered during my stay in Sierre and the Monastère Notre-Dame de Géronde.

The sound installation *Mga Awit mula sa Gimokud/Chansons de mes deux âmes* (Songs from the *Gimokud* or My Two Souls) (Lac Géronde, Sierre, Switzerland, 2004) consists of two structures built from grape branches. The structures were suspended from two trees over Lac Géronde (Fig. 1). Inside the structures were sound speakers. The sounds coming from the two structures were different—one was completely synthetic (melody, score and timbre were algorithm-defined) and the other analogue/natural (recordings of water, wind, foot-

steps and the hourly prayer and singing of nuns at the Monastère Notre-Dame de Géronde). Little boats carrying gold leaf were placed under the grape structures near the water (Fig. 2).

The symbolic act of “release and offering” by sending one of the grape boats out into Lac Géronde as part of the sound installation (Fig. 3) recalls the Philippine myth of the soul, the significance of the journey and the offering to the skyworld through the waters. It represents the release of the soul, its journey through the water toward the center of the universe; it can also represent the offering of gifts, such as gold or food, as still performed by the Tagbanuwa people of Palawan in their dramatic ritual offering of a ceremonial raft for protection from spirits of epidemic disease. Subterranean streams are believed to pass through the highest mountains of every region of the Philippines, eventually converging at a main stream that heads to Mount Kanlaon, the center of the universe.

The concept of the *gimokud* derives from an ancient Philippine myth. According to the Bagobo people of Davao, in the south of the Philippines, there are in every person two souls, called the *gimokud*. The right-hand *gimokud* is the good soul, associated with health and joy. The left-hand *gimokud* is the bad soul, associated with pain and sickness [6].

In *Mga Awit mula sa Gimokud*, my two souls are represented in the form of two drops of water from which the sounds

emanate. The forms are woven from grape branches. In the vineyards of Sierre I see the eternal cycle of life and death, just as the soul is like a raindrop carried by the spirit boat in an eternal journey between heaven and earth. The songs from my two souls are reflections of this eternity through the sound of the endlessly flowing river and the hourly singing of contemplative nuns in Notre-Dame de Géronde.

In the Philippine pantheon, the god Mamaguayen ferries the soul in a boat to the end of the world; even when they were placed at the walls of caves, the shape of coffins of ancient Filipinos was that of a boat. In Sierre, my soul will journey in a boat made of the branches of the ancestral grapes. Gold leaf is placed inside the boats as payment for Mamaguayen.

In *Mga Awit mula sa Gimokud* I use sound to measure the distance between Philippine animist religion and Catholicism, between the cold and Sierre, the City of the Sun, between the ancestral grapes and the eternal waters of the Rhône. *Mga Awit mula sa Gimokud* is about a struggle within myself; it is about the world of opposites and my resistance to the desire for isolation (Color Plate C No. 2).

Periods of crisis in human history are marked by historically conjured barriers between manual and mental labor, in that fissure between workers' movements and the existence of intellectuals in a deceptively bipolar world, neglecting and obscuring the triad of communalism, sovereignty and autonomy. In what is often dubbed a postmodern world, it has become too convenient to either split or homogenize a bipolar world and make us forget the role of the triad from the time of our most ancient systems through which we demonstrated and challenged not merely our privileged knowledge but respected a “reality” that escaped our ambitions and reminded us of the limits of what we know. Recently it has become all too easy to overlook the barbarism, the loss of balance through the illusion of momentum preached by globalization, while we are awed by the reflection in the mirror. It has become all too easy now to be “taken in by love” when imperialism, education and capitalism are so intimately enmeshed, rendering even our experience of hunger and injustice insignificant.

The triad as an analytical position calls for a deeper contemplation and internalization of “local rhythms” and reaffirmation of rights activated by the urgency of our identities. The triad is like the in-

ternal pendulum of the ancient Chinese seismograph. This is how we know imbalance and the dichotomy as it transpires from across the globe. But this inner contraption must be protected from the commodification and scientification that many of our cultures have already been subjected to; for intellectuals, activists and cultural producers, it is time to use that which we have, yet do not know.

## References

1. Z.A. Salazar, *Ang Babaylan sa Kasaysayan ng Pilipinas* (Quezon City, the Philippines: University of the Philippines Press, 1999) p. 4.
2. R. Constantino, *The Philippines: A Past Revisited (Pre-Spanish-1941)* (Quezon City, the Philippines: Foundation for Nationalist Studies, 1975) p. 26. Engels distinguished rank societies from class societies as follows: "First, a distinction must be made between social ranking of various sorts and a system of classes based on different relations to the basic sources of subsistence and production: rank per se does not indicate the existence of classes. As Fried puts it, in 'rank societies,' marks of prestige are 'not used to acquire food or productive resources.' They do not 'convey any privilege claim to the strategic resources on which a society is based. Ranking can and does exist in the absence of stratification.'" Frederick Engels, *The Origin of the Family, Private Property and the State*, with an introduction and notes by Eleanor Burke Leacock (London: Lawrence & Wishart, 1972) p. 20.
3. A.C. Barbosa, "The Subanun Buklug Complex," *Culture and Peace Studies* 2, No. 1, 31-45 (2003).
4. A rank society is a prestige and kinship society where "slaves" or dependents are marks of prestige and ostentation, so the "slaves" or dependents had a status that was not regarded as low or degraded.
5. C. Jung, foreword and commentary to *The Secret of the Golden Flower*, R. Wilhelm's German translation of the *T'ai I Chin Hua Tsung Chih* (Chinese Book of Life) and part of the *Hui Ming Ching* (Book of Consciousness and Life); C.F. Baynes, English trans. (New York: Harcourt Brace Jovanovich, 1962) p. 136.
6. F. Demetrio, F. Zialcita and R. Feleo, artist, *The Soul Book* (Quezon City, the Philippines: GCF Publications, 1991) p. 102.
7. Y. Yamamoto, "On the Meanings of Babaylan in Historical Perspective," essays from the exhibition *Sino Ka? Ano Ka?*, Art Department Gallery, San Francisco State University, 20 September-21 October 1998 <[www.sfsu.edu/~gallery/babaylan/Pages/miko.html](http://www.sfsu.edu/~gallery/babaylan/Pages/miko.html)>; accessed 4 August 2005.

## Glossary

**Babaylan**—a Tagalog term used to refer to spirit mediums, with cognates prevailing among the di-

lects of the Philippine languages and among a limited number of dialects in Indonesia. The sociopolitical functions of the Babaylan have been lost since the Philippines' "flag independence" from the U.S.A. in 1946. In recent years, however, the term has become closely associated with women, now becoming a pan-Filipino term in the socio-cultural context symbolically associated with the artists praising a new feminism [7].

**Datu**—from *datò*, a Tagalog term used to refer to the headman of a barrio or town, or the chief of a (Mohammedan) Moro tribe, usually subject to a sultan.

**Pandáy**—blacksmith.

*Fatima Lasay (b. 1969) is an artist, independent curator and educator working in digital media. Her work investigates ownership, sovereignty and autonomy in the practice and theory of technology-based arts, and cultural (re)definitions of technologies within the context of post-development/neocolonialism. She has presented her work in Denmark, India, the Netherlands, Singapore and Taiwan, and has conducted workshops and worked with artists in Burma, Switzerland and the Philippines. Lasay was professor of computer art at the University of the Philippines, where she developed its first computer art elective courses and organized the Digital Media Festivals.*

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# Technoetic Pathways toward the Spiritual in Art: A Transdisciplinary Perspective on Connectedness, Coherence and Consciousness

Roy Ascott

**I**n technology we are witnessing the convergence of dry computational systems and wet biological processes, involving the assembly of bits, atoms, neurons and genes in conjunctions that will provide the artist with a new kind of material substrate, for which I have coined the term *moistmedia* [1]. Of these components, it is the bit that is the most familiar to artists: computational systems and digital media have dominated the techno-art scene for at least 30 years. Attention in this paper, however, is directed to the atom, to the nano level of interaction, and to the molecular domain—more particularly, to an organism's information network of photons emitted by DNA molecules, paralleled technologically by the constant flows of electrons and photons across the body of the planet through telematic networks. As science digs deeper into matter, moving, re-assembling and coordinating atoms and molecules in the nanofield, the distinction between the organic and the technological is becoming less clear. Similarly our molecular knowledge may lead us to a better understanding of changes in consciousness and perception afforded by pharmacology. Whatever turns out to be the case, we are now increasingly focusing our attention on the very small, at a level far beyond miniaturization: A nanometer is one-billionth of a meter. This level of operation is, in any retinal sense and no matter how technologically augmented our eyes are, literally out of sight. So much so that the scanning tunneling microscope (STM) calls for touch [2] rather than vision to navigate the nanofield and to manipulate individual atoms. I argue below that the nanofield mediates between pure matter and pure consciousness and that its significance as an interface between two levels of reality can hardly be overestimated.

## THE NANOFIELD

There are a number of ways to view the nano phenomenon. The popular view is that advanced by K. Eric Drexler [3], who has provided a mechanistic and materialist understanding of its potential. His ideas on nano-engineering and materials science promise self-replicating nanobots, self-renewing

structures and self-assembling environments, working within the body, within its environment and in outer space. While molecular robotics, positional assembly and self-organization suggest exciting possibilities for building new materials, manufacturing nano-machines and generally ordering the fundamental blocks of nature into whatever configuration we desire, there is a danger that the outcomes, even when beneficial in engineering, medical and social terms, could be spiritually hollow and as such would exacerbate rather than attenuate the excessive materialism of our time. In medicine, for example, there is the hope that artificial entities could identify or anticipate breakdowns in living systems and provide aid to failing organisms. However, some biophysicists, such as Mae-Wan Ho [4], for example, find that this view violates our understanding of the body as constituting a holistic mind-body field. If the body is seen as no more than a material collection of atoms, it may make sense to apply a materialistic strategy of repair. The living organism, however, is infinitely more complex than the cyborg model, however sophisticated, allows. Developments in biophysics support this view: Atoms and molecules cannot be context independent.

The other way of understanding the significance of our penetration of the nano world is to view these developments from the point of view of consciousness. This could lead to what could be called technoetic ontology [5], because nano is the plane on which technology and consciousness can meet. This presents a challenge to the artist that is as much metaphysical as material.

Materialists may see working in the nanofield as the end-game, but it is not necessary to embrace a radical transcendentalism to see that nano is located between the material density of our everyday world and the numinous spaces of subatomic immateriality. The STM cuts through the dense complexity of matter to focus on the individual atom—at a level that is both touchable and untouchable, immediate and remote, as Gimzewski and Vesna have shown [6]. Nano-watching changes the ratio of the senses: To touch is to know. The auditory sense can also be involved. Gimzewski has discovered that to touch the atomic plane is to hear the voices of molecules, whose sounds may signal distress as much as harmony. The atomic force microscope (AFM) allows him to hear the

## ABSTRACT

The coherence of living systems may be due in part to an information network of biophotons emitted by DNA molecules. This network can be seen as parallel to the telematic networks that connect the planet. Nanotechnology can play a significant role in the emergence of a moistmedia substrate for technoetic art. Immaterial connectedness confers a spiritual dimension on both telematic art and quantum mechanics. Field theory supports the contention that the material body may be a consequence rather than a cause of consciousness. A technoetic art may locate its ground in the triangulation of connectivity, syncretism and field theory.

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scream of a yeast cell as it is doused in alcohol. The individual atom, rather than simply a building block for material construction, can be considered a point of access to the complexity of immaterial, subatomic domains.

## BIOPHOTONICS

In the context of the brain, the nanofield provides the transition point between quarks and elementary particles, on the one hand, and molecules, cells (neurons) and neural assemblies on the other. In the context of consciousness, it is located between our material frame and the subtle body, between organs and aura. It is toward the aura, and the function of biophotons in living processes, that this text is principally directed. From the perspective of both biophysics and mysticism, a consideration is advanced about how an understanding of biophotons might contribute to a new perspective for telematic art: to find creative inspiration in the parallelism between the internal information network of biophotonic light in the body and the external networks of telematic communication. Masaki Kobayashi describes the mechanism and characteristics of biophoton emission in this way:

A biophoton is a spontaneous photon emission, without any external photo-excitation, through chemical excitation of the internal biochemical processes underlying cellular metabolism. . . . Biophoton emission originates in the chemical excitation of molecules undergoing oxidative metabolism. It is distinct from thermal radiation arising from body temperature. Biophoton phenomena have been surveyed from cellular or subcellular levels up to individual organism levels [7].

The term *biophotons* was first used by Fritz-Albert Popp [8] in 1976 to describe the quantum phenomenon of photonic emission from biological systems. All living systems emit biophotons, both those absorbed initially from the sun and those emitted spontaneously from molecules. Building on the ideas of Alexander Gurwitsch [9], the Russian biologist who introduced ideas of the "morphogenetic field" and "mitogenetic radiation," Popp argues that every change in the biological or physiological state of the living system is reflected by a corresponding change in biophoton emission. The signals of biophotons emanating from the quantum processes of living systems are ultra-weak in strength. Because the fundamental biological processes of DNA replication and protein synthesis occur

continuously in all living systems, the emissions occur everywhere and unceasingly.

In the words of R.P. Bajpai,

The intensity of a biophoton signal should capture ongoing changes in the information content of the system. A large amount of information is generated in mitosis, so those cells undergoing division must emit intense biophoton signals. Similarly, the processes that suddenly destroy a large amount of information e.g. cell death must also emit intense signals [10].

There is a strong indication, Popp argues, of an information channel within living systems that may relate to chemical reactivity in cells, intercellular communication and biological rhythms. Cohen and Popp have shown that normal patterns of emission are disrupted in people suffering from various illnesses and diseases [11]. Without this model of biophotonic information transmission, we are thrown back on mechanistic biology, in which the role of genes is hugely exaggerated. While it can show that the genetic code in DNA molecules determines the sequence of amino acids in proteins, it cannot show how proteins are arranged in cells, cells in tissues, tissues in organs and organs in organisms.

To look for parallels between the biophotonic network and telematic networks requires some examination of the possibility of quantum behavior in information processing at the technological level. Leaving aside speculation on the eventual realization of a quantum computer [12] as a nodal agent in network structures, quantum behavior in the context of telematics will mean teleportation of particles. Photons have been teleported, and more recently there has been success in transporting the physical properties of an atom, such as its energy and spin [13]. This involves the "entanglement" of two atoms, in which a disturbance to one particle instantly affects the other, no matter how far away it is [14].

Research in biophotonics, and on electromagnetic fields, is of significance to the development of technoetic art. It may no longer be seen as paradoxical that our scientifically driven thought relates to models of consciousness and human identity based in the spiritual traditions of cultures previously dismissed as exotic or marginal. Art may increasingly take on a more psychoactive complexion, and it will be found useful to link archaic models of consciousness, such as we find in Amazonia, for example, or among the

Tsogho of Gabon; ideas of quantum coherence, such as we find in biophysics; and biophotonics research. These archaic models implicitly locate the human mind within a field of consciousness, rather than seeing consciousness as an epiphenomenon of the brain, as in Western materialist orthodoxies [15]. Altered states of consciousness can be accessed by means of ritualized forms of breathing, dancing and chanting, or by the ingestion of psychointegrator plants [16]. This understanding of consciousness as a field, and our ability to navigate it (and, as many aver, to be navigated through it by other spiritual entities) is seen most vividly in the syncretic doctrine of Afro-Brazilian Umbanda [17], which brings together African Yoruba and European spiritualist beliefs with the native wisdom and traditions of the forest. Likewise, from the Buddhist point of view, the mind is not a by-product of the brain but a field that is an entity separate from the body and confers an inherent connectedness on the human condition. This concept of "immaterial connectedness" has been brought into current scientific discourse by Hans-Peter Dürr of the Max-Planck-Institut für Physik, Munich, who argues that quantum physics reveals that matter is not composed of matter, that reality is merely potentiality and that the world has a holistic structure, based on fundamental relations and not material objects, admitting more open, indeterministic developments [18].

## FIELD THEORY

Biophysics is a field-based science. Recently, field theories have been reviewed in both their biophysical and metaphysical dimensions by Lynne McTaggart in *The Field* [19], just as a field-based morphogenetic model of biological process and its spiritual implications informed Richard Shelldrake's *New Science of Life* [20] 20 years ago. Shelldrake's theory of formative causation states that there is in nature memory of physical order, structure or pattern that finds expression in "morphic fields." The memory in these form-fields comes from previous forms of a similar kind. In the view of Shelldrake, morphic fields are an organizing principle of nature. Shelldrake supports the contention that genes carry only a very small part of the biological information in a living system; most of it is in the memory carried within the organizing fields of an organism. Over time, the development of a larger memory of species experience leads to the process of "morphic

resonance," whereby at all levels in nature the form of systems is influenced by the form of previous systems. McTaggart identifies major scientists who have contributed significantly to field thinking across a number of disciplines—holistic, metaphysical, spiritual or paranormal—including Karl Pribram, David Bohm, Fritz-Albert Popp, Charles Tart, Robert Jahn, Dean Radin, Hal Puthoff, Irvin Laszlo and Mae Wan-Ho.

Field thinking informs an understanding of healing practices of various kinds. Research into the connection between the biophoton parameters and the parameters of electromagnetic fields active on living systems, such as that undertaken at the laboratory of the International Institute of Biophysics at Neuss, Germany [21], may provide some scientific validity to those ideas of self-regulation of the body to which various spiritual practices and somatic therapies subscribe. The network of "meridians" in acupuncture may be related to the body's biophoton field, as may the *prana* of yoga. However, the very inconclusive nature of scientific research in these areas opens them, perhaps inevitably, to consumer fraud on the Web, just as Western medical jargon has long been exploited for the purposes of quackery, deception and commercial gain. However, just as the healing rituals in older cultures involved performative, interactive and imaging activity, it may be that art in contemporary society will come to acquire a more compelling value. In art, it is the field of interactivity that integrates the work, the artist and the viewer in what is both a material and an immaterial connectedness [22].

Within quantum field theory, the coherence thought to define a living organism reflects the understanding of quantum mechanics that material reality forms an unbroken whole that has no parts. As Marco Bischof argues in his introduction to Popp's *Integrative Biophysics* [23]:

These holistic properties of reality are precisely defined mathematically by the Einstein-Podolsky-Rosen (known as "EPR") correlations. In quantum mechanics, it is never possible to describe the whole by the description of parts and their interrelations. This holistic view of quantum theory cannot be rejected anymore because the strange EPR quantum correlations of non-interacting and spatially separated systems have been amply demonstrated in many experiments [24].

The reductionist worldview of classical physics, Bischof points out, must give way

to the understanding in quantum mechanics of the primacy of the inseparable whole and of the fundamental interconnectedness *within* the organism as well as *between* organisms, and that of the organism *with the environment*. This assertion finds support in the work of a number of leading physicists, among whom, for example, first David Bohm [25] and then Karl Pribram [26] arrived at the understanding of the holographic nature of reality: They proposed that the brain is a hologram, interpreting a holographic universe. Our brains construct what we perceive as material reality by interpreting frequencies from another dimension, a domain of primary reality, of *implicate order*, which is non-local and non-temporal. A hologram creates an illusion of three-dimensional structure where there is none.

### CONNECTIVITY AND COHERENCE

Interconnectedness raises an important issue regarding the connectivity of new media art—simply put, between what fields might interconnectedness lie? How might the internal information system of networked photons interface with the external information network of our telematic planet? Art embraces the central concepts and features of the new biophysics: coherence, macroscopic quantum states, long-range interactions, nonlinearity, self-organization and self-regulation, communication networks, field models, interconnectedness, non-locality and the inclusion of consciousness. Indeed, these attributes relate to the canon of interactive art, the five-fold path of *connectivity, immersion, interaction, transformation and emergence*. This path relates to the shamanic path to immersion in the spiritual domain, where interaction with psychic entities is the means, transformation of consciousness is the goal and the emergence of new knowledge the outcome.

Cybernetics has shown interaction between systems to be field dependent, just as it has informed interactive art theory. Process-based art implies field awareness, in contrast to the object dependency of much art practice. In biophysics, field thinking is of importance in synthesizing the complexity of its details and as the means to model interconnectedness and non-locality.

A revision of older theories of living systems, abandoned with the successful rise of molecular biology, is now taking place. Mae-Wan Ho, a former colleague

of Popp, advances the idea of the "new organicism." This holds that it is the total organization of an organism, rather than the functioning of individual organs, that determines all life processes. Her argument that contemporary Western scientific concepts of the organism are leading us beyond quantum theory and offering insights that reaffirm and extend our intuitive and poetic notions of spontaneity and free will is worth quoting at length:

Freeing itself from the "laws" of physics, from mechanical determinism and mechanistic control, the organism becomes a *sentient, coherent* being that is free, from moment to moment, to explore and create its possible futures. . . . The static, deterministic universe of absolute space and time is replaced by a multitude of contingent, observer-dependent space-time frames. Instead of mechanical objects with simple locations in space and time, one finds delocalized, mutually entangled quantum entities that carry their histories with them, like evolving organisms [27].

The relevance of theories of the quantum indeterminacy of elementary particles to our understanding of biological systems, especially those of the human being, was explored by Heisenberg [28], who argued that the quantum indeterminacy of a single particle is deeply influential: in mutation in the genetic code and in changes in the behavior of neurons during thought processes.

There is evidence showing that consciousness is a causal factor in biology and not just an inconsequential epiphenomenon. Starting from the analysis of the phenomenology and the experimental evidence of mind-body interaction, field models . . . may provide the necessary tools for bridging the mind-body gap [29].

In line with the claim of radical constructivists [30] that the mind constructs reality, it can be argued that the body itself, in matters of both identity and biology, owes its specificity to the mind.

Connectivity at the planetary level and entanglement at the quantum level mean that our ideas, our institutions, even our own identities are constantly in flux. Consistent with this, moistmedia may bridge the artificial and natural domains, transforming relationships between consciousness and the material world. To assist in the embodiment of this connectivity of mind is part of the artist's task; to navigate the fields of consciousness that new material systems will generate is part of art's prospectus.

## MIXED REALITY

At the material level, Mixed Reality technology [31] provides us with another skin, another layer of energy to the body, adding to the complexity of its field. Instead of populating Mixed Reality space with (virtual) objects, we could perhaps be more integrative if we were to consider it as a medium for the creation of fields, or more precisely as an extension of the biofield itself. Just as the relationships between biophotonics and psychic states is under examination, so too might virtual space be seen as the generator of altered consciousness. Just as DNA is the main source of biophoton activity, so might Mixed Reality be the field in which new possibilities for living systems are rehearsed and from which a cybermorphology might emerge. By rendering visible the normally invisible processes of biological information exchange through visualization at a higher level, and embedding that visualization in our everyday retinal experience, a Mixed Reality environment could accelerate the transmission of biophotonic knowledge.

Since it emanates from a quantum system, a photon is a signal of a quantum nature. The whole body must be considered in a state of quantum coherence, with each molecule interacting with each other within a field. Just as the field has a regulatory effect on molecules, so molecules give the field boundaries. What then happens when a Mixed Reality environment, by merging virtual and biological systems and amplifying their interdependency, extends this boundary and redefines the field? Mixed Reality, networked reality and telematic virtuality, I would suggest, become entangled with the quantum states of coherence, leading to the emergence of universal connectivity and nonlinear relationships that exist beyond the classical constraints of space and time. Biophotons orchestrate the quantum coherence of the living being and may lead us to understand a pixel-particle exchange as having the potential to establish the quantum coherence of virtual states. The concept of coherence describes the wholeness of the organism, which, in a Mixed Reality environment, could mean the synthesis of a virtual-actual organicism. Andy Clarke proposes the inclusion of our telematic technology in the definition of the human organism [32], embracing the whole as a unified sentient field, just as Gregory Bateson argued that mind was immanent in whole systems rather than being the property of finite things and, in the con-

text of technology, saw mind as brain-plus-computer-plus-environment [33]. Western technology, in its potential for amplifying cognition and extending perception, and through its planetary connectivity, may contribute to the evolution of mind such that, far from being the negation of the spiritual as it is commonly thought to be, it will enable access to higher states of consciousness.

## ONTOLOGICAL ENGINEERING

In the context of the artist's use of technology to explore consciousness, the technologies of other cultures can provide important examples. As data is stored deep in the memory space of the computer, so knowledge is stored deep in the psychic space of the shamanic world. Western codes and protocols of computer access find their equivalent in the rituals and procedures of sacred ceremonies. In traditional cultures, another technology predominates, providing its users with tools of consciousness and a spiritual technology whose use and history lie beyond the historical record. This is the technology of the psychointegrator plant, a vegetal technology. Such plants as *Salvia divinorum* or the shamanic liana ayahuasca (*Banisteriopsis caapi*), called "the vine of the soul" and used in countless communities in Brazil and Colombia, are known as teachers, imparting wisdom as spiritual avatars. The researches of ethnobotanists such as Richard Evans Schultes [34], Eduardo Luna [35] and Benny Shanon [36] document the power of these plants in their sacred setting to enable us to transform consciousness, to enter into other states of being, to communicate over great distances, to connect with other entities and to receive knowledge and instruction from the plant domain. In recent decades the use of vegetal technology to heighten spiritual experience has spread in towns and cities, most extensively in Brazil, but increasingly in other countries, largely through the practices of Santo Daime [37] and União do Vegetal. The opening up of public awareness to the power of plants to heal the body and to transform the mind will doubtless infiltrate art theory, if not immediately the practice of art. Just as the artist's fascination with new technology has led electronic art and digital art, so it is possible to foresee a chemical or pharmacological ethos arising in art.

Indeed, it is my contention that the pharmacological processes of what can be called Vegetal Reality and the compu-

tational systems of Mixed Reality could combine to create a new ontology, just as our notions of outer space and inner space may coalesce into another order of cosmography. Jeremy Narby has speculated that the origin of shamanic visions induced by the ingestion of psychoactive plants may be found in the light emitted by DNA [38]. Popp and other molecular biologists have shown that DNA emits a weak form of coherent light that has been demonstrated to work like a communication system between cells and even between larger organisms. This suggests an information network of light existing not only within the body but among all living things. It may not be too extreme to suppose that it constitutes the infrastructure of mind, accounting for the immanence of consciousness.

In the frame of ontological engineering, the West has recently pursued a more "synthesizing" approach to the study of altered states of consciousness, using the science of chemistry to investigate the organization of the brain and to provoke changes of emotion, perception and cognition. In *The Chemical Architecture of the Human Mind: Probing Receptor Space with Psychedelics* [39], Tom Ray provides the first comprehensive view of how 19 psychedelic compounds interact with the human receptome (i.e. all the receptors in the body). Understanding the chemistry of consciousness is the final objective of this research.

The space in which technoetic art might be constructed can be located by the triangulation of connectivity, syncretism and field theory. Connectivity is at the root of cultural coherence, syncretism at the root of spiritual coherence, and field theory at the root of quantum coherence.

## CONCLUSION

New science is emerging from its classical carapace, creating new paradigms, defining new realities and reviving very ancient ones. This leads to an understanding of the world and ourselves in which what was classically seen as coherent is now seen as illusory, rather as if we had acquired behind-the-scenes access to Duchamp's *Étants donnés* [40] in the Philadelphia Museum of Art. In the spiritual context, dealing with illusion has not only been the province of Buddhism (maya) but is at the root of shamanism, Western spiritual disciplines and psychic practices: All address how to break the bonds of normative perception to attain the reality of higher consciousness. West-

ern art in the 20th century was also marked by the desire to break the bonds of convention, to seek emancipation from social, religious and cultural constraints. A path toward the spiritual and the desire to make visible the invisible were expressed in various ways by a number of influential artists [41]. The 21st-century art world, by contrast, seems to have largely abandoned the spiritual in favor of a strident sociology or craven submission to celebrity and capital. However, debates are stirring in art, especially in technology-based art, addressing art's relationship to science, the value of transdisciplinary discourse, the search for new metaphors and meaning, and the problem of relativism and ethics, all of which points to a dissatisfaction with the materialist culture that we have inherited. Technology, in the amplified meaning that embraces non-Western, unorthodox cultures, and art, which finds its place across disciplines and across cultures, together may mark out a pathway to the spiritual. In the process, navigating consciousness through the conjunctions of biophotonic-teleomatic networks, may contribute significantly to this goal.

## References and Notes

1. R. Ascott, *Telematic Embrace: Visionary Theories of Art Technology and Consciousness*, edited with an essay by Edward A. Shanken (Berkeley, CA: University of California Press, 2003) pp. 363–365.
2. G. Binnig, and H. Rohrer, "In Touch with Atoms," *Reviews of Modern Physics* **71** (1999) S324–S330.
3. K.E. Drexler, *Engines of Creation* (Garden City, NY: Anchor Press, 1986).
4. M.W. Ho, *The Rainbow and the Worm: The Physics of Organisms* (Singapore: World Scientific, 1993).
5. I coined the term *technoetic* from *technology* and the Greek *noetikos* (mind, consciousness) to mean consciousness accessed, augmented, distributed or transformed (depending on the user's worldview) by technology. This may have an ontological effect on the sense of self and of the world.
6. J. Gimzewski and V. Vesna, "The Nanoneme Syndrome: Blurring of Fact and Fiction in the Construction of a New Science," *Technoetic Arts: A Journal of Speculative Research* **1**, No. 1, 7–24 (2003).
7. See <www.tohtech.ac.jp/~eecs/ca/kobayashilab\_hp/BiophotonE.html> (accessed 10 November 2004).
8. Popp is director of the International Institute of Biophysics, Neuss, Germany.

9. L. Belousov, J. Opitz and S. Gilbert, "Life of Alexander G. Gurwitsch and His Relevant Contribution to the Theory of Morphogenetic Fields," *International Journal of Developmental Biology* **41**, No. 6, 771–777 (1997).
10. R. Bajpai, "Possibility of Photon Emission in the Fundamental Biological Processes Involving Quantum Search of Base Pairs and Amino Acids," presented at the International Institute of Biophysics, 9 March 2000. See <www.biophotonen-online.de/abstract/abs2000-13.htm> (accessed 10 November 2004).
11. S. Cohen and F.-A. Popp, "Biophoton Emission of the Human Body," *Journal of Photochemistry and Photobiology B: Biology* **40** (1997) pp. 187–189.
12. A useful description of a quantum computer is found at: <www.ph.unimelb.edu.au/~marc/marc\_coe/about/whatsaqc.htm> (accessed 22 May 2005).
13. This result has been achieved independently by the University of Innsbruck in Austria and the National Institute of Standards and Technology in Boulder, CO. Reported in M.D. Barrett and D.J. Wineland, "Deterministic Quantum Teleportation of Atomic Qubits," *Nature* **429** (17 June 2004) pp. 737–739.
14. D. Greenberger, L. Reiter and A. Zeilinger, eds., *Epistemological and Experimental Perspectives on Quantum Mechanics* (Dordrecht, the Netherlands: Kluwer, 1999). This volume contains many research papers on entanglement. See also K.J. Resch et al., "Distributing Entanglement and Single Photons through an Intra-City, Free-Space Quantum Channel," *Optics Express* **13**, No. 1, 202–209 (2005).
15. See D.C. Dennett, *Consciousness Explained* (New York: Pantheon, 1992). Dennett could be described as the pope of epiphenomenalism.
16. M. Winkelman, "Psychointegrator Plants: Their Roles in Human Culture, Consciousness and Health," in M. Winkelman and W. Andritsky, eds., *Yearbook of Cross-Cultural Medicine and Psychotherapy* (Berlin: Verlag für Wissenschaft und Bildung, 1995) pp. 9–53.
17. D. Brown, *Umbanda: Religion and Politics in Urban Brazil* (New York: Columbia Univ. Press, 1986).
18. H.-P. Dürr, "Inanimate and Animate Matter: Orderings of Immaterial Connectedness—The Physical Basis of Life," in H.-P. Dürr et al., eds., *What Is Life? Scientific Approaches and Philosophical Positions* (Hackensack, NJ: World Scientific, 2002) pp. 145–166.
19. L. McTaggart, *The Field: The Quest for the Secret Force of the Universe* (New York: Quill, 2003).
20. R. Sheldrake, *A New Science of Life* (London: Granada, 1983).
21. See <www.lifescientists.de/ib\_000e\_.htm> (accessed 16 November 2004).
22. R. Ascott, "Towards a Field Theory for Post-Modernist Art," *Leonardo* **13**, No. 1, 51–52 (1980).
23. F.-A. Popp and L. Belousov, eds., *Integrative Biophysics: Biophotonics* (Dordrecht, the Netherlands: Kluwer, 2003).
24. M. Bischof, "Introduction to Integrative Biophysics," in Popp and Belousov [23] p. 4.

25. D. Bohm, *Wholeness and the Implicate Order* (London: Routledge and Kegan Paul, 1980).
26. K. Pribram, "The Neurophysiology of Remembering," *Scientific American* **220** (1969) pp. 73–86.
27. M.-W. Ho, "The Biology of Free Will," *Journal of Consciousness Studies* **3** (1996) pp. 231–244.
28. W. Heisenberg, *Physics and Philosophy* (New York: Harper and Row, 1958).
29. M. Bischof [24] p. 6.
30. P. Watzlawick, ed., *The Invented Reality* (New York: Norton, 1984) (originally published as *Die Erfundene Wirklichkeit* [Munich: Piper, 1981]).
31. Y. Ohta and H. Tamura, *Mixed Reality: Merging Real and Virtual Worlds* (Tokyo: Ohmsha & Springer-Verlag, 1999).
32. A. Clark, *Natural Born Cyborgs: Minds, Technologies, and the Future of Human Intelligence* (Oxford, U.K.: Oxford Univ. Press, 2003).
33. G. Bateson, *Steps to an Ecology of Mind* (San Francisco: Chandler, 1972).
34. R.E. Schultes and R. Raffauf, *Vine of the Soul: Medicine Men, Their Plants and Rituals in the Colombian Amazonia* (Santa Fe, NM: Synergetic, 2004).
35. L.E. Luna and S.F. White, eds., *Ayahuasca Reader: Encounters with the Amazon's Sacred Vine* (Santa Fe, NM: Synergetic, 2000).
36. B. Shanon, "Ayahuasca Visions: A Comparative Cognitive Investigation," in C. Ratsch and J. Baker, eds., *Yearbook for Ethnomedicine and the Study of Consciousness* **8** (Berlin: VWB Verlag, 1999).
37. A. Polari de Alverga, *Forest of Visions: Ayahuasca, Amazonian Spirituality, and the Santo Daime Tradition* (Rochester, NY: Park Street, 1999).
38. J. Narby, *Le serpent cosmique, l'AND et les origines du savoir* (Geneva, Switzerland: George Editeur, 1995).
39. T. Ray, "The Chemical Architecture of the Human Mind," *Corante* <www.corante.com/brainwaves/archives/2005/02/05/the\_chemical\_architecture\_of\_the\_human\_mind\_by\_tom\_ray.php> (accessed 3 March 2005).
40. M. Duchamp, *Étants Donnés (Given: 1. The Waterfall; 2. The Illuminating Gas)*, 1946–1966.
41. Kandinsky, Mondrian and Malevich, for example, believed that art could evoke a spiritual experience.

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# Contemplations on Our Physical Links to the Universe: Searching for and Finding the Hidden Harmony

C.S. Unnikrishnan

**T**his discussion concerns my individual efforts as a physicist to formulate a consistent and satisfactory worldview. This worldview must be consistent with a variety of facts of the observable physical world and even the imaginable physical world. It is also desirable that it be spiritually satisfying. There is no requirement that such a worldview be correct and final, since the history of physics teaches that at no time in history has such an understanding of the physical world been achieved, and there is no reason to think that we have now achieved such a view. There has, of course, been a progressive sharpening of our understanding, and this will continue.

The single most important motivation for my reconsiderations of fundamental physical theories, especially the theory of relativity, is the new awareness in physics of the existence of the massive and vast universe and the ever-present and all-encompassing gravitational link of everything in this universe to everything else [1]. Contemporary theories of motion in space and time do not incorporate the presence of the universe, but it is an essential presence to be acknowledged. Apart from the theoretical and philosophical need for reconsideration, there is also experimental evidence that supports a new point of view. What I want to stress in the present context is the inseparability of all entities in the universe, even if it is only a physical, gravitational inseparability.

At this point in time, the physicist's worldview is formed by two fundamental theories of motion. One, Einstein's general theory of relativity, deals with the inter-relations of matter, space and time as they are linked through gravitational interaction. The other theory, that of quantum mechanics, deals with observables of the microscopic, quantum world. Underlying all physical theories is the theory of modifications of space and time resulting from motion in empty space, called the theory of special relativity. The theory of the constituents of matter and their interactions, called the Standard Model of particle physics, is based on quantum theory and special relativity. We also have a mature theory of cosmology, based on general relativity and observations. This standard model of the cosmos, the big-bang theory, describes an evolving, "expanding" universe that originated about 14 billion years ago. This model is based on the *guess* that the universe is the

same at all points of space, which is supported approximately by observation and also influenced by the observation that distant galaxies are moving away from us at speeds proportional to their distance from the solar system.

The success of these theories can be measured by how well their predictions agree with the observations we are able to make. It is indeed remarkable that physicists and cosmologists are able to draw precise correspondences between what they observe and what is contained in the theoretical representation of the physical world. Yet all physicists who have studied the foundations of these theories are well aware that they are either shaky or mutually incompatible. For example, all attempts to harmonize the quantum theory with the general theory of relativity have been unsuccessful. Thus, the standard model of particles and interactions cannot incorporate the most fundamental interaction—gravity—into its successful scheme. The highly successful theory of quantum electrodynamics, which describes the motion of charged particles such as the electron and their interactions with light and other charged particles, also posits an absolute vacuum—empty space without real particles or light—that contains *infinite* energy density. This conflicts with generally accepted cosmology: Our standard model of the evolution of the universe states that the universe as a whole is expanding and that the rate of expansion is proportional to the average density of matter and energy in the universe. An infinite or even a large amount of energy density implies a rate of expansion far exceeding the observed rate of expansion.

*Therefore, natural philosophers of today are not at peace.* Their worldviews are confused and they are desperate, more so than ever in the history of physics, to understand these interconnections in their lifetimes. So much is known as fact and observation, and various theories seem remarkably successful in their own domains. Yet there is no harmony, and in fact there are clashes of dissonance.

This situation is particularly disturbing for those who are interested in origins and interconnections. My research in the past few years has been guided by a determined effort to understand the foundations of quantum physics and of the theory of space, time and motion. This determination comes from a very personal belief, underlying which is a definite philosophy, formed by various influences, in the fundamental har-

## ABSTRACT

The author discusses the evidence and consequences of our indissoluble physical links to the entire universe. He finds that the apparent conflicts in fundamental physical theories regarding issues of causality and locality are not real conflicts based in the physical world. He presents an emergent worldview interpreted in the context of a cultural, philosophical and linguistic background in which a strong tension between inseparability of the whole and the local causal flow of events seems not to exist. The existence of the whole can be felt in the parts, as something real, measurable and undeniable. Its simplicity and harmony are spiritually enriching and emotionally moving.

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mony and unity of the material world. Above all I believe that the entire universe originated in accordance with well-defined, simple natural principles, and its various constituents—both living and nonliving—are constrained in their motion and evolution by these simple principles. My research has convinced me that each constituent of this universe is part of an indissoluble link, but also subject to the simple progression of cause and effect, without instantaneous influences. Although this link is purely physical, acting through the long-range and irresistible gravitational interaction, it is a link that can be felt and experienced by every individual. This realization then affects one's attitude toward everything living and nonliving, as they are all linked to oneself.

At this point let me briefly mention the intellectual and cultural background relevant to my research. It includes direct and indirect influences and teachings, as well as the cultural and philosophical background specific to my formative years.

While mysticism is familiar and even influential in our lives in India, our philosophies are strongly rooted in rational enquiry, causality and unified existence. Science in the modern sense, especially physical science, is hardly 100 years old in India. India's rich traditions in astronomy and mathematics have not found continuity into modern times. Most Indian science today is not original. This is a very unsatisfactory situation intellectually, especially for anyone with even the slightest familiarity with the intense perseverance and spirit of inquiry highlighted in Indian philosophical systems [2]. These teachings underscore the importance of going to sources and foundations, and encourage asking the most fundamental questions. They encourage seeking knowledge even from "Death." They repeatedly remind us that the entire perceptible universe, including the living and the nonliving, is a single whole, and material realizations are transformations of a fundamental indestructible and indescribable entity.

Culturally, there was a strong materialist influence on my thinking, as I grew up in a place that received considerable communist influence politically and intellectually [3], but this was mixed with an innate intuition that acknowledged clues and revelations originating in non-material sources, including art and life. Aesthetic consonance in the perceptible, observable and imaginable worlds has been a criterion of mine for deciding preferences of inquiry. I have maintained

a certain confidence in first-person inner experiences while contemplating the physical world and its interconnections.

All higher education in India, especially science, is carried out in English, which is not the native language of most of those opting to study science. The original sources of all ancient Indian knowledge are in Sanskrit, which is also not part of contemporary native language abilities. Thus, acquiring authentic knowledge of science and philosophy often means acquiring new language skills. While this might not be a problem in the long run, it cannot be concluded that this factor is irrelevant.

It is difficult to trace philosophical influences in a direct manner, since one is only vaguely aware of them during one's formative years, or even later. The idea of the axiomatic approach was familiar to me from an early stage, as was the feeling that everything we see happen in the world around us must have a cause behind it and that the result of any action cannot be erased away. The principle of causality was a strong influence; so also was a leaning toward determinism in the inanimate world. I was also consciously influenced by the ancient Indian method of reaching pristine truths by eliminating what is not truth, saying, "It is *not* this." Thus our notions of physical reality can never be final. We must be prepared to change our theories as we perceive and comprehend more of the world.

I will discuss the possibility of modification of our fundamental theories in order to make them consistent with the presence of our "once given" Universe [4]. Theories are representations of the physical world and not the physical world itself. In fact, our physical theories employ several unobservable factors for a successful description of the physical world. The uncertain objective reality of the unobservables creates an open territory, the exploration of which can lead to new physical theories, perhaps based on new unobservables.

### UNOBSERVABLES IN PHYSICAL THEORIES

Observable phenomena, and what is considered measurable reality, are described in physical theories in terms of certain *unobservables*, things beyond perception, the objective reality of which is debatable or indefinite [5]. This seems to be an inevitable structure in all our physical theories. Observables—tangible reality—are usually derivatives of these unobservables. Familiar examples of unobservables

in our physical theories are the field, potential, phase, vacuum, etc. If we go deeper we see that *even space and time are unobservables*.

### An Example from Cosmology

I will now discuss an important example from cosmology. The big-bang model of cosmology describes an evolving and expanding universe. Estimation of the amount of matter in the universe is an old problem. It is an important issue because the fate of the universe crucially depends on its matter content. If the density of matter exceeds a particular value called the critical density, then the universe will re-collapse. This special density value signifies that the total energy in the universe—the sum of the positive energy of motion and matter and the negative energy of gravitational binding—is zero, as perhaps it should be if everything started from nothingness (matter and energy are equivalent and both influence the evolution of the universe). All observations show that the matter that constitutes us and our environment and all that is visible in the universe—made of electrons, protons, neutrons and light—amounts to hardly 3% of the critical density. There are, however, other dependable observations that can measure even nonluminous and unseen matter using their gravitational properties, and these observations indicate that in fact the density of matter in the universe is close to the critical density [6]. Of what, then, does the other 97% of the matter in the universe consist? What are its properties? We do not know yet. Currently prevailing speculation is that about 30%—provisionally called "dark matter"—consists of yet-to-be discovered particles that interact with matter only very weakly and are therefore very difficult to detect. The rest of the unseen matter seems to be even stranger. One important observation that studies very distant supernovae (bright stellar explosions) and measures their distance and speed of recession seems to show that the rate of expansion of the universe is increasing [7]. To understand the strangeness of this observation, imagine watching a stone thrown upward and seeing it speed up as it rises. This can happen only if there is repulsive gravity, but we have no experimental evidence in the whole history of physics for repulsive gravity. Yet we confront a situation in cosmology that requires a form of matter that can generate the equivalent of repulsive gravity. The inferred properties of this dominant form of matter are so close to that of vacuum or empty space

that *it could only be the vacuum itself*—an unobservable! The physical vacuum familiar to us, however, contains nothing and should not influence anything. This is the point at which peculiarities of the quantum microscopic world come into the picture.

The vacuum in quantum physics is not just emptiness. It is postulated to be a reservoir containing an infinite amount of energy residing in quantum oscillations of various fields including the electromagnetic field, and it is generally asserted by quantum physicists that this infinity is not observable directly. What are really observable are some very small residues in very special physical situations. The structure of present quantum theory demands such a strange, perhaps absurd, construction. By paying this price, theoretical physicists are able to calculate and predict several microscopic physical effects with amazing accuracy. When the dynamics of the universe is considered, however, every bit of energy contributes, and the concept of a quantum vacuum with infinite or even merely large energy density becomes discordant for reasons mentioned above. However, the new cosmological observations that indicate accelerated expansion require a very small amount of “dark energy,” just about the equivalent of a hydrogen atom per cubic meter, with properties similar to that of the quantum vacuum [8]. So sophisticated observations have led us to a form of matter that is almost mystical, and certainly the most mysterious we have ever come across. Not only does it dominate, it will eventually become the only form of matter in the universe because of this strange property: It does not diminish as the Universe expands!

This is the Copernican principle at its extreme. In its original form it held that man and Earth had no privileged position in this solar system. The generalized Copernican principle applied to the universe, asserting that even the solar system is just one of the infinite equivalent positions in the universe. Now it turns out that even the matter that we are made of is only an insignificant fraction of all matter. This worldview implies a strange alienation. Most of the universe is “not of our kind.”

The matter we are made of is rare. We, our environment, our cosmic neighborhood and so on may not be unique, but they are certainly rare. Our integrated worldview should not ignore this, and in fact should incorporate this realization not only in our science, as we are forced to, but also in our philosophy and ethics.

### An Example from Quantum Physics

My next example is related to an unobservable that has given rise to numerous debates, speculations and even philosophies—the *wavefunction* in quantum mechanics. It is one of two basic entities, along with time, employed in describing the dynamics of the microscopic world, just as position and time are the basic entities used in the classical description of motion. The wavefunction represents the wave-particle duality manifest in the quantum world. As far as we know, no objective reality can be ascribed to the wavefunction, but all observational results in physics are supposed to be potentially associated with it.

One of the basic issues involved in this question is that of nonlocal influence. One can discuss and experiment with situations in which there are two particles described together by one wavefunction and no objective property can be ascribed to either particle *separately*. Making an observation of just one of the particles yields some result and therefore a definite property for that particle. The other particle then simultaneously, spontaneously and nonlocally assumes a definite property, however far this second particle is from the first! That is what standard quantum theory and related experiments together imply. This of course violates the basic notion of locality inspired by special relativity (in Einstein’s words, “On one supposition we should, in my opinion, absolutely hold fast: the real factual situation of a system is independent of what is done with another system, which is spatially separated from the former” [9]).

This is the situation in our most successful theory, all arising from the need to deal with a mysterious unobservable. This problem and its tension with the spirit of relativity are perhaps the most-discussed fundamental issues in physics. See for example the famous discussion by Einstein and his collaborators Podolsky and Rosen (EPR) [10]. This situation created an intense emotional problem for me with the process of rational inquiry, mainly due to the clash of quantum nonlocality with everything else one knows about the physical world, especially causality. Even the philosophies that are familiar to me, which advocate wholeness and oneness, do not deny the cause-effect link [11].

Any satisfactory understanding of motion and events in space and time will have to address the relation between cause and effect in quantum physics. The

reason is simple. If physical influences can propagate instantaneously, then there is no meaning in the cause-and-effect order of events. What is “before” for one observer can become “after” for another one moving relative to the first.

I have ventured into probing the consequences of the unobservables in quantum theory, especially the process of the realization of observable results from the unobservable ones, and the issue of the cause-effect link. I will briefly mention these aspects after a discussion of a new view of space, time, motion and matter.

### SPACE, TIME AND MATTER: THE NEED FOR A NEW THEORY

Space and time are the fundamental metaphysical concepts on which kinematics and dynamics, and thus every description of the physical world, are built. Our theories use these concepts as priors. They are, however, *unobservables*. They have no physical existence separated from matter. All the same, descriptions of matter—of its states and changes—require these concepts.

The accepted theory of motion deals with space and time as one unified four-dimensional entity despite the qualitative and perceptive difference between space and time. Called the special theory of relativity, it is basic to every other description of physical phenomena and has immensely influenced human thought. This theory confers equal status to all observers and reference frames in uniform motion relative to one another. All physical laws have the same form in these inertial systems, and every such observer has the right to claim the state of rest. Spatial and temporal intervals are modified based on relative motion, and clocks in relative motion age at different rates. There is no absolute time or invariant concept of simultaneity, and there are no preferred reference frames relative to which one can discuss motion in an absolute sense.

*We now know, however, that there is a preferred frame relative to which we can measure our motion precisely*—this is the average rest frame of the matter in the universe [12]. Operationally the absolute velocity of motion can be measured by measuring the Doppler shift of the all-pervading cosmic microwave background radiation (CMBR). This radiation is supposed to be isotropic—with no preferred direction. Its properties, especially the spectrum, are expected to be the same when measured in any direction. Observation-

ally, however, there is excess energy in one direction and correspondingly less from the opposite direction, exactly like the Doppler effect changes in the frequency of sound as the listener moves away or toward the source. From these measurements we can determine precisely how fast Earth is moving through the radiation background as well as through the average absolute frame of the universe. So *no observer really has the right to claim a state of rest without being at absolute rest relative to this frame*. In addition, there is absolute time available. The temperature of the microwave background decreases uniformly as the universe expands and can serve as the absolute time, at least in principle. These facts were not known when special relativity was formulated and certainly not recognized even in later times. This is why a reconsideration is needed.

This is not the occasion to discuss the technical details of the reconsideration of the theory of relativity [13], but some facts do need to be mentioned. If we start with the obvious assumption that every physical entity is gravitationally linked to every other physical entity in this universe, then it turns out that all physical effects hitherto thought to be due to kinematics of relative motion are in fact due to gravitational interaction with the matter in the universe. The velocity of light and of all communications, including quantum communication, is restricted to a maximum value by this gravity. The rates of moving clocks are affected by the gravity of the universe. Certain peculiar behaviors of elementary particles and atoms, including the Pauli exclusion responsible for the stability of atoms and life, seem to be related to gravitational interaction with the universe. There is a precursor to these ideas in Mach's well-known but largely ignored principle advocating a connection between inertial forces and the matter in the universe [14].

If the universe were empty, none of the effects thought to be the results of the theory of relativity would be seen. Therefore, special relativity will have to be replaced by another theory that describes modifications of space and time due to motion as resulting from gravitational interaction with the universe. I call this theory *cosmic relativity*.

It is not difficult to verify by direct calculations that the influence of the universe on every local action is in fact large and cannot be ignored. For example, if we calculate the gravitational potential of the Earth at its surface, it is a very small number. The gravitational potential of

the sun is 10 times larger, and that due to the Milky Way galaxy is 1,000 times larger. Even this number is small, being only one millionth of the gravitation potential due to all the matter in the universe. If we calculate the integrated gravitational potential of all the distant galaxies, however, we get a number that is a billion times larger than Earth's gravitational potential. Although most of the galaxies are far away, there are so many of them that in the end they dominate the gravitational influence.

I will mention one crucial difference between the new theory and special relativity, and also mention the relevant experimental evidence that supports the new theory. It is well known from the early explorations of relativity that a clock in motion slows down in comparison to a stationary clock. As stated in Einstein's original 1905 paper,

if one of two synchronous clocks at A is moved in a closed curve with constant velocity until it returns to A, the journey lasting  $t$  seconds, then by the clock that has remained at rest the travelled clock on its arrival at A will be  $(\frac{1}{2})vt^2/c^2$  second slow [15].

If applied to a clock that takes off in a flight at typical flight speeds, goes around the earth and comes back in about 40 hours, this prediction gives a tiny retardation of about 0.04 microsecond compared to a clock stationary in the laboratory. Because Einstein's theory deals only with relative velocities, the fact that the earth's surface is moving relative to the cosmos is of no consequence to the theory. For example, clocks that are transported westward and eastward at equal speeds will both suffer the same time dilation; but what is it that really happens?

In cosmic relativity, what matters is the true velocity relative to the preferred frame of the cosmos. A clock that is "stationary" on the earth's surface is in fact moving eastward at a speed of 220 meters per second because of the eastward rotational velocity of the earth. A clock that goes westward at 200 m/s has a true speed eastward of only 20 m/s. Thus we arrive at the amazing prediction that the clock traveling westward can age more than a stationary clock, directly contradicting Einstein's 1905 prediction.

It turns out that the clock comparison experiments performed by Hafele and Keating in 1972, as well as some subsequent tests, have demonstrated exactly this effect [16]. There is experimental evidence that a traveling clock can run faster than a stationary clock, an effect that can be understood only by taking into account the preferred frame and the

gravitational effect of the universe. Thus there is unambiguous evidence that the 100-year-old theory of relativity must be replaced with a theory based on cosmic gravitational effects. Of course one expects that this change will take time, because science is one of the most conservative disciplines and accepts change only slowly.

## DETERMINISM AND CAUSALITY IN MICROSCOPIC PHYSICS

Quantum physics is supposed to have brought the deterministic phase of physical descriptions to an end. Events in microscopic physics are not predictable, even when there is full knowledge of the initial conditions, as described by the present quantum theory. Only the probabilities of elementary events are predictable. Related to this point is the issue of nonlocality and instantaneous influences mentioned above.

A detailed consideration of quantum correlations has allowed me to conclude that there is in fact no nonlocal influence in quantum mechanics [17]. Arguments based on some earlier work by Einstein and Karl Popper show that there is no nonlocality and that therefore the standard quantum theory is incomplete as it stands [18]. This view is supported by the finding from cosmic relativity that no physical influence whatsoever can propagate faster than the limit specified by the gravitational interaction of the entire universe.

This insight prompted me to ask whether quantum phenomena could be understood without their inherent indeterminism. In the standard quantum theory, cause-effect uniqueness is violated in the sense that the same initial cause described by a particular wavefunction can give rise to a multitude of final results occurring at random in different observations. This is what is meant by indeterminism in quantum mechanics. There are empirical and theoretical reasons not to depend on a gambling dice model—called hidden variable theories—of quantum phenomena. I have a proposal that is related to the properties of the unobservable wavefunction [19]. The randomness is encoded in a wave property called a *phase*; by its very nature this initial phase is an unobservable. If we include this random phase in a new description, it is conceivable, but by no means definite, that the uniqueness of the cause-effect relation can be restored in quantum mechanics. Such a change in quantum theory can lead to a tremendous change in our worldview and phi-

losophy, given that the indeterminism of quantum theory has profoundly affected modern philosophy of science.

## CONCLUSIONS: DISCOVERING HARMONY

I have attempted to present some explorations into the foundations of our physical theories that are affected by mutual tensions and contradictions. Taken one by one, these successful theories have practically consistent foundations. When the physical world is seen as a whole, however, obvious and serious discrepancies and conflicts arise. I have been personally disturbed by these problems, but not bewildered by their magnitude, because the systems of inquiry with which I am familiar within my culture have asked more difficult questions and have explored larger interconnections. Finally, the result of my contemplations so far has been positively encouraging, revealing several aspects of harmony between our fundamental theories. Most importantly, the research has highlighted the causal inseparability of the massive and vast universe and its role in determining properties of local physical phenomena, such as modifications of intervals of space and time due to motion through the universe, and an intricate balancing of the atomic world. The realization of the strong inseparability of everything in this universe will have lasting influences upon my future scientific studies as well as in my worldview, philosophy and even personal life.

This search for harmony seems to take the explorer to new notions of space and time, material and causal, and yet inseparable from the local. The existence of

the whole can be felt in the part, as real, measurable and undeniable. Its simplicity and harmony are spiritually enriching and emotionally moving, and its scale and intimacy make one feel secure in some strange way.

### Acknowledgments

I thank Roger Malina and Mohammed Aziz Chafchaoui for the invitation to and help with participation in the Melilla symposium. Encouraging words from Ahmad Mostafa, Fathi Saleh and Martine Armand have been important. I thank all the Melilla symposium organizers for their friendship and help.

### References and Notes

1. C.S. Unnikrishnan, "Cosmic Relativity: The Fundamental Theory of Relativity, Its Implications and Experimental Tests," electronic preprint (2004) available at <<http://arxiv.org/abs/gr-qc/0406023>>.
2. The variety of "Indian philosophical systems" does not allow me to make any general statements on them. What I have in mind here is the philosophy highlighted in the *Upanishads*. What one generally imbibes as philosophy while growing up in India is a mixture of these and thoughts from Buddhism and Jainism, along with ethical and moral lessons from Hindu mythology.
3. Kerala, India's southernmost state, has elected communist governments since 1957. It boasts a strong popular science movement that is predominantly leftist. In terms of the multi-religious coexistence, it has some similarity to Melilla.
4. The phrase "once given universe" was used by E. Mach in *The Science of Mechanics* (London: Open Court, 1942) to stress the importance of taking into account its presence with its real properties in the formulation of mechanics.
5. C.S. Unnikrishnan, "The Role of Unobservables in Physics," in S. Menon et al., eds., *Science and Spiritual Quest: Consciousness, Cosmology and Technology in Indic Traditions* (Bangalore, India: National Institute of Advanced Studies, 2004).
6. N. Bahcall, J.P. Ostriker, S. Perlmutter and P.J. Steinhardt, "The Cosmic Triangle: Revealing the State of the Universe," *Science* **248** (1999) pp. 1481-1488.
7. Bahcall et al. [6].
8. Bahcall et al. [6].

9. Quoted in P.A. Schilpp, ed., *Albert Einstein, Philosopher Scientist* (Evanston, IL: Library of Living Philosophers, 1949) p. 85.

10. A. Einstein, B. Podolsky and N. Rosen, "Can Quantum Mechanical Description of Physical Reality Be Considered Complete?," *Physical Review* **47** (1935) pp. 777-780.

11. The arguments against "causality" (sometimes called refutations of it) highlighted in Buddhist interpretations are not a denial of the causal chain, but an argument against the separable identification of cause and effect.

12. See, for example, G.F. Smoot and D. Scott, "The Cosmic Background Radiation" (1996), available at <<http://arxiv.org/abs/astro-ph/9603157>>.

13. Unnikrishnan [1].

14. Mach [4] pp. 277-306.

15. A. Einstein, "On the Electrodynamics of Moving Bodies," *Annalen der Physik* **17** (1905) pp. 891-921; p. 904.

16. J.C. Hafele and R.E. Keating, "Around-the-World Atomic Clocks: Observed Relativistic Time Gains," *Science* **177** (1972) pp. 168-170.

17. C.S. Unnikrishnan, "Is the Quantum Mechanical Description of Physical Reality Complete? Proposed Resolution of the EPR Puzzle," *Foundations of Physics Letters* **15** (2002) pp. 1-25.

18. C.S. Unnikrishnan, "Proof of Absence of Spooky Action at a Distance in Quantum Correlations," *Pramana—Journal of Physics* **59** (2002) pp. 295-301.

19. C.S. Unnikrishnan, "Resolution of Nonlocality Puzzle in EPR Paradox," *Current Science* **79** (2000) pp. 195-201.

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## AN OPEN LETTER TO THE MELILLA CONFERENCE PARTICIPANTS

I was extremely happy when I first heard about this conference and was excitedly looking forward to the discussions. Unfortunately, circumstances have prevented me from attending the conference. I am especially sorry, too, that I shall miss the rich union of many cultures, a subject in itself dear to my heart for decades.

I thought that I could at least present a summary of the remarks I would have made, in the hope that through this method I can engage some sort of dialogue with the conference attendees.

For nearly 30 years I have been working on a series of books entitled *The Nature of Order* [1], an attempt to bring a fusion of the scientific world view with an adequate view of art and architecture. It has been my desire not merely to present a theoretical view, or the kind of thing an analytical or critical thinker might produce, but rather to produce a work that could directly affect the life and day-to-day work of a working artist while simultaneously clearly expressing concepts in terms that physicists and biologists can appreciate and benefit from, so that in some way our picture of the universe can be altered by this new picture.

Above all, none of this can work unless it is seen in a context that admits God—unrestricted wholeness—as the underpinning of all that is seen and experienced. I certainly do not mean, by this, adherence to any particular religion or religious tradition. Rather, I mean that the life of objects and buildings and places and our inner experience of self, all of which we experience in art, can be understood both in terms congruent with science as we presently know it and also in personal terms that touch us in our hearts, activate our hearts.

The view of science that provides the underpinnings to all four books in *The Nature of Order* series relies on a relatively small number of observations and a small number, also, of new concepts that define living structure and the processes that generate living structure in objective terms. These include:

- *an attempt to identify wholeness as an objective structure existing in some degree in all material systems*

- *a method of observation that allows impartial observers to measure the degree of life in different structures according to their own inner state when in the presence of these structures*
- *an attempt to see all evolution and development in physical systems, in living systems and in the creation of works of art as defined by a sequence of wholeness-preserving or “structure-preserving” transformations.*

This way of thinking thus provides a vision of reality in which all events come about as transformations of the existing whole. Above all, it redefines the nature of our efforts as artists.

What is most important is that all this is not merely a theoretical scheme, but rather a way of thinking and a set of tools that first teach the artist to make things, and show the way to making things—paintings, works of sculpture, buildings, and the many manifold possible structures that must appear in buildings at a huge range of scales. The buildings and public spaces that can be reached by these methods are entirely different from those typically created in the 20th century; they point the way to a humane world in the future and a cogent, sharable way for people to reach this humane world together.

I have attempted a fusion of science and art in a hard-nosed fashion compatible with scientific thinking yet inspired and nourished by concern for the well-springs of human experience and the origin of the human self. I could never have managed even this first step without the range of cultures and civilizations that I have paid attention to, visited and been part of during my life.

The material in these books is largely culture-independent. By that I do not mean that different cultures should be somehow absorbed in some general mass culture of the future. Quite the opposite. It turns out that the criteria of life in artifacts has the same deep substrate in all cultures and civilizations, and the work in these four books draws on these hugely different cultures and shows what is common to them, doing it in a way that

honors and respects the art and building traditions of this worldwide range of civilizations.

In particular, I have benefited from my lifelong association with Islamic culture and my love of ancient Turkish and Persian carpets as well as my long association and friendship with Japan and the Japanese people. India, Latin America, Russia, the Pacific, many European nations, Moorish Spain, North Africa and China all have played a significant role in helping me to understand the phenomena with which I have been concerned. The unification of cultures, and the exchange of profound respect from culture to culture, is vital to the proper understanding of artistic phenomena and to the practice of individual art and individual building in various local cultures today.

During the last two centuries, art and science were strongly separated. The thought that made sense in science made little sense in art, and vice versa. This has been most uncomfortable. It made both—art and science in their separate ways—seem less valid, since it was obvious that neither one of them had much claim to an authentic view of reality, able to encompass the strength of human intellect and the stretch of human passion. I have attempted to paint a world picture that suggests that there is a single view of matter, the universe and mind that stretches wide enough to encompass both art and science. If that is true, we shall all be very much the richer for it in the future.

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### Reference

1. Chris Alexander, *The Nature of Order: Book 1: The Phenomenon of Life; Book 2: The Process of Creating a Life; Book 3: A Vision of a Living World; Book 4: The Luminous Ground* (Berkeley, CA: Center for Environmental Structure, 2002–2004). See also <www.natureoforder.com>.

## LEONARDO REVIEWS

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## BOOKS

### **BUILDING STATA: THE DESIGN AND CONSTRUCTION OF FRANK O. GEHRY'S STATA CENTER AT MIT**

by Nancy E. Joyce. MIT Press, Cambridge, MA, U.S.A., 2004. 160 pp., illus. Paper. ISBN: 0-262-60061-7.

*Reviewed by Rob Harle (Australia).*  
*E-mail: <recluse@lis.net.au>.*

A book can only provide a limited approximation of the reality of the subject it describes and presents. *Building Stata* goes just a bit further than most books of this type. It gives one the feeling that one has been part of the design process, been "on site" with the mud, concrete and steel, then finally strolled around the almost finished building.

This extra reality is due in large part to the brilliant photographs of Richard Sobol. He has managed to capture the spirit of the entire enterprise, from the excavation of the 5.3 million-cubic-foot-hole to the finished glistening metal exterior surfaces. The book is lavishly illustrated with color and black-and-white photographs, plans, diagrams and sketches. The photographs are as much about the people who created this architectural masterpiece as the building itself. The book recognizes the contribution of all involved in the project, from the philanthropists who made it financially possible, to Gehry, the mastermind behind the design and, equally, to the construction workers who brought the concept into material reality.

The book starts with a rather candid commentary by Frank O. Gehry. This is followed by various introductions that provide a brief, though very interesting, history of MIT and its relationship with Cambridge, Boston and Massachusetts. There are chapters on "Planning," "Design" and "Construction." The construction chapter is divided into sub-sections: "Excavations," "Concrete," "Structural Steel," "Masonry," "Metal," "Glass" and finally "Interiors." These sections give an in-depth pictorial insight into the complexity, difficulties and dangers involved in creating a building of this stature.

It is almost a miracle that the building ever got built, considering the nature of this project. As Mitchell mentions in the Afterword, "modern universities do not present themselves as singular architectural clients" (p. 132). The list of those who have an interest (and say) in the project is extensive and includes powerful corporation members, deans, alumni, donors, local community groups, students and academic faculty representatives. The success of Gehry's building seems partly to come from the attention paid to this diverse group of people, all with different ideas and needs.

MIT has been and continues to be a center for invention, technical excellence and radical innovation in both theoretical and practical engineering, science, communication and now IT and electronic engineering. It was this radical innovation that needed to be articulated and represented in the proposed new Ray and Maria Stata building. The main aspects of the charter were to: (a) bring MIT's computer, information and intelligence-science researchers under one roof on main campus; (b) create spaces designed to improve the productivity of humans rather than efficiently house apparatus; and (c) provide a gateway to the revived R&D center and transport hub north and east of the campus, "creating a distinctive icon for MIT in the twenty-first century" (pp. 16-17).

One of MIT's enduring traditions is the "fostering of creative revolutions by thinking outside of the box" (p. 17).

Gehry's building by any standard is conceived "outside the box"; the external form and appearance is challenging and unique. The simplicity of the offices and work spaces belies the profound insight of Gehry and his associates in solving complex interaction problems and providing inspiring spaces for researchers to achieve the highest levels of technological innovation. In Gehry's own words at the beginning of the project, "What I want to do is make some kind of magic and take people someplace they've never been before" (p. ix).

This book is essential reading for anyone involved in building design and planning or in commissioning architecture. Part of the reason for the book's success is that, like the building it describes, it conveys a wonderful feeling of interaction at a human level. The author, Nancy Joyce (also MIT project director for the Stata Center) and Richard Sobol, photographer, are to be congratulated on producing an informative and inspiring book that will also become a valuable document in the future, especially regarding the history of MIT.

*Reviews Panel: Peter Anders, Fred Allan Andersson, Wilfred Arnold, Roy Ascott, Curtis Bahn, Claire Barliant, René Beekman, Roy R. Behrens, Andreas Broeckmann, Annick Bureaud, Chris Cobb, Robert Coburn, Donna Cox, Sean Cubitt, Nina Czegledy, Shawn Decker, Margaret Dolinsky, Dennis Dollens, Luisa Paraguai Donati, Victoria Duckett, Maia Engeli, Enzo Ferrara, Deborah Frizzell, Bulat M. Galejev, George Gessert, Elisa Giaccardi, Thom Gillespie, Artur Golczewski, Allan Graubard, Dene Grigar, Diane Gromala, Rob Harle, Craig Harris, Josepha Haveman, Paul Hertz, Amy Ione, Stephen Jones, Richard Kade, Curtis E.A. Karnow, Nisar Keshvani, Julien Knebusch, Daniela Kutschat, Mike Legget, Roger F. Malina, Jacques Mandelbrojt, Robert A. Mitchell, Rick Mitchell, Mike Mosher, Axel Mulder, Kevin Murray, Frieder Nake, Maureen A. Nappi, Angela Ndalians, Simone Osthoff, Jack Ox, Robert Pepperell, Kjell yngve Petersen, Cliff Pickover, Patricia Pisters, Michael Punt, Harry Rand, Sonya Rapoport, Edward Shanken, Aparna Sharma, Shirley Shor, George K. Shortess, Joel Slayton, Christa Sommerer, Yvonne Spielmann, David Surman, Pia Tikka, David Topper, Rene van Peer, Stefaan Van Ryssen, Ian Versteegen, Stephen Wilson, Arthur Woods, Soh Yeong.*

**LIMINAL LIVES:  
IMAGINING THE HUMAN  
AT THE FRONTIERS OF  
BIOSCIENCE**

by Susan Merrill Squier. Duke Univ. Press, Durham, NC, U.S.A., 2004. 368 pp., illus. Trade, paper. ISBN: 0-8223-3381-3; ISBN: 0-8223-3366-X.

*Reviewed by Eugene Thacker, School of Literature, Communication, and Culture, Georgia Institute of Technology, Atlanta, GA, U.S.A. E-mail: <eugene.thacker@lcc.gatech.edu>.*

"Biotechnology" is a strange term. Does it denote a set of scientific practices (e.g. cloning, genetic engineering); an array of new technologies (e.g. gene sequencing machines, artificial wombs); a research field that produces particular kinds of knowledge (e.g. genomics, proteomics); a discipline linked to institutions and industry; or simply something that is, in the most relativistic way (e.g. farming, breeding, fermentation), isomorphic with human civilization itself? Today, in an era in which "twice dead" human beings kept alive by medical technologies make news headlines, an era in which individual cells with the capacity for regeneration politicize political elections—biotechnology seems to be at once the most visible and the least legible aspect of technologically advanced cultures. We "see" biotechnology everywhere, even in science fiction, cartoons and TV commercials, and yet its pervasive visibility always seems to point to its inherent illegibility as a specialized discourse. In a nutshell: You, the average consumer, are free to try Celebrex, but this is always on the condition that you first "ask your doctor" for more information.

Susan Merrill Squier's book *Liminal Lives* is a welcome intervention in this cultural landscape. Her book takes a look at the inescapably biocultural aspects of new medical technologies such as stem cell research, new reproductive technologies, and regenerative medicine. But Squier does not simply take these scientific fields as self-evident; her method is to consider how a multiplicity of narratives, metaphors and imagery are an inseparable part of how "life itself" is recontextualized and redefined. Squier's book combines approaches from literary studies, feminist science studies, the history of medicine and cultural analyses of gender, age and the practice of

science fiction. Her analyses are not simply the scientific fields in themselves, but also the variable lenses through which science co-emerges with culture. Thus biotechnology cartoons, poem-writing scientists, science fiction from *Amazing Stories*, anatomical art and a storytelling seminar for those living with Alzheimer's are all part of her "biomedical imaginary." The focus of *Liminal Lives* is, as Squier notes, "the ways literature and science collaborate on, and contest, a new vision of human life" (p. 3). Squier's approach is welcome because it asks us to carefully avoid distinguishing "narrative" as a practice exclusive to literature or film. *Liminal Lives* prompts us to consider the ways in which "science fiction" is a verb and not simply a literary or film genre. "Science fictioning" would therefore be a way of understanding a practice in which the very relation between medicine and culture, science and fiction is constantly expressed, reflected, distorted and worked through. This science fictioning is, by turns, melodramatic, ironic, critical, playful and above all performative.

The concept Squier develops to describe this negotiated zone is the "liminal life": "Those beings marginal to human life who hold rich potential for our ongoing biomedical negotiations with, and interventions in, the paradigmatic life crises: birth, growth, aging, and death" (p. 9). The liminal life is the life that is at once biological and more-than-biological (legal, ethical, cultural, economic), the life that is at once unmoored from the determinism of age and death and redetermined via a host of medical interventions, the life that hovers between being unbelievable and everyday. Squier's chapters consider a kind of "liminal life span," including stem cells, tissue cultures, hybrid embryos, organ transplantation, the "rejuvenate" and finally the idea of "regenerative medicine" and renewable life. Above all, the concept of the liminal life points to the way in which we are all liminal lives, and this is indeed one of the broader effects of Squier's book. Certainly there is a sense in which "biotechnology" is inevitably abstract, surreal and "science fictional." Yet, at the same time, biotechnology is also narrated in many different ways outside of the so-called specialist discourses, and popular culture is one domain in which this is especially true. Furthermore, each of us is also a "vir-

tual" patient, a medical subject in potentiality, and we exist in some relation to the everyday, even banal, reality of health insurance, diet, fitness, visits to the doctor, reproduction, aging, prescription drugs, "medical" TV shows and a broader "care of the self" contextualized by this intersection between medicine and culture.

**THE TRANSPARENT BODY:  
A CULTURAL ANALYSIS OF  
MEDICAL IMAGING**

by Jose Van Dijck. University of Washington Press, Seattle, WA, U.S.A., 2005. 208 pp., illus. Paper. ISBN: 0-295-98490-2.

*Reviewed by Jan Baetens, Katholiek Universiteit Leuven, Faculty of Arts, Blijde Inkomst 21, B-3000 Leuven, Belgium. E-mail: <jan.baetens@arts.kuleuven.ac.be>.*

In the endlessly growing field of studies on the representation of the body, Jose Van Dijck's book on medical imaging should be welcomed for more than one reason. Written from the triple background of literary studies, cultural studies and science studies (more specifically the SCOT, or social construction of technology, approach), *The Transparent Body* offers in a sense the best of both worlds: on the one hand a series of seductive and astute close readings of very concrete and highly diverse cultural artifacts such as Thomas Mann's *Magic Mountain*, the classic science fiction film *Fantastic Voyage* or the plastinated cadavers of the touring exhibition *Bodyworlds*; and on the other hand an overall theory of the way medical imaging techniques such as X-rays, endoscopy or ultrasound imaging of fetuses interact with cultural interpretations and re-uses of these techniques outside the medical world.

In seven concise and well-illustrated chapters, Jose Van Dijck accomplishes the tour de force, first, to introduce her readers to the (pre)history of the most current applied techniques of medical imaging and their social representations; second, to explain their main issues and stakes on a technical as well as an ethical and ideological level; and third, to relate these techniques to a broad set of cultural longings, hopes, fears, (mis)understandings and reconstructions. Following the basic claims of the SCOT approach, which already informed her two previous books (*Imagination: Popular Genetics and Manufacturing Babies* and *Public Consent: Debating*

*the New Reproductive Technologies*), Van Dijck demonstrates the dialectical relationship of society and technology, each of them constructing, miscon-structing and reconstructing each other.

The major qualities of this book are primarily rooted in its acute awareness of the very historicity of representation. If *The Transparent Body* is much more than a work of cultural studies, then it is not only because it exhibits a thorough knowledge of the technologies involved in medical imaging, but also because of the attention paid to the historical frameworks that surround the invention and use of specific techniques. *The Transparent Body* is, hence, also a media history of medical imaging, and the reader can only feel grateful for the clarity of the author's journey through modern Western representational techniques inside and outside medicine.

However, in order to avoid information overkill as well as the temptation of overwhelming generalizations, Van Dijck has rightly decided not to propose one single history. Each chapter focuses neatly on one specific medical imaging technique, following a simple but very efficient triadic scheme: a historical introduction, a close reading of a particularly well-chosen case study and a political reflection on the contemporary cultural interpretations and implications of the given technique. Although not necessarily presented in this order, this schema provides the reader with an exemplary didactic framework that never prevents the author from giving many original insights on the phenomena studied.

The real pleasure the reader takes from this book is not only intellectual. It should be stressed that Van Dijck's style has a kind of elegance that has become too rare in current scholarship. *The Transparent Body* displays from its very first to its very last sentence a real sense of rhythm, of wit, of rhetorical devices, a perfect balance of theory and anecdote, a sound feeling of how to dispatch information without ever giving the impression of being too slow or too fast and finally a strong moral and political commitment (yes, this is style, too!).

Together with the wonderfully rich range of objects treated, all these qualities make *The Transparent Body* a fascinating book for all readers eager to learn about a crucial aspect of their daily lives and the technological culture that is impregnating their body.

## ROBERT SMITHSON

edited by Eugenie Tsai. University of California Press, Berkeley, CA, U.S.A., 2004. 280 pp., illus. Paper. ISBN: 0-520-24409-5.

## ROBERT SMITHSON: LEARNING FROM NEW JERSEY AND ELSEWHERE

by Ann Reynolds. MIT Press, Cambridge, MA, U.S.A., 2005. 384 pp., illus. Paper. ISBN: 0-262-68155-2.

*Reviewed by Amy Ione, the Diatropé Institute, P.O. Box 6813, Santa Rosa, CA 95406-0813, U.S.A. E-mail: <ione@diatropé.com>.*

Jorge Luis Borges, one of the most celebrated authors of the 20th century, once penned a series of book reviews critiquing books that had never been written. In true Borgesian fashion, he explained that since people seemed more inclined to read the reviews, sometimes not finding time for the book itself, it seemed that producing only the critique was a better approach. His caricature of reading habits in our fast-paced lives came to mind as I wondered how I might enthusiastically encourage others to read *Robert Smithson* and *Robert Smithson: Learning from New Jersey and Elsewhere*, the two books that are the subject of this review. Neither of these full-bodied volumes can be captured in this short piece. Given this, let me begin by saying that all who have an interest in Robert Smithson's impact on contemporary art should put this review aside and turn to the books directly.

*Robert Smithson*, fully illustrated and augmented by writings by Eugenie Tsai, Alexander Alberro, Suzaan Boettger, Mark Linder, Ann Reynolds, Jennifer L. Roberts, Richard Sieburth, Robert A. Sobieszek, Moira Roth, Robert Smithson, Cornelia H. Butler and Thomas E. Crow, was conceived for the comprehensive American retrospective of Smithson's work, opening at the Whitney Museum in June. (It began at the Museum of Contemporary Art, Los Angeles and recently closed at the Dallas Museum of Art.) Smithson's knack for bridging incongruent perspectives comes across well in this over-size volume, as does his multi-layered legacy. Well-chosen photographs of his works (drawings, sculptures, nonsites, etc.) are mixed with cultural images as well as photographs of his excursions,

giving this artist a dynamic presence despite being confined to the staid pages of the book. As one would expect of a catalogue, this publication offers many topical essays on the artist's complex and highly influential career as well as an overview of his short life. Born in 1938, Smithson died prematurely in 1973 when the plane he was using to survey a site crashed. Yet, as the catalogue details, the reach of his work is extraordinary.

What I liked most about the presentation was the way his drawing, "A Surd View for an Afternoon, 1970," used on the cover, captured his coarseness, complex mind and range of thought. A surd is defined as something that is irrational and voiceless. Sketched during an interview conducted in 1969, and signed in 1970, Smithson's surd map spins us around the time and space he develops, deploys and re-configures in his projects. The scratchy composite, on a piece of graph paper, offers a glimpse of the gyrations of his mind. Composed of diagrammatic markings, explanatory words, directions and several of his signature motifs (the spiral, a map of New Jersey, and words we tend to find in discussions of his work such as "perception," "nonsite" and "entropy"), it is a map, a mirror and a plan. Its vertiginous quality is explained to some degree in the book's foreword, written by Jeremy Stick. Stick tells the reader that the difficulty in coming to grips with this far-reaching and paradoxical artist is due to the way Smithson extended the scope of his work outward to more and more distant locations. Yet, at the same time, he continued to integrate an awareness of the museum, gallery and art world in general in his projects. How this worked within his practice is unpacked by Thomas Crow to some degree when he speaks of Smithson's pursuit of the spiral. Homing in on this one motif, Crow illustrates this artist's remarkable intellectual reach. Similarly, the interview with Moira Roth, taped in 1973, allows us to see him through his own words. For example, although he is frequently coupled with Marcel Duchamp in discussions about the evolution of art in the 20th century, it is intriguing to find that Smithson expressed some negativity toward Duchamp during the interview with Roth. Also of note are the essays by Suzaan Boettger and Ann Reynolds. Both offer unique and insightful views of Smithson's mind and practice.

Ann Reynolds's own, quite different

volume, *Robert Smithson: Learning from New Jersey and Elsewhere*, is a wonderful companion to the catalogue. She effectively situates Smithson in terms of both contemporary art and history. In doing so, she demonstrates how deeply she has thought about his work and why it continues to feel contemporary even as our relation to its historical moment fades. Her decision to open a dialogue with earlier Smithson scholars adds to the book's readability. When this author stakes out her space and places herself in terms of earlier scholars (e.g. Craig Owens), she adds her voice in a way that encourages the reader to want to closely read her research. We are rewarded by her ability to express Smithson's practice and to explain how it was informed by his interest in repetition, as well as her grasp of much that went beyond his earthworks and the construction of the Spiral Jetty. Some projects, for example his *Untitled (Map on Mirror-Passaic, New Jersey)* (1967), establish Smithson's uncanny ability to simplify a complexity of threads into a coherent work. In this case, the work consists of seven square pieces of stacked glass of incrementally decreasing sizes. The artist mounted a black-and-white photocopy of a square section of the Weehawken, New Jersey, quadrangle on each stacked glass piece. The completed object thus creates a tension between the 2D map and the 3D work, while also commenting on Smithson's New Jersey. (How effectively Reynolds takes us into the mind of the artist is perhaps clearer when one turns to her very short contribution to the *Robert Smithson* catalogue.)

Overall Reynolds grapples with the blind spots at the center of established ways of seeing and thinking, conveying Smithson in a sympathetic way throughout. She introduces us to his background and, in doing so, brings to life the way Smithson saw his home state of New Jersey as such a blind spot. Her inclusion of small details further humanizes his life. For example, she mentions that the poet William Carlos Williams was Smithson's pediatrician and describes the impact his poetry had on this boy from New Jersey. A key to her success is her lengthy discussion of Smithson's early sculpture (1963–1967), which aids in exposing his early perceptual experiments. This, in turn, supports her claims that Smithson passionately embraced questions related to how we perceive the world during this period and that Smithson's rejection from the exhibition *The*

*Responsive Eye* at the Museum of Modern Art in 1965 had an impact on his later work. Smithson's submission for this legendary show (which brought together many "optical artists," such as Victor Vasarely, Bridget Riley and Frank Stella) was rejected by the curator, William Seitz, who wrote that "although interesting and relevant to the scope of the exhibition," the work did not "have an individuality that other artists on our list have expressed" [1]. Reynolds proposes that this dismissal propelled Smithson toward sculpture and 3D work. Within months he turned to free-standing enantiomorphic experiments in distortion of familiar objects, which allowed him to more fully experiment with the processes of perception and the interplay between art and culture.

Given my lifelong passion for works on paper, the reproductions of Smithson's drawings and diagrams in the Reynolds book particularly fascinated me. This aspect of his legacy is often given less attention, so finding so many reproductions was a real treat. Studying them raised many questions; however, I was surprised to find that much of his graphic work brought Paul Klee to mind. The catalogues of his library (which differed in the two books discussed in this review) included no books by Klee. While this might suggest that Smithson did not closely examine Klee's graphic experiments and that the similarities were coincidental, I do not feel comfortable drawing this conclusion. He surely must have come across Klee's work in his travels. What I did find interesting, when I perused the two lists detailing his massive cross-disciplinary book collection to see if he knew Klee's work, was that Smithson collected fewer books about artists and art history than volumes catalogued in other subject areas (fiction, philosophy, science, etc.). Moreover, the volumes listed under art leaned toward theory and criticism rather than studies of individual artists. In other words, scanning his library provided the best evidence of how this ground-breaking artist and autodidact reached far beyond art practice and the art world in formulating the ideas that are so intertwined with his legacy.

When the catalogue is juxtaposed with the Reynolds publication, it is clear that they offer complementary perspectives. Even the covers point toward this conclusion. Both were designed with the titles superimposed over a Smithson image. The Reynolds image, a 1967 photograph, *The Bridge*

*Monument Showing Wooden Sidewalks*, is not a picture reminiscent of Smithson ruminating so much as an illustration that demonstrates his early perceptual experiments. Looking at it we see that he chose an angle that could present the two sides of the bridge walkway converging toward a vanishing point. This quite standard perspectival choice brings to mind that Smithson's relationship with perceptual views evolved over the course of his career. While it is generally recalled that in his last years he voiced some skepticism toward art's fixation on sensory perception, much of his early work shows he participated in sensory investigation as well. Indeed, the most accurate way of summing this up would be to say that his fascination with how we perceive was a defining tension throughout his life, and one that his work reveals he viewed from several vantage points.

In summary, both books convey that Robert Smithson was among the artists who pushed the boundaries of art in the 1960s and 1970s. Both also contextualize his historical position and offer a wealth of delicious details. The complementary perspectives they offer greatly enhance our knowledge of this well-regarded artist and give us a genuine feel for how he combined art and culture in the eclectic projects that his fertile, creative mind brought into being.

#### Reference

1. William Seitz, *The Responsive Eye* (New York: The Museum of Modern Art, 1965) p. 57.

#### AFTER ADORNO: RETHINKING MUSIC SOCIOLOGY

by Tia DeNora. Cambridge Univ. Press, Cambridge, U.K., 2003. 192 pp., illus. Trade, paper. ISBN:0-521-53724-X; ISBN: 0-521-83025-7.

*Reviewed by David Beer, University of York and York St John College, York, U.K. E-mail: <david.beer@britishlibrary.net>.*

The writings of Theodor Adorno often attract fairly firm criticism. His work is often dismissed on the grounds of its deterministic, curmudgeonly or elitist nature. This criticism has perhaps snowballed as these dominant critical readings have become increasingly ingrained in contemporary social theory. With this in mind, it is perhaps surprising to find that in much of the recent literature on popular music, music technology and, in the case of

DeNora's work, music in everyday life, the critique and application of Adorno's work has taken center stage in the development of new approaches and theoretical frameworks. We have now reached a point, as foreseen by DeNora, where a reappraisal of Adorno's legacy has become near essential for the future of the sociology of music, and, more broadly, I would argue, for a sociology of technology and culture.

Often close readings of Adorno's work uncover new dimensions and new intricacies that contradict both his own writings and the dominant readings of his work. The contradictions inherent within Adorno's work, and between dominant readings of his work, make the construction of monological or totalizing interpretations extremely problematic.

In this text DeNora is concerned with reconsidering Adorno's work by formulating a detailed critique of his theoretical conceptualizations and then attempting to apply these within empirical research practices. The objective is to overcome the problems that DeNora identifies in Adorno's work, which are, first, that he theorizes on a level that is too general, and, second, that his work is abstract and does not attempt to access music in the everyday lives of listeners. The angle that DeNora adopts here could well have descended into an unconstrained celebration of Adorno's failings. However, DeNora treats Adorno's work with a great deal of care. Her critical evaluations of his work do not overly dwell upon the perceived problems. Rather Adorno's work is used here as a point of departure for a reassessment of DeNora's own research projects. The problem that DeNora inevitably encounters is that as she moves toward an analysis of her own data she tends to leave Adorno behind. As a result the text feels like it is constructed around two poles. On one side, we find the abstract, the theory and the concept; on the other, we find the microscopic analysis, the case study and the analysis of music in people's everyday lives. I would suggest that this is an almost insurmountable problem, because, as it seems clear from a reading of DeNora's text, Adorno did not intend for his writings to be used in this type of research. DeNora must therefore be offered a good deal of credit for facilitating such a successful empirical application of Adorno's work, a practice that is tantamount to inserting a square peg in a round hole.

With this aside, and perhaps ignoring Adorno's own attempts at empirical research—in his analysis of the symphony on the radio or the opera on the long-playing record—DeNora has constructed a valuable text that, through the critical evaluation of Adorno's writings, has created a pragmatic reference point for the study of music, and for the study of the ways in which music affects, either passively or actively, people's everyday lives. This is not an easily obtainable objective. Music is one of those black boxes, those hidden elements, those concealed practices and cultural forms that cannot be illuminated without small-scale case studies of the type used by DeNora.

Overall this is an interesting text that creates a variety of opportunities for future research. The development of further understandings of the ways in which music is appropriated in the reflexive stimulation of memory and emotions is one among a set of opportunities that emerge from a reading of this text. However, I would like to suggest that the next step requires a detailed critique of DeNora's approach and of the empirical techniques that form the foundation of the text, so that the strategy of critique and application adopted by DeNora is reflected back upon *After Adorno: Rethinking Music Sociology*.

### TELEVISION AFTER TV: ESSAYS ON A MEDIUM IN TRANSITION

edited by Lynn Spigel. Duke Univ. Press, Durham, NC, U.S.A., 2005. 480 pp., illus. Paper. ISBN: 0-8223-3393-7.

Reviewed by Kathleen Quillian.  
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Undoubtedly the Internet has changed the nature of mass communication from a centralized one-way model to a decentralized multi-directional model. How this will affect the industry of broadcast media has yet to be fully decided. While producers are falling over themselves to try to figure out how to successfully negotiate the media landscape in the age of the Internet, scholars are building upon their cache of expertise to develop a new dialogue of communications studies. In an attempt to give this new era some kind of identifiable form, Lynn Spigel has brought together the perspectives of several leading television scholars in *Television after TV: Essays on a Medium in Transition*.

It seems that while the dialogue is still developing around the new nature of mass communication, so too is the language. Throughout the collection, no less than a dozen different terms are given in the attempt to identify the scope of contemporary media communications—terms ranging from "omni-media" (Martha Stewart's term for her own media empire) and "post-broadcasting" to "the neo-network era." The book is divided into four sections that, broadly speaking, focus on: changes in the television industry in the age of the Internet; television's social context in the larger scope of culture; how television defines or redefines community; and the educational potential of television studies. Aside from two essays devoted specifically to European television (lifestyle programming in Britain and the introduction of television in Sweden, respectively) and a look at the development of Hong Kong as a media capital, the majority of the book is devoted to the many ways that the industry of (U.S.) commercial television has evolved and how it influences, or is influenced by, the Internet. To those of us who cannot conceive of life without the all-pervasive influence of commercial television, this collection of essays certainly gives one pause to think as we work our way through the next generation of mass media. One of the more interesting angles on this is given in "Flexible Microcasting: Gender, Generation, and Television-Internet Convergence," by Lisa Parks, in which the author surmises how the rise and popularity of television game shows foreshadowed the interactivity of the Internet. She then goes on to address how certain forward-thinking big-budget television producers have successfully (or unsuccessfully) negotiated the territory between television and the Internet with programs designed to encourage the involvement of women and youth while still maintaining the dominant ideologies perpetuated by commercial television.

The "flow" of the book (referencing a term coined by early television scholar Raymond Williams, one mentioned consistently throughout this collection of essays) moves from a rather focused look at new forms of marketing in the television industry to a broader look at the influence of television on culture and society. Two notable contributions presented toward the latter end of the flow are by Anna McCarthy and Lynn Spigel, whose respective essays give two very different

spins on power and broadcast media. In "The Rhythms of the Reception Area: Crisis, Capitalism, and the Waiting Room TV," Anna McCarthy discusses how the market of closed-circuit television programs both manifests and perpetuates certain social and economic strata in relation to the measurement of time in public waiting areas. Spigel's own contribution to this collection, "Television, the Housewife, and the Museum of Modern Art," chronicles a lesser-known and otherwise short-lived era in the early days of television when the Museum of Modern Art experimented with the potential gains offered by the new, avant-garde medium. In this essay, Spigel weaves an interesting narrative around leisure time, niche marketing and the clash between "high" and "low" culture in post-war America. An image of Barbara Streisand posing while singing in the museum gallery, wearing a designer gown similar to the modernist paintings on the wall next to her, illustrates this essay quite well.

In the attempt to position so many ideas in one conversation, however, inevitably some parts of the discussion get left out. In this case, it seems that while much thought is developed around the industry of commercial television and the social consequences of the medium in the age of the Internet, the roles of journalists and media activists—those individuals who negotiate and shape the media landscape on a daily basis—were overlooked altogether. The few times the news media is given attention in this collection is only in terms of its absence. Anna Everett's essay "Double Click: The Million Woman March on Television and the Internet," describes how the organizers of the Million Woman March utilized the resources of the Internet to fill in the gaps that were left in coverage of this event by mainstream media. Similarly, in "Pocho.com: Reimagining Television on the Internet," Priscilla Pena Ovalle discusses the lack of media attention directed toward the Hispanic community and how one web site in particular succeeds in shaping an alternative community by subverting mainstream media. The discussion of television in the age of the Internet would greatly benefit from a focused look at independent media organizations such as the Independent Media Center, Democracy Now! and MoveOn.org, which are forced to find their way through and around the tightly regulated confines of broadcast

media to bring alternative perspectives to the table. These organizations largely rely on the power of the Internet as well as what little room is left in public access and public-sponsored media channels to develop dialogues that are sorely lacking in corporate-controlled, mainstream media. We could learn a thing or two from their experiences of communicating through new and alternative avenues in broadcast media.

This collection of essays comes at a critical time, one when we are looking at not just a change in media but a change in form, practice and consequence. Whether or not television producers succeed in steering the market in their favor, governments succeed in maintaining hegemony through regulation, or citizens succeed in claiming their rightful territory within the new terrain of mass communications really only comes down to who figures things out first. By revisiting the history of television in terms of the new media landscape, we may be able to pick up some valuable clues as to how to go about shaping some kind of acceptable future for broadcast communications.

#### **ARTE TELEMÁTICA. DOS INTERCÂMBIOS PONTUAIS AOS AMBIENTES VIRTUAIS MULTIUSUÁRIO**

by Gilberto Prado. Itaú Cultural, São Paulo, Brazil, 2003. 128 pp., illus. CD-ROM included. ISBN: 85-85291-40-0.

*Reviewed by Stefaan Van Ryssen, Hogeschool Gent, Jan Delvinlaan 115, 9000 Gent, Belgium. E-mail: <stefaan.vanryssen@pandora.be>.*

*Arte Telemática. Dos intercâmbios pontuais aos ambientes virtuais multiusuário* (Telematic Art: From Instant Exchanges to Virtual Multiuser Environments) is one in a series of three books on the contemporary Brazilian arts scene published by Itaú Cultural, a very active Brazilian cultural foundation sponsored by Itaú Banking Company (the other books are on dance and literature). The book's scope is the field of artistic experiments with new technological means, their transformations and derivatives. It reflects on these realizations as the "new poetics" of a dynamic universe of digital images, as a necessary means to understand and explore technological progress. It ranges from the fax and modem pieces of the 1970s and 1980s to the Internet

works of the 1990s and the multiuser virtual environments that contemporary Brazilian artists are building.

Gilberto Prado is a professor in the department of Fine Arts at ECA/USP (University of São Paulo) and has been the curator of the Welcomet Mr. Halley exhibition and the 12th Brazilian Symposium of Graphic Computing and Image Processing. He has participated in numerous shows in Brazil and abroad, including Paris, Athens, Milan and Barcelona. As such, he certainly is in the right position to present a well-documented overview of what Brazilian artists have been producing over the past 40 years. He does so in four chapters. In the first, which is devoted to artistic experiments with telecommunication networks, he analyzes networks of artists, collaboration and complementarity, technical opportunities and limitations and the role of exchange and participation. Chapter 2 presents a chronology of the pre-web years 1977–1994. Chapter 3 is about the Internet years and work on and with the Web. In the final chapter, multiuser virtual environments are discussed.

The book includes a CD-ROM with the full text, about 20 video clips and a large number of images related to the works described in the book.

Even though this book is in Portuguese, it will prove an invaluable source of information and reference for anyone who is interested in the history and practice of new media art. With some background knowledge of Spanish (or Latin), the gist of the text will be clear enough; or one may run it through some free on-line translator and simply browse the CD-ROM and enjoy.

#### **ABY WARBURG AND THE IMAGE IN MOTION**

by Philippe-Alain Michaud. Sophie Hawkes, trans. Zone Books, New York, NY, U.S.A., 2004. 382 pp., illus. Trade. ISBN: 1-890951-39-0.

*Reviewed by Michael Punt, University of Plymouth, Drake Circus, Plymouth, U.K. E-mail: <Mpunt@easynet.co.uk>.*

Philippe-Alain Michaud's new book, *Aby Warburg and the Image in Motion*, does three things. Two it does rather well, and the third it leaves open for other scholars and artists to pick up. The first thing that it does well is to remind us who Aby Warburg was and why he is important today. In 1892 Aby

Warburg, the eldest son and heir to the M.M. Warburg Bank, defended his doctoral thesis on Botticelli's paintings of the *Birth of Venus* and the *Primavera*. His thesis revealed these paintings as works in which the programmed interactions of classical and modern forms were juxtaposed in such a way that in their surrender to a contemporary context there was a release of spirit. This exposed the function of art as the ritualistic liberation of the contained, and reiterated the Dionysian impulse that had been driven underground (at least in the arts) by the stoic rationalism of the classical period. By following what might be called an ethicalist vision, Warburg showed the limitation of bounded disciplines in art history and the insufficiency of canonical terms such as "the Renaissance" to fully account for the acts of human consciousness during its prescribed period.

Warburg (1866–1929) recognized that art could not be understood exclusively as an epistemology of objects; it was also the trace of a historically persistent human obsession with movement and one of many activities that ritually re-enacted the transient moment of "becoming." Art, according to Warburg, was crucial because in painting and sculpture, for example, in the bringing into being of an intention, matter was subordinated to human consciousness. His approach was informed by a rising confidence in cultural anthropology and (although it seldom appeared in his work directly) the emergence of cinema. The effect of these two key influences can be seen in the organization of his library in Hamburg, the Kultur-wissenschaftliche Bibliothek Warburg (KBW), which in addition to books also contained over 20,000 images. Toward the end of his life he used this collection to produce a series of black painted boards on which he attached images of artifacts from quite different time periods and cultures to reveal a continuity of ideas that operated in contradiction to their temporal and geographic provenance. These boards, of which we have an incomplete record, were subsequently called the Mnemosyne Atlas. They were stood purposefully against the shelves in his library and in this arrangement proposed a relationship between memory and culture that refused to reduce the human ritual of art to artifacts in the service of master narratives of influence and attribution. They epitomized Warburg's idea that the origins of the obsession with movements lay in a

worldview that revelled in excess and boundless possibility.

What is at stake in Warburg's intellectual approach and his Mnemosyne Atlas extends beyond the boundaries of art into a broader set of concerns that embrace science and technology. As with some late-19th-century theoretical physicists, his real object of study was the distance between the individual and the object. In this context the crucial condition for movement was not the incompatibility between the magical and the logical but rather the impossibility of connection between them: In the dark gap of indeterminate dimension between one state and another, the only possible connection is the pulse of ahistorical consciousness. Michaud's way of retelling of Warburg's life and ideas (and credit here must also go to the translator) is compelling and evocative of the current debates that occupy us at the fringes of art and science. At times Michaud's discussion of the way that Warburg saw the Renaissance resonates with some of the philosophical writings of Varela and a more radical constructivist view of the world. However, Michaud's rhetorical tactic of situating Warburg in a contemporary context of ideas also amplifies the injustice that Warburg has been subjected to by historians and art educators. Although his ideas were influential, his own unique contribution fell into a certain obscurity, and his work became known primarily through his students (Wind, Saxl and Panofsky especially) and certain forms of art practice. His ideas arguably lie at the core of the postwar art-school movement and the fascination with collage and montage editing that more or less shaped the aesthetic of video art and performance. And his understanding of art as universal impulse inflected by style but never subordinated to it, together with his use of the image as an epistemological object and his method of practice research (the mnemosynes and rearranging the library in order to express the inexpressible, etc.), is the essence of much current thinking.

Michaud can claim great credit for making this evident in the way that he tells the story in an engaging style that wears its knowledge lightly. Sophie Hawkes, the translator, has done a good job in presenting complex concepts without the need for endless rereading that most translations of French theory used to insist upon as a badge of seriousness. It is, however, dealing with the relationship between Warburg and

the cinema that Michaud does less well, which, given that he is the curator at the Musée national d'art moderne at the Centre Georges-Pompidou, may be surprising. It is also surprising that when Michaud talks of early cinema and its invention, there are some historical errors, and a still from Griffith's *Way Down East* used as an illustration is titled incorrectly (this may be an editorial slip, since it is correct in another paper elsewhere). The larger difficulty is that while Michaud reveals the intellectual significance of Warburg's ideas with enthusiasm, they seem to have had little impact on his own profoundly teleological conception of history. As a consequence, the more one becomes engrossed in the connections that Michaud's text makes and the implications that flow from them, the more frustrated one becomes by the way that he tells the history of cinema as a technological and formal inevitability. What the book finally misses is Warburg's significance for the enterprise of history as it is currently understood as a contingent view of something we choose to call the past.

Warburg forms part of a corpus of European ideas that developed on the cusp of the 20th century and were too quickly overlooked. I am thinking in particular of the subtle philosophical thinking of Henri Bergson, which was displaced by the more mechanistic intellectual paradigms of psychoanalysis and semiotics at precisely the moment when science needed the tools to manage contingent truth and relativism. That said, Michaud does a great service in the way that he reopens the problem of history as he accounts for Warburg in such an engaging way. In doing so, his book is a considerable contribution to the growing intellectual enthusiasm for articulating those ideas epitomized not only in the work of Bergson but also in more contemporary thinkers such as Vilém Flusser, Edgar Morin and Barbara Maria Stafford.

### STUFF IT: THE VIDEO ESSAY IN THE DIGITAL AGE

edited by Ursula Biemann. Springer, Vienna, Austria, 2003. 166 pp., illus. 155 col. Paper. ISBN: 3-211-20318-4.

*Reviewed by Dene Grigar, Texas Woman's University, Denton, TX, U.S.A.  
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The metaphor of compression sits at the heart of Ursula Biemann's anthol-

ogy *Stuff It: The Video Essay in the Digital Age*, for it suggests such physical states as contraction, pressure, squeezing, crowding, reduction and deflation. According to the back cover, these are the very issues the collection of 15 essays addresses about the

art, theory and critical practice [of the video essay] in all its variations: from monologues of disembodiment to cartographies of diaspora experiences and transnational conditions, from the essay as the organization of complex social shifts to its technological mutation and increasing digitalization.

Biemann's introduction sets the tone for the book and elaborates on the origins and trends of the video essay: As she tells us, the film essay was first introduced in the early 1980s by Chris Marker in *Sans Soleil*. Intrigued by what happened to the genre in the digital age, she hosted a conference, also named "Stuff It," in 2002. The book, like the conference, "recontextualize[s] the audio-visual essay both technologically and culturally," focusing on a

wider development of new media, the Internet and digital image production and understand how these technologies emphasize or mutate the characteristics of the essay while opening up new possibilities for a critical engagement with them (p. 8).

Two other essays, Nora Alter's "Memory Essays" and Jorg Huber's "On the Theory-Practice of the Transitional," help to further expand on Biemann's introduction. Alter's essay situates the video essay in the long tradition of the essay genre, beginning with *Essais*, Montaigne's 16th-century work, progressing through time to de Sade, Emerson, Nietzsche, Lukacs, Adorno and Barthes. No one who has taught any form of the essay recently will disagree with Alter's stance that the essay is "critique of ideology" or that "since film, video, or literature is the work of re-presentation, veracity is an impossibility" (pp. 13-14). Her final statement that the video essay is now a "full fledged peer of the narrative and documentary films" (p. 21) is substantiated by the other essays that follow, particularly Huber's, who focuses his attention on theoretical underpinnings of the video essay.

It is Huber's essay, in fact, that explains to the novice of the genre the reasons surrounding the shift to a post-colonial, cultural-studies approach. As he says,

Practical experience shows that traditional forms of knowledge production with their enclosure into disciplines and dogmatic methods are hardly adequate to this task. It rather requires an approach that understands itself as an open, interminable and transdisciplinary process which is self-reflective of its procedure, also in terms of its style (p. 92).

Traditional literary studies, particularly those ensconced in formalist and even new critical approaches, insist on objectivity fixed upon a static object, while the

video essayistic mode exposes the process of subjective perception and associative thinking: ... is involved in translation and transition; [and] ... focuses on the ambulatory character of imagination, far removed from any programmatic statements (p. 93).

Thus, the video essay is symptomatic of the general ambiguity that emerged in the late 20th century—what Huber describes as a "general sliding, gliding and shifting, where any discourse can transform into any other discourse, where it can be continued in other fields, be grafted onto anything and placed anywhere else" (p. 96).

The general nervousness about utilizing theories involving language for discussing the video essay is echoed in Jan Verwoert's "Double Viewing: The Significance of the 'Pictorial Turn' to the Critical Use of Visual Media in Video Art." Verwoert argues for an approach to the video essay that turns away from semiotics (or a linguistic approach) to a "post-linguistic, post-semiotic rediscovery of the visual image as a complex interplay involving viscosity, apparatus, institutions, discourse, bodies, and figurativity" (p. 25). His notion of "double viewing" offers, he suggests, a "model of a mobile, pleasure-oriented, yet emancipated recipient of the media of popular culture ... based on the presumption of the multidimensional character of identification and consumption processes" (p. 26). His own term for "double viewing" is "disjunctive synthesis," a method that

seeks to make use of the two contradictory principles of fascination and skepticism, exploiting the power of fascination in the images to the maximum at the formal level, taking advantage of the possibilities for establishing coherency through traditional narrative means (voice-overs, continuous flow of image)—thus using all of the tools that contribute to narrative closure and thereby maximize the effect of a work of video (p. 29).

No doubt the most provocative essay in the book—and one that exemplifies cultural and political compression—is Walid Ra'ad and the Atlas Group's "Civilizationally, We Do Not Dig Holes to Bury Ourselves." This essay is a "public interview" with Souheil Bachar, a Lebanese man held captive for 10 years—a 3-month period of it with the five Americans captives held in Lebanon during the event that came to be known as the arms-for-hostages scandal. The interview was conducted by Maha Traboulsi, a media artist representing the Atlas Group, instrumental in helping Bachar to make videotapes of his experience. At the time of the interview he had made 53 short videotapes about his captivity. Only two of them would he allow to be viewed in North America and Western Europe. His characterization of the kidnapping of Benjamin Weir, Terry Anderson and the others as a political act, rather than a criminal one, born from frustration and anger at American policies toward the Middle East, has been applied to more recent hostilities between the U.S.A. and the Middle East. What catalyzed Bachar into action in 1999 to make his videos, however, was the way the "contested narratives" (p. 39) that emerged from the investigations into American foreign policy following the scandal were distilled into a single myth of American righteousness. That discovery led him to explore "how this kind of experience can be documented and represented," something the American stories stemming from this experience "failed miserably" at, he believes (p. 43).

Other notable essays include Rinaldo Walcott's "But I Don't Want to Talk about That: Postcolonial and Black Diaspora in Video Art," which applies postcolonial theory to video essays on issues relating to "black modernity" (p. 58); "En la calle: From an Interview on TropiCola," a discussion of the *timba*, the complex and political music of Cuban youth culture; and Christa Blumlinger's "Harun Farocki: The Art of the Possible," which questions the "conceptual opposition of analog or videographic media and digital or post-photographic images" (p. 110), which she suggests is derived from a purely technological standpoint. Also, those interested in narrative and cognition will find Maurizio Lazzarato and Angela Melitopoulos's essay "Digital Montage and Weaving: An Ecology of the Brain for Machine Subjectivities" helpful. They argue that

the montage technique makes it possible to speak of the second aspect of Bergson's concept of memory, which involves changing the duration of the input-output relationship through deliberate influence. This function of the human brain can be simulated in the imaging processes used in montage (p. 121).

The book also provides critiques of 11 video essays, a selected videography, selected bibliography and author biographies. Missing from this rich trove of resources, though, is an index, which would have been useful for retracing ideas, names and events mentioned in the book.

While the publisher claims that the book is written for "experts and laymen interested in media theory, history of art, cultural science, social theory," I would add to this list those working in the areas of visual rhetoric, composition studies, electronic literature and digital culture. Certainly it should find its way onto the reading lists of any scholar interested in new media.

## FESTIVAL

### 2ND FILM MUSEUM BIENNALE: DIGITAL TECHNOLOGIES MEET EARLY CINEMA

Netherlands Filmmuseum,  
Amsterdam, the Netherlands,  
5–10 April 2005.  
Web: <[www.filmmuseum.nl/](http://www.filmmuseum.nl/)>.

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Alongside the two renowned annual festivals of film restoration in Bologna and Pordenone, Italy, the Filmmuseum in Amsterdam has established its own biennial festival, the *Biennale*. Drawing wide public and international attention in its second edition, the festival is beginning to reveal its specialty as recent restorations, newly rediscovered films and the accompaniment of silent films with contemporary music scores. The result was a most ambitious program comprising 35 films, almost all rediscovered film jewels, screened over 5 days and a sequence of presentations and discussion forums focusing on specific restoration issues such as digital restoration. This ambition and

courage was to be expected, since the Netherlands Filmmuseum is well known for its openness to experiments with new (and digital) technologies and alternative treatments of the aesthetics and ethics of film preservation and presentation. In the late 1980s it was one of the first archives to experiment with the duplication of tinted, toned and stenciled early films on color stock, and also stood out with its famous "Bits & Pieces Collection" (compilations of remarkable early film fragments), as well as its experimental musical accompaniments to "silent" films.

One of the most memorable events of the 2005 Biennale was the screening of one of the many lost silent Hollywood films, a worthy topic as more than 80% of the nitrate film heritage made between 1895 and the mid-1950s is considered "lost." This discovery was *Beyond the Rocks*, a melodramatic star vehicle made by Sam Wood (U.S.A.) in 1922. The film features Rudolph Valentino and Gloria Swanson, two of the most celebrated stars of the time, in their only film together. The six reels of the Dutch release of *Beyond the Rocks* were discovered in the conservation department of the Netherlands Filmmuseum between 2000 and 2004 during the registration work of a recently acquired private collection of about 2,000 rusty film cans. The tinted 35mm nitrate positive print was in relatively good condition, with some parts of greater damage and chemical decomposition (still visible in the restored copy), which coincidentally affected the most emotionally intense and dramatic scenes of the film. Because of the international interest in this remarkable film, extra funds for the restoration process became available, and the Filmmuseum found itself in the luxurious position of being able to restore a feature-length film digitally. To dispel the common misconception of digital restoration as a substitution process, curator Giovanna Fossati, responsible for the restoration of *Beyond the Rocks* and for digital restoration technologies within the conservation department, pointed out that for an archive, digital technology complements the photochemical duplication process but in no way replaces it. One reason for this is that digital technologies still change too quickly and do not yet offer reliable tools for archives to transfer their entire collection to digital formats for preservation. So far to date, good old celluloid

is still the most reliable material for preserving film heritage under the best conditions.

Nonetheless, Fossati was very positive about the various new possibilities that digital restoration technologies offer for active film restoration. She showed some "before" and "after" examples from *Beyond the Rocks* and demonstrated the values of image manipulation using Diamant software (developed by HS-Art Graz in collaboration with the Filmmuseum; see <[www.hs-art.com/](http://www.hs-art.com/)>). Next to de-flickering, stabilization of the image and dust removal, digital intervention includes interpolation—one example of which is the restoration of an almost completely damaged frame by copying image fragments from the neighboring frames. The newly created frame is similar to the original, but has not existed before, and as a consequence raises ethical issues. On the one hand, there are more orthodox and "safe" approaches that avoid any elaborate image manipulation, but on the other hand, the experiment-friendly approaches resonate with the Filmmuseum's innovative spirit.

The addition of a musical score to *Beyond the Rocks* created technical, ethical and aesthetic problems for the restoration process. In order to duplicate a print for cinema distribution, the soundstripe had to be added to the film and the silent 35mm images had to be resized in order to make space for the soundtrack without losing the original ratio. It was also necessary to increase the frame rate from the original 18fps to 24fps, the standard speed in European cinema projection. To achieve this effect, every third frame in the film was repeated, a trick that remains invisible for the general audience; only some of the archive specialists claimed to have noticed it during the screening. While opinions on the ethical and aesthetic decisions on the restoration of *Beyond the Rocks* may have differed, Fossati made very it clear on behalf of the Filmmuseum that in the first instance, even before the public announcement of the discovery of *Beyond the Rocks*, the Filmmuseum had duplicated the original nitrate print via the photochemical process in the laboratory to ensure the immediate preservation of the decaying material. In this preservation, the original copy is duplicated one to one without any manipulation; the digital restoration was made in addition to this copy in order to gain a cleaner version of the film with its new soundtrack for

worldwide distribution in cinemas and on DVD. And while the Biennale was unfolding, the computers in the laboratory of Haghefilm at Cineco were running continuously to create the English inter-titles for the international distribution copy of *Beyond the Rocks*, raising a further ethical issue around the topic of authenticity.

The case of this new production, comprising a digital restoration with a new soundtrack, opened up a substantial discussion about digital technology for film preservation and presentation that was continuous with issues reflected in other parts of the Biennale program. For example, the additional value of digital technology for film preservation and presentation was a topic in the section "Archives and Education," where the Filmmuseum presented its collaborations with the professional master's program "Preservation and Presentation of the Moving Image," at the University of Amsterdam (see <[www.hum.uva.nl/graduateschool](http://www.hum.uva.nl/graduateschool)>).

For the early cinema connoisseur the Biennale offered an ambitious program of unique discoveries and recently restored films, for example Germaine Dulac's *La Coquille et le Clergyman* from 1927, based on Antonin Artaud's screenplay; and the 1941 version of *Regen* (Rain), by Joris Ivens and M.H.K. Franken (Netherlands, 1929 and 1932), with the famous score by Hans Eisler ("Fourteen Ways to Describe Rain"), which no longer existed in its original form. Elsewhere on offer there was the most complete version of *The Robber Symphony* (Friedrich Feher, U.K., 1936) newly restored, and the most recent restoration of *Sunset Boulevard* (Billy Wilder, U.S.A., 1950), presented and introduced by Barry Allen, the head of restoration at Paramount Pictures. The Danish Film Institute also presented a program showing such treasures as *Afgrunden* (1910), by Peter Urban Gad (starring Asta Nielsen in her debut), accompanied by, among other films, a documentary on Nielsen, *The Talking Muse*, by Torben Skjodt Jensen (2003). The "Danish Day" concluded with another discussion about the issue of restoration and digital technologies, with a particular emphasis on the approach of the Danish Film Institute, which is well known for its outstanding restorations and its purist approach (in contrast to the more experimental Netherlands Filmmuseum).

Music, so essential to cinema, constituted another key focus of the Bien-

nale, which featured contemporary scores in some most impressive musical evening performances, such as the adventure film *Le mystère de la Tour Eiffel*, by Julien Duvivier (1927). This performance was one of the highlights of the week, both in its unique restoration by the Filmmuseum, presented for the first time, and in its musical accompaniment by composer Fay Lovsky together with an ensemble of Dutch musicians. Another highlight was the screening of *Menschen am Sonntag* (Robert Siodmak and Edgar G. Ulmer, Germany, 1930), restored by Martin Koerber in collaboration with the Netherlands Filmmuseum, with a new soundtrack performed live by the Alliage Orchestra (available on DVD). The performance of *Spinvis*, by Erik de Jong and his ensemble, created a true soundscape for the "Bits & Pieces" compilation from the Filmmuseum, as did DJ Aardvarck (Mike Kivits), who turned the tables until late on Saturday night, when half of one of the Cinerama theaters was transformed into a dance floor so that the Biennale audiences could shake off their film festival stiffness, and again in an engagement with a "Bits & Pieces" compilation titled "Human Bits."

Much more could be said about the rich program of the Biennale; for a complete overview, please visit the Netherlands Filmmuseum's web site at <[www.filmmuseum.nl](http://www.filmmuseum.nl)>. Hardly ever has there been so much fresh and experimental breath in an early cinema festival as at the Filmmuseum Biennale, and it is a credit to the team of innovative, engaging specialists who were responsible for bringing it all together. More significantly, the Biennale successfully reached out for both a broad audience and specialists from the field of film archives and set a trend with its innovative and experimental approach. It also set high expectations for its next edition in 2007, when, one hopes, the audience can share again some of the excitement of the Filmmuseum staff working in the cool vaults, opening rusty film cans that once in a while reveal small or bigger jewels of film heritage. The Biennale shows some of these jewels in an excellent festival created by a brilliant team at the Filmmuseum in Amsterdam and deserves all the credit for having created a new forum where historical material is approached with innovative ideas that keep pace with contemporary technological developments and anticipates visions of the future.

## FILMS

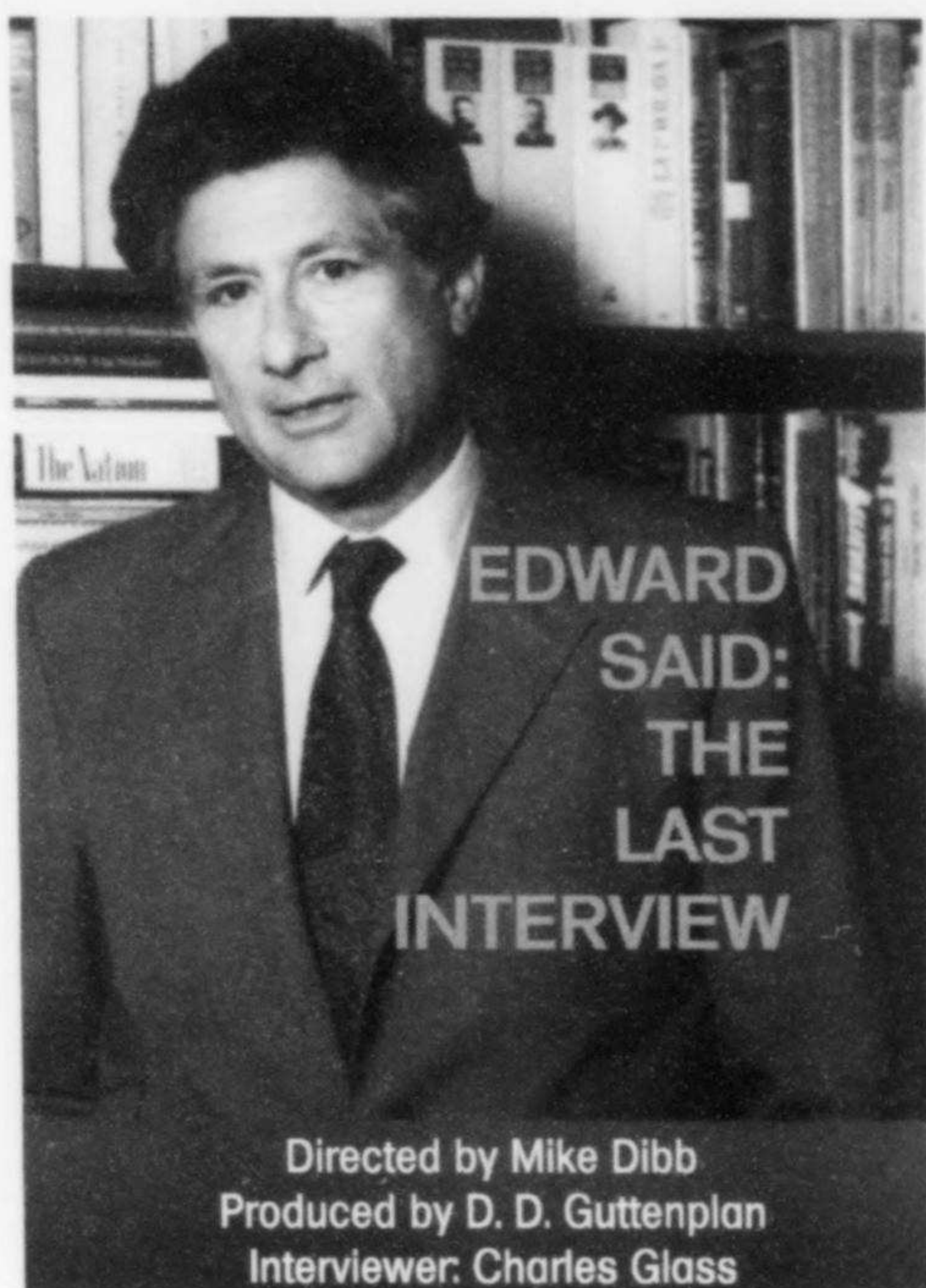
### EDWARD SAID: THE LAST INTERVIEW

by Mike Dibb. 2004. VHS/DVD, 114 min., color. Available from First Run/Icarus Films, Brooklyn, New York, U.S.A.,

Reviewed by Andrea Dahlberg.  
E-mail: <[dahlberg@bakernet.com](mailto:dahlberg@bakernet.com)>.

Less than a year before his death on 25 September 2003, Edward Said gave his final interview over the course of three days. This interview is recorded in Mike Dibb's film. Said speaks of his illness and how he was virtually unable to read, write or listen to music. But there is no sign in this remarkable film of any abatement of Said's immense intellectual energy or passionate engagement with life. Said speaks for almost two hours about his life, his major works, including *Orientalism* and *Culture and Imperialism*, his films, his role as a member of the Palestine National Council and his subsequent profound disillusionment with Arafat and the Oslo Accords. It is hard to think of another individual who could carry an entire film of this length merely by speaking to an appropriately low-key interviewer such as Charles Glass.

Said is blazingly articulate, with a face that could have been painted by El Greco. He illustrates his points with references to Vico, Foucault, Jane Austen, Gerard Manley Hopkins, Conrad, Graham Greene, Daumier, Tagore, Faulkner, Shakespeare, Hemingway, Mailer, Eliot, Roth, Chomsky and Napoleon. He describes his obsession with counterpoint and his preference for Rossellini over Verdi (Verdi is always "in italics"). Said also discusses American self-identity, the U.S. educational system and the provincial nature of its intellectuals, such as Philip Roth and Norman Mailer, who remain focused on the interior life of the country and do not engage with its immense impact in the world. Yet Said is always accessible and engaging. Whether describing his schooling in Cairo and the U.S.A., his views of his parents, his existential experiences of exile or his intellectual and political passions, Said makes sparks fly. His words paint a vast, vivid world, one that he inhabits more intensely than most. His emotional and imaginative range is as great as his



intellect. I had the pleasure of watching this film with people who are well versed in Said's work and with others who had barely heard of him. Not one of them failed to be drawn in or energized and left wanting to respond to Said's ideas.

The director of this film, Mike Dibb, was a friend of Said's who knew his subject sufficiently well to make the roles of the interviewer and the camera as unobtrusive as possible. Said wears the same clothes over the three-day period of the film's shooting, which helps create the illusion that the viewer is the third party in a small room listening to Said and, to a lesser extent, Glass conversing. The result is an intimate portrait of a great mind.

With the passing of Edward Said, the world lost a great intellectual and an articulate and credible spokesman for Palestine. This film captures the man himself.

### PROTEUS: A NINETEENTH CENTURY VISION

by David Lebrun. 2004. VHS/DVD, 61 min., color and black-and-white. Available from First Run/Icarus Films, Brooklyn, NY, U.S.A.

*Reviewed by Roy R. Behrens, Department of Art, University of Northern Iowa, Cedar Falls, IA, U.S.A. E-mail: <ballast@netins.net>.*

My favorite statement by German scientist Ernst Haeckel (1834–1919) is not mentioned in this film. A zoologist, scientific illustrator and advocate of pantheism ("God is everywhere"), he

wrote in 1899, in *The Riddle of the Universe*, that the typical Christian description of God is that of "a gaseous vertebrate." This wonderfully interesting, prize-winning film provides an informative overview of Haeckel's intellectual growth, the social setting in which his ideas matured, and the progress of his writings on evolutionary biology (he popularized the "tree of descent," the notion of ecology, and the biogenetic assumption that the development of an individual [ontogeny] is indicative of the stages by which its species evolved [phylogeny]). Haeckel was among the most widely read writers of the 19th century and yet he is all but forgotten today. When his name is mentioned, it may be not for his scientific writings, but for his innumerable drawings made (using a microscope connected to a camera lucida tracing device) from live specimens of astonishing one-celled animals called radiolarians. These tiny sea creatures were called that because their silicon skeletons are examples of radial symmetry; yet (like snowflakes) no two are identical, and their variety is truly amazing.

I have been aware of Haeckel's work for years because I own a copy of *Art Forms in Nature*, a book of his drawings and paintings that was first published in 1904 and was more recently reissued (with the plates only, without his scientific text) by Dover Publications in 1974. Those same images are used inventively throughout this film to produce animated sequences of the similarities and differences of radiolarians and other protozoa, a term that alludes to Proteus, a Greek god of the sea, who (like radiolarians) could appear in countless varied forms. Haeckel's greatest influence was Charles Darwin, but, as this film postulates, he may have been equally influenced by Johann Wolfgang von Goethe's attempts to reconcile art with science; by *The Rime of the Ancient Mariner*, the epic poem about the

sea and creativity by Samuel Taylor Coleridge, who described the ocean as "the reservoir of the soul"; and, most surprisingly, by the inadvertent research of ocean life that came from the laying of the first transatlantic telegraph cable by Cyrus Fields in 1866. When this film premiered in 2004, it was deservedly given awards at several film festivals as the "best documentary." In watching it, I learned quite a lot about Ernst Haeckel as a person, Darwinian evolution theory, the beginnings of oceanography, the Victorian era, and society's age-old equation of the quixotic moods of the ocean with madness and the imagination—so much so that, prior to the formation of mental institutions, people who were mentally ill were sometimes set adrift on ships, in ill-fated crafts that were commonly known as "ships of fools."

(Reprinted by permission from *Ballast Quarterly Review*, Volume 20, Number 4, Summer 2005.)

### BAUHAUS: LESS IS MORE

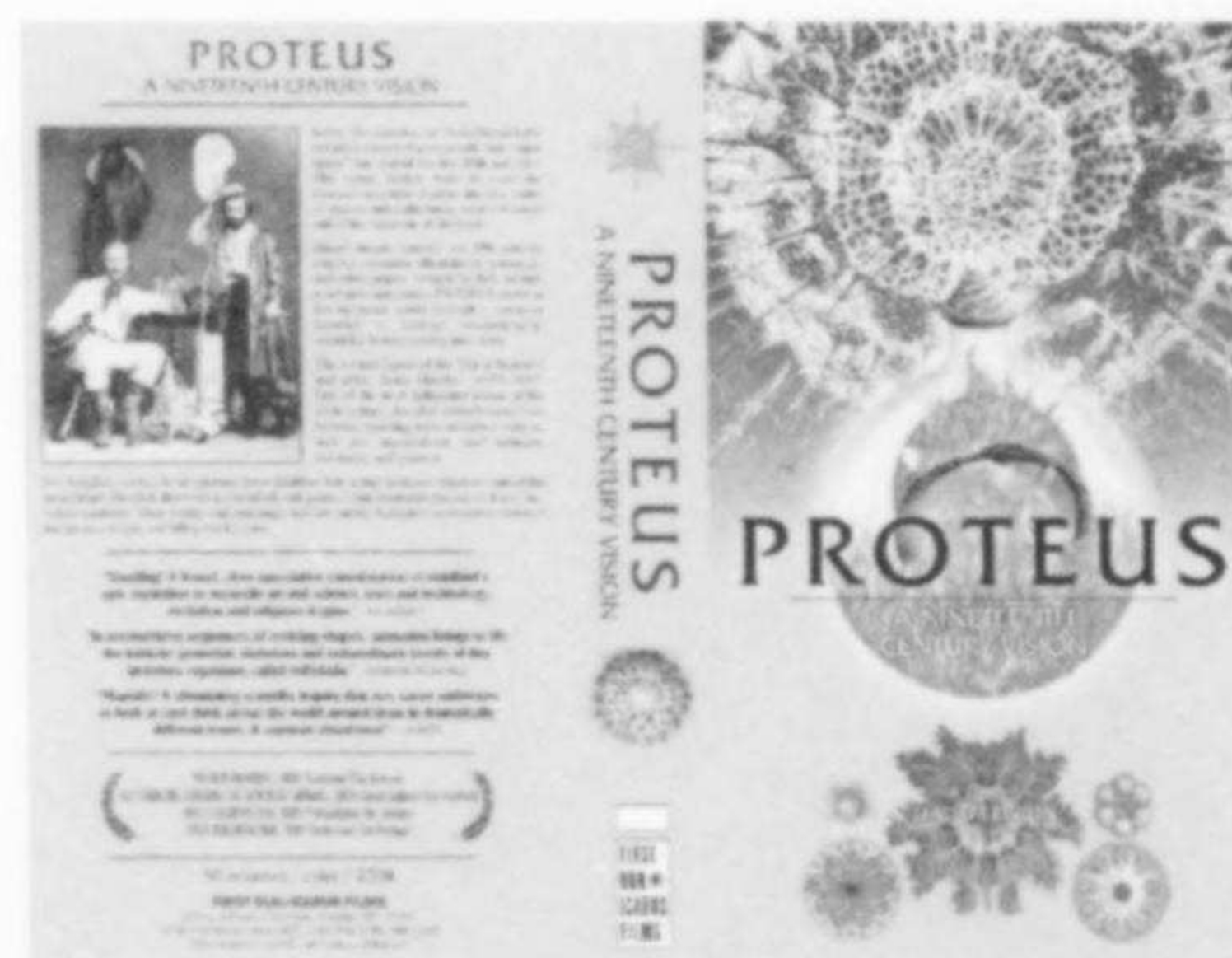
by Eliseo Alvarez. 2005. VHS/DVD, 32 min., color. ISBN: 1-4213-0360-4; ISBN: 1-4213-1429-0.

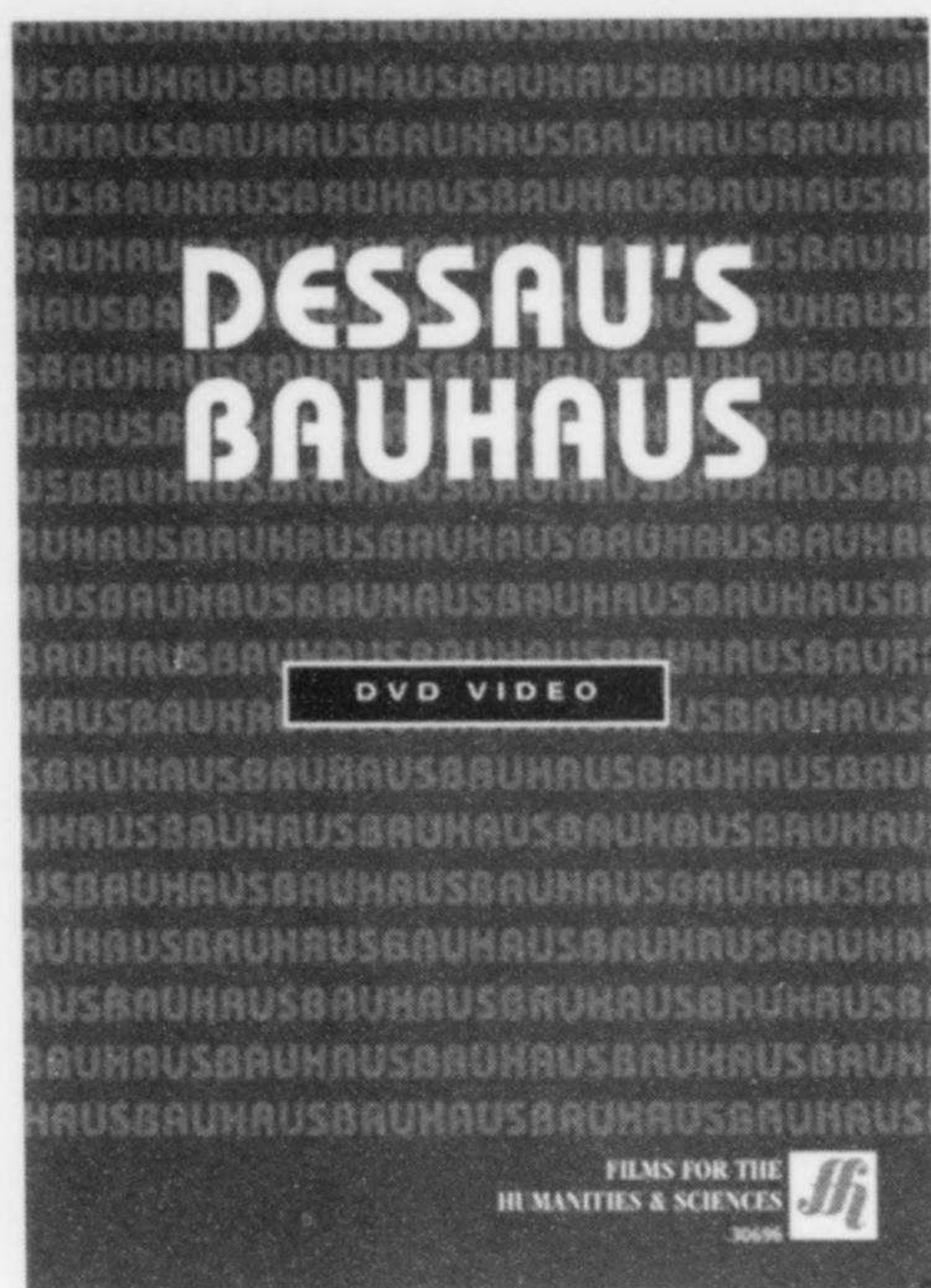
### DESSAU'S BAUHAUS

by Frederic Compain. 2000. VHS/DVD, 29 min., color. ISBN: 0-7365-5124-7. Both films available in the United States and Canada from Films for the Arts and Humanities, P.O. Box 2053, Princeton, NJ 08543-2053, U.S.A. Web: <www.films.com>.

*Reviewed by Roy R. Behrens, Department of Art, University of Northern Iowa, Cedar Falls, IA, U.S.A. E-mail: <ballast@netins.net>.*

These are two current educational films on the Bauhaus, the most influential art, design and architectural school of the 20th century. It began (at the risk of repeating what everyone knows) in 1919 in Weimar, Germany, moved in 1927 to an important new building designed by Walter Gropius in Dessau, and was eventually forced to relocate in 1933 to a Berlin warehouse, where it was closed by the Nazis. Currently available to school libraries are two longer, more compelling films on this same subject: One is a balanced, well-edited view of the school's history and legacy by British historian Frank Whitford, titled *Bauhaus: Face of the 20th Century* (available from the distributor of these films), while the other is a





memorable, detailed account of the school's American influence (enriched by brief excerpts from rare historic films and recent candid interviews with eyewitness participants), by Judith Pearlman, titled *Bauhaus in America* (available from Cliofilm at <cliofilm@mindspring.com>).

Of the two new films considered here, neither stands up to the quality of those earlier films, and, of the two, the newer one, titled *Bauhaus: Less Is More*, is easily more disappointing. In an ironic misuse of the slogan "less is more" (popularized by Bauhaus architect Mies van der Rohe), the film consists of a jam-packed overview of the 13-year history of the Bauhaus in a mere 32 minutes (an average allocation of about two minutes per year). Despite such excess ambitions, it is still a helpful, informative mix of images that have to do with Bauhaus personalities, products, buildings and historic events, backed up by a monotone voiceover text. Unfortunately, whatever its visual virtues, the film is effectively ruined by what, in the credits, is called a "music mix," and which sounds like canned music ad nauseum ("chewing gum for the ears"), of the sort that we all are condemned to endure in the waiting rooms of dentists or on the telephone whenever we get put on hold. No doubt canned music has its place, but the subject of this film is artistic innovation (at the Bauhaus), and the annoying use of auditory wallpaper (along with other oddities) is a conspicuous contradiction of that—the film preaches one thing but practices the opposite. In contrast, at the real Bauhaus, the students formed a makeshift band (not unlike

today's student rock bands) that played improvisational jazz at school parties, mixed in with avant-garde classical scores.

The second of these two new films, called *Dessau's Bauhaus* (which is also half an hour long), is far more successful, in part because it focuses on a single, central aspect of Bauhaus history. Produced in cooperation with the Pompidou Center, it too provides a historical context, but it does so while always remaining within the topic of the Dessau Bauhaus, the now-famous cluster of buildings designed by Gropius. The film offers an in-depth analysis of this architectural classic, making ample use of sketches, vintage photographs, historic film footage and even comparative aerial views, showing its changes in setting, then and now. Of particular value is extensive footage from a tour of the buildings in their current state (all aspects are being precisely restored), photographs of the wartime damage and animated diagrams of the plan of the buildings, which clearly reveal how the architect made a structure that would effectively function in support of the school he envisioned.

(Reprinted by permission from *Ballast Quarterly Review*, Volume 20, Number 3, Spring 2005.)

## LEONARDO REVIEWS ON-LINE

The reviews published in print are but a small selection of the reviews available on the *Leonardo Reviews* web site. Below is a full list of reviews published in *LR* March–April 2005 <leonardoreviews.mit.edu>.

### September 2005

*The 2005 Venice Biennale: William Kentridge and the Limbo of Contemporary Art*. Reviewed by Simone Osthoff.

*Aby Warburg and the Image in Motion*, by Philippe-Alain Michaud. Reviewed by Michael Punt.

*Appropriating Technology: Vernacular Science and Social Power*, edited by Ron Eglash et al. Reviewed by Michael R. (Mike) Mosher.

*The Cinema, or the Imaginary Man*, by Edgar Morin. Reviewed by Martha Blassnigg.

*Cognitive Science, Literature and the Arts*, by Patrick Colm Hogan. Reviewed by Amy Ione.

*The Cradle of Humanity: Prehistoric Art and Culture*, by Georges Bataille. Reviewed by Allan Graubard.

*Eyes, Lies and Illusions: The Art of Deception*, by Laurent Mannoni, Werner Nekes and Marina Warner. Reviewed by Martha Blassnigg.

*The Frankenfood Myth: How Protest and Politics Threaten the Biotech Revolution*, by Henry I. Miller and Gregory Conko. Reviewed by Craig Hilton.

*Gehry Draws*, edited by Mark Rappolt and Robert Violette. Reviewed by Rob Harle (Australia).

*Human Factors Methods for Design: Making Systems Human-Centred*, by Christopher P Nemeth. Reviewed by John Knight.

*Kurt Schwitters*, from the Discovery of Art Series. Reviewed by Artur Golczewski.

*The Network Society (Key Concepts)*, by Darin Barney. Reviewed by John Knight.

*The Paradoxes of Art: A Phenomenological Investigation*, by Alan Paskow. Reviewed by Robert Pepperell.

*Qatar Foundation: Innovations in Education: The Art and Science Partnership*. Reviewed by Michael R. (Mike) Mosher.

*Ramshackle Pier*, by Andy Bole. Reviewed by Michael R. (Mike) Mosher.

*Read\_Me: Software Art and Culture*, edited by Olga Goriunova and Alexei Shulgin. Reviewed by John Knight.

*Red Persimmons*, by Shinsuke Ogawa and Peng Xiaolian. Reviewed by Soo C. Hostetler.

*Santiago Calatrava's Travels*, by Christoph Schwab. Reviewed by Artur Golczewski.

*The Shunned Country and Venus Handcuffs*, by Bob Drake. Reviewed by Michael R. (Mike) Mosher.

*The Situationist International: A User's Guide*, by Simon Ford. Reviewed by Claudia Westermann.

*A Visit to Ogawa Productions*, directed by Oshige Jun' ichiro; produced by Yasui Yoshio. Reviewed by Soo C. Hostetler.

## August 2005

*The 2005 Venice Biennale: William Kentridge and the Limbo of Contemporary Art*. Reviewed by Simone Osthoff.

*Appropriating Technology: Vernacular Science and Social Power*, edited by Ron Eglash et al. Reviewed by Stefaan Van Ryssen.

*Artificial Life IX: Proceedings of the Ninth International Conference on the Simulation and Synthesis of Living Systems*, edited by Jordan Pollack et al. Reviewed by Stefaan Van Ryssen.

*La Biennale di Venezia, 51st International Art Exhibition*. Reviewed by Yvonne Spielmann.

*Carnal Art: Orlan's Refacing*, by C. Jill O'Bryan. Reviewed by Rob Harle.

*The Curvature of Spacetime: Newton, Einstein, and Gravitation*, by Harald Fritsch. Reviewed by Stefaan Van Ryssen.

*Disruptive Pattern Material: An Encyclopedia of Camouflage*, by Hardy Blechman. Reviewed by Stefaan Van Ryssen.

*Encounter: Merce*. Reviewed by Richard Kade.

*Hans Haacke*, by Walter Grasskamp. Reviewed by Artur Golczewski.

*Infinite Variety: The Life and Legend of the Marchesa Casati*, by Scot D. Ryerson and Michael Orlando Yaccarino. Reviewed by Stefaan Van Ryssen.

*Leonora Carrington: Surrealism, Alchemy and Art*, by Susan L. Aberth. Reviewed by Roy R. Behrens.

*Proteus: A Nineteenth Century Vision*, by David Lebrun. Reviewed by Roy R. Behrens.

*Shades of Black: Assembling Black Art in 1980s Britain*, edited by David A. Bailey, Ian Baucom and Sonia Boyce. Reviewed by Michael R. (Mike) Mosher.

*Symmetry 2000: Part 1 and Part 2*, edited by I. Hargittai and T.C. Laurent. Reviewed by Rob Harle.

*Talking Drum and Rogue Wave*, by Chris Brown. Reviewed by René van Peer.

*Technology as Experience*, by John McCarthy and Peter Wright. Reviewed by John Knight.

*Them: A Memoir of Parents*, by Francine du Plessix Gray. Reviewed by Roy R. Behrens.

*Visionary Anatomies*, by Harvey Fineberg, J.D. Talesk and Michael Sappol. Reviewed by Amy Ione.

## July 2005

*Le arti e la psicologia*, by Lucia Pizzo Russo. Reviewed by Ian Verstegen.

*Baikal Ice*, by Peter Cusack. Reviewed by Stefaan Van Ryssen.

*Empathic Vision: Affect, Trauma and Contemporary Art*, by Jill Bennett. Reviewed by Alex Rotas.

*For Ever Godard*, edited by Michael Temple, James S. Williams and Michael Witt. Reviewed by Jan Baetens.

*Innovation and Its Discontents: How Our Broken Patent System Is Endangering Innovation and Progress, and What to Do About It*, by Adam B. Jaffe and Josh Lerner. Reviewed by Zainub Verjee.

*Leap Second Neutral*, by Machine and the Synergetic Nuts. *Pork Chop Blue*

*around The Rind*, by Fast n' Bulbous and *Emissaries*, by Radio Massacre International. Reviewed by Michael R. (Mike) Mosher.

*Light/Image/Illusion—The Aegina Academy, A Forum for Art and Science*, by Gustav Deutsch and Hanna Schimek. Reviewed by Martha Blassnigg.

*Masterworks of Technology: The Story of Creative Engineering, Architecture, and Design*, by E.E. Lewis. Reviewed by Rob Harle.

*The Nick of Time: Politics, Evolution, and the Untimely*, by Elizabeth Grosz. Reviewed by Rob Harle.

*The Other Side of Nowhere: Jazz, Improvisation, and Communities in Dialogue*, edited by Daniel Fischlin and Ajay Heble, with an introduction by Ingrid Monson. Reviewed by Stefaan Van Ryssen.

*In Senghor's Shadow: Art, Politics and the Avant-Garde in Senegal, 1960–1995*, by Elizabeth Harney. Reviewed by Michael R. (Mike) Mosher.

*Text and the City: Essays on Japanese Modernity*, by Maeda Ai. Reviewed by Andrea Dahlberg.

*Unsorted: An A to Z for SonicActsX*, by Arie Altena et al., with an introduction by Taco Stolk. Reviewed by René Beckman.

*VAS: An Opera in Flatland*, by Steve Tomasula; art and design by Stephen Farrell. Reviewed by Eugene Thacker.

*A Visit to Ogawa Productions*, directed by Oshige Jun' Ichiro; produced by Yasui Yoshio. Reviewed by Michael R. (Mike) Mosher.

*Vocals*, by Ian Breakwell. Reviewed by Mike Leggett.

*Walter Benjamin and Art*, edited by Andrew Benjamin. Reviewed by Michael R. (Mike) Mosher.

# Leonardo Network News

*The Newsletter of the International Society of the Arts, Sciences and Technology  
and of l'Observatoire Leonardo des Arts et Technosciences*

## Leonardo Co-Sponsors Space Sciences Lab Artists-in-Residence Semiconductor

Following upon the success of Liliane Lijn's summer 2005 artist's residency at the University of California at Berkeley's Space Sciences Lab (SSL), Leonardo is pleased to welcome the SSL's new artists-in-residence: U.K. artists Ruth Jarman and Joseph Gerhardt. Jarman and Gerhardt, who work collaboratively as Semiconductor, will spend 4 months at SSL, working at the lab as part of Isabel Hawkins's Center for Science Education. Work by Semiconductor includes films and digital animations "made out of sound," using abstract landscapes and architecture as a means to describe aural and visual interpretations of the world. Live digital performance is one strand of Semiconductor's output; they also produce surround-sound installations and single-screen sound films that are exhibited at galleries, festivals and biennials worldwide. Examples of their work can be found on-line at: <[www.semiconductorfilms.org](http://www.semiconductorfilms.org)>.

## Pacific Rim New Media Summit Experimental Publishing Project

How are information technology and creativity shaping new directions in the arts and sciences around the Pacific Rim? What challenges face organizations and individuals in the region who are working in the fields of architecture, design, literature, theater and music? How do academic research and information-technology-based industry fit into this picture?

The political and economic space of the Pacific Rim represents a dynamic context for innovation and creativity. Experimentation in the many disciplines that encompass art, science and technology is resulting in the emergence of new forms of cultural production and experience unique to the region. The complex relations and diversity of Pacific Rim nations are exemplified as well throughout the hybridized communities that compose Silicon Valley.

The Pacific Rim New Media Summit will be a gathering of organizations and representatives from the Pacific Rim and elsewhere in Asia to investigate the characteristics of Pacific Rim nations while focusing on the development of partnerships in order to address the multiple challenges faced throughout the region as it develops its art-and-science networks in tandem with its increasing economic influence. This transdisciplinary event will have a specific focus on educational methodologies and practices.

The summit is organized into seven working groups according to the following topic areas:

- *Container Culture* (Chair: Steve Dietz)
- *Education* (Chair: Fatima Lasay)
- *Place, Ground and Practice* (Chair: Danny Butt)
- *Urbanity and Locative Media* (Chair: Roh Soh-Yeong)
- *Latin American/Asia-Pacific New Media Initiatives* (Chair: José-Carlos Mariategui)

- *Directory, Organizations and Residencies* (Co-Chairs: Julianne Pierce and Nisar Keshvani)

- *Piracy, Ethics and Community* (Chair: Steve Cisler)

For more information on the Pacific Rim New Media Summit, visit <<http://isea2006.sjsu.edu/prnms.html>>.

## Leonardo Pacific Rim Publishing Initiative

In conjunction with the Pacific Rim New Media Summit, Leonardo will undertake a multifaceted publishing initiative directly related to its role as co-sponsor of the summit event. This initiative has three components:

### Hybrid Print and DVD Journal Issue of *Leonardo*

To coincide with the summit, *Leonardo* is publishing a special hybrid issue based on the work of the seven Pacific Rim working groups, featuring new-media educational programs and artists from the Pacific-Asia region. The print issue of the journal will include statements by artists as well as articles by cultural theorists looking at issues germane to the seven working-group topics, plus introductory texts by the working-group chairs. The accompanying DVD will feature short video works by artists from around the Pacific Rim.

### LEA Special Sections on Working Group Topics

As a lead-up to the summit, the *Leonardo Electronic Almanac* has been publishing on a regular basis materials submitted by the working groups as each develops its mandate. Working-group statements, names of working-group members and contact information for the working-group chairs have been available in issues of LEA since March 2005 (on the Web at <<http://lea.mit.edu>>). Additional materials will continue to be published in LEA as the working groups define and refine their focus in preparation for the summit.

### On the Web

Simultaneous with the release of the *Leonardo* special issue, the Leonardo On-Line web site <[www.leonardo.info](http://www.leonardo.info)> will include video-clip teasers from the Pacific Rim DVD.

## First Spanish-Language LABS Abstracts in LEA

Leonardo is pleased to announce the first group of top-rated Spanish-language thesis abstracts appearing via the Leonardo Abstracts Service, all of which have been posted in the Spanish LABS database during the second quarter of 2005. The Spanish LABS database is hosted by Artnodes, a project of Universitat Oberta de Catalunya. The top-rated authors, chosen by a panel of peer-reviewers under the direction of Pau Alsina,

*Leonardo Network News Coordinator: Kathleen Quillian.  
E-mail: <[isast@leonardo.info](mailto:isast@leonardo.info)>.*

are: Stella Veciana, a student at Universidad de Barcelona, for her thesis "Research Arts: La interseccion arte, ciencia y tecnología como campo de conocimiento y de acción"; Roc Parés i Burguès, a student at Universitat Pompeu Fabra, Barcelona, for his thesis "El procés d'interacció com a base de l'experiència estètica en les propostes artístiques que utilitzen la tecnologia de la realitat virtual"; and Maria do Rosário de Assumpção Braga, a student at House of Oswaldo Cruz at Oswaldo Cruz's Foundation Institute, for her thesis "Relations between Art and Science at Museums and Science Centres from 1969 to 2000." Top-rated thesis abstracts from each quarter are published in *Leonardo Electronic Almanac*. More about the Spanish-language LABS database and how to submit material can be found at: <[www.uoc.edu/artnodes/leonardolabs](http://www.uoc.edu/artnodes/leonardolabs)>.

## In Memoriam: Robert Moog

### A Personal Tribute by Marc Battier

Robert A. Moog died on 21 August 2005. He had been diagnosed with a brain tumor in the spring. Sadly, the disease spread rapidly despite all the support and care of his family and from the Duke Cancer Center in Asheville, North Carolina.

Some time before Bob's passing, a list was set up by his family on the Internet. It was amazing to watch the message list grow by the hour. People from all over the world expressed their appreciation, often saying that Moog's instruments had changed the course of their lives.

I was able to witness an outpouring of this feeling at the May 2004 Moogfest in New York City as I sat in a booth with Bob that evening. People approached quietly and expressed their gratitude. Bob took this very soberly and with great dignity.

Born in 1934, Moog began his career at an early age. Born

to a father who was a passionate radio amateur, he grew up amidst electronic equipment. It is from this fertile soil that he started to build theremin instruments to support his engineering studies. His theremins became popular, and Moog, very naturally, became a full-time musical instrument builder. In 1964, he presented to the Audio Engineering Society an initial prototype of an electronic synthesizer. While the idea of such an instrument came from discussions with composer Herbert Deutsch, Moog brought to life a number of decisive innovations. The following year, the modular synthesizer began to sell. A few years later, the instrument entered the public realm through the craft and talent of Wendy Carlos and *Switched on Bach*. Other brilliant designers invented various types of electronic instruments, but none became as popular as the synthesizers Moog invented. As Marcel Duchamp once wrote, "The invention of new musical instruments changes the whole sensibility of an era." Eventually, Moog met the man through whom he was led to designing instruments, Leon Theremin. Composer and computer music pioneer John Chowning was a witness when Moog and Theremin met at Stanford in 1991: "Moog quietly thanked Theremin for having inspired him and so many others. Theremin understood and so did Bob."

Moog's instruments changed the way music was made in the 20th century. Even today, more than 40 years after his first modular synthesizers were commercialized, people gather to celebrate the Moogs. Bob Moog was the recipient of numerous awards for his innovative work as an instrument maker. There have been Moogfests, where famous performers as well as emerging ones meet and played for the fun of it. In September 2005, Tokyo will host a second Moog Day. It is likely that people will continue celebrating the man and his instruments.

## LEONARDO, THE INTERNATIONAL SOCIETY FOR THE ARTS, SCIENCES AND TECHNOLOGY

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Artists, scientists, engineers, researchers and others interested in the contemporary arts and sciences are invited to join Leonardo/ISAST. Benefits include reduced rates for Leonardo/ISAST publications, the opportunity to nominate artists for the Frank J. Malina Leonardo Award for Lifetime Achievement, and a forum for reporting and promoting readers' activities. For further details contact Leonardo/ISAST, 800 Chestnut Street, San Francisco, CA 94133, U.S.A. E-mail: <isast@leonardo.info>. *Organizational and Corporate Membership also available.*

Leonardo, the International Society for the Arts, Sciences and Technology (ISAST), founded in 1981, is a nonprofit organization that seeks to encourage the interaction of art, science and technology. We seek to make visible the work of artists involved with science or technology and promote the collaboration of artists, scientists and engineers.

### Publications

**PRINT JOURNALS:** The *Leonardo* journals are scholarly peer-reviewed journals of record. *Leonardo*, published bimonthly, is the official journal of Leonardo/ISAST. *Executive Editor:* Roger F. Malina. *Leonardo Music Journal* with CD is published annually. *Editor-in-Chief:* Nicolas Collins.

**WORLD WIDE WEB:** The Leonardo On-Line web site ([www.leonardo.info](http://www.leonardo.info)) publishes organizational information, the Leonardo Electronic Directory and more. *Managing Editor:* Patricia Bentson.

**ELECTRONIC JOURNAL:** *Leonardo Electronic Almanac* ([lea.mit.edu](http://lea.mit.edu)) is an electronic peer-reviewed journal. *Editor-in-Chief:* Nisar Keshvani.

**LEONARDO REVIEWS:** The Leonardo Reviews Project, through a panel of reviewers, publishes reviews of relevant books, journals, electronic publications and events. Reviews are published on the Web ([leonardoreviews.mit.edu](http://leonardoreviews.mit.edu)), and selected reviews are published in *Leonardo Electronic Almanac* and in *Leonardo*. *Editor-in-Chief:* Michael Punt.

**BOOKS:** The Leonardo Book Series ([lbs.mit.edu](http://lbs.mit.edu)), published by the MIT Press, highlights topics related to art, science and developing technologies.

**LABS DATABASES:** Databases of master's and Ph.D. theses. English LABS: <<http://leonardolabs.pomona.edu>>; *Coordinator:* Sheila Pinkel. Spanish LABS: <<http://www.uoc.edu/artnodes/leonardolabs>>; *Coordinator:* Pau Alsina.

### Awards

**Frank J. Malina Leonardo Award for Lifetime Achievement** recognizes eminent artists who through a lifetime of work have achieved a synthesis of contemporary art, science and technology. Winners include Gyorgy Kepes, Nicolas Schöffer, Max Bill, Takis and Abraham Palatnik.

**Leonardo Award for Excellence** recognizes excellence in articles published in Leonardo publications. Winners include Rudolf Arnheim, Otto Piene, Charles Ames, Frieda Stahl, Donna Cox, Janet Saad-Cook, George Gessert, Alvin Curran, Karen O'Rourke, Eduardo Kac, Hubert Duprat with Christian Besson, José Carlos Casado with Harkaitz Cano, Bill Seaman, Arthur Elsenaar with Remko Scha, and Steve Mann.

**Leonardo New Horizons Award for Innovation** is given to individuals or groups for innovation in new media. Winners include Critical Art Ensemble, Gregory Barsamian, Graham Harwood, Evelyn Edelson-Rosenberg, Jean-Marc Philippe, Jaroslav Belik, Peter Callas, Patrick Boyd, Christian Schiess, Kitsou Dubois, I Wayan Sadra, and Ewen Chardronnet.

**Makepeace Tsao Leonardo Award** recognizes organizations or groups that have increased public awareness of art forms involving science and technology, particularly through exhibitions. The first award has been given to La Cité des Arts et Nouvelles Technologies de Montréal.

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### Collaborations with Other Organizations

Leonardo/ISAST frequently collaborates with other organizations on topics of current interest by collaborating on conferences or workshops and by publishing special sections in *Leonardo* or co-sponsoring events. Current collaborations include:

With the Association Leonardo:

The Association Leonardo is a collaborating organization in France. Projects carried out in collaboration include: L'Observatoire Leonardo des Arts et Technosciences web site ([www.olats.org](http://www.olats.org)), the Space Art Workshops, the Virtual Africa Project, and the Pioneers and Pathbreakers Project.

With the Banff Centre (Canada):

Refresh! Art History Conference, Banff, September 2005.

With Pomona College (California):

LABS, the Leonardo ABstracts Service (<http://leonardolabs.pomona.edu>), a comprehensive database of abstracts of Ph.D. and master's theses reporting on work in the field of art-science-technology, available free on-line via Pomona College, Claremont, CA. Selected abstracts chosen through a peer-review process will appear in *Leonardo Electronic Almanac*, and invited articles will be published in *Leonardo*.

With Humboldt University (Berlin):

Database of Virtual Art: Oliver Grau, project leader.

### Leonardo Project Working Groups

Leonardo hosts working groups on projects with a topical focus:

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See <[www.leonardo.info/isast/events/leonardocaa.html](http://www.leonardo.info/isast/events/leonardocaa.html)> for complete list.

*Leonardo Space Arts Working Group:* Annick Bureaud, Richard Clar, Roger Malina, Jean-Luc Soret, Arthur Woods

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## Special Thanks

Leonardo/ISAST gratefully acknowledges the special efforts of the following:  
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**NEW ON-LINE JOURNAL: PLASTIR.** Plasticities Sciences Arts (PSA) is pleased to announce the launching of a new on-line journal called PLASTIR (Transdisciplinary Review of Human Plasticity). It will cover the field of art-science, transdisciplinarity

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**RUSSIAN SYNESTHESIA BIBLIOGRAPHY PROPOSAL.** The research institute Prometheus has collected a unique bibliography of nearly all Russian publications concerning synesthesia, "color hearing" and related art experiments such as light-music, abstract films with music, multimedia compositions, etc. The bibliography covers the last 100–125 years and consists of nearly 3,000 book titles, journal articles and conference theses. As these works are little known in the West, the Prometheus Institute is planning to issue an English version of the bibliography (print and Internet) and include an abstract with each item. In order to realize this project, we need financial support. Any grants or donations from interested organizations will be most gratefully received. Info: <galeyev@prometey.kcn.ru>.

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**LEONARDO/OLATS LAUNCHES LES BASIQUES:** a project on art and multimedia, at: <<http://www.olats.org/livresetudes/basiques/basiques.php>>. The project is in French only. Les Basiques answers the basic questions on a given topic within the field of art, science and technology. The first module deals with artworks on the Internet, CD-ROM or DVD. Les Basiques: Art and Multimedia has been funded by the French Ministry of Culture/DDAT.

**THE WEB SITE WWW.MANDELBROJT.COM** presents some of Jacques Mandelbrojt's paintings and exhibitions. Several aspects of his work are emphasized, such as the time aspect, depicted in elongated formats that induce the onlooker to read the painting in the same direction in which it was painted, and a series of space-time paintings. The site also features his collaboration with music composers of MIM (Laboratoire Musique et Informatique de

Marseille) leading to works combining painting and music. Theoretical works on the site contain Mandelbrojt's reflections on art and science, published in particular in *Leonardo*, based on his first-hand experience as both a painter and a theoretical physicist. The site also includes a bio-bibliography and a lecture.

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**DATABASE OF VIRTUAL ART** documents the rapidly evolving field of digital installation art: <<http://virtualart.hu-berlin.de>>. This complex, research-oriented overview of immersive, interactive, telematic and genetic art has been developed in cooperation with established media artists, researchers and institutions. The web-based, cost-free instrument—appropriate to the needs of process art—allows individuals to post material themselves. Compiling video documentation, technical data, interface and displays, and literature offers a unique answer to the needs of the field. All works can be linked with exhibiting institutions, events and bibliographical references. Over time the richly interlinked data will also serve as a predecessor for the crucial systematic preservation of this art. Contact: Oliver Grau <oliver.grau@culture.hu-berlin.de>.

**THE CENTER FOR THE REPRESENTATION OF MULTIDIMENSIONAL INFORMATION (CROMDI)** is an interdisciplinary group at the University of Utah whose research focuses in developing new data representation architectures to facilitate rapid and accurate analysis of complex databases in real time. Application areas range from industrial processes and networking monitoring to business activities, security, medicine and art performances. CROMDI's visualization methodology maps data variables into 3D objects, spaces and attributes, which enables significantly faster, more accurate and less cognitively demanding recognition of events than with traditional representations. CROMDI faculty and researchers come from a wide variety of fields such as architecture, art, business, computer science, medicine, music, planning and psychology. For more information: <<http://www.cromdi.utah.edu/>>.

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**THE EIGHTH DAY: THE TRANSGENIC ART OF EDUARDO KAC** (Tempe: The Institute for Studies in the Arts, Arizona State University, 2003). Distributed by DAP, New York. Edited by Sheilah Britton and Dan Collins. ISBN: 0972429107. The transgenic art of Eduardo Kac raises often unanswerable and controversial questions about ethics, evolution, biogenetics, and animals' rights. From his first experiments online in the mid-1980s to his current convergence of the digital and the biological in *The Eighth Day* installation, Kac has always investigated the philosophical and political dimensions of communication processes.

**TECHNOETIC ARTS** is an international journal of speculative research edited by Roy Ascott <[roy.ascott@btinternet.com](mailto:roy.ascott@btinternet.com)>. This peer-reviewed journal presents cutting-edge ideas and projects at the confluence of art, science, technology and consciousness research, with special interest in matters of mind and the extension of the senses through technologies of cognition and perception. Published by Intellect Books: <[www.intellectbooks.com/journals/technoetic/index.htm](http://www.intellectbooks.com/journals/technoetic/index.htm)>.

**ALTA TECNOLOGIA ANDINA [ATA]** is a private, nonprofit cultural organization created with the objective of helping the development of a new culture based on the use and growth of the relations between art, science and technology in Peru and Latin America. The foundations for this development involve the promotion and support of young art professionals. Contact us at <<http://www.ata.org.pe>> or e-mail: <[jcm@ata.org.pe](mailto:jcm@ata.org.pe)>.

**JÜRGEN CLAUS WEB SITE.** The web site of *Leonardo* International Co-Editor Jürgen Claus offers seven chapters, focusing on the different areas of his work, including his Solar Art pieces and lists of his exhibitions, books and other publications. There are many links to English web sites and numerous illustrations of the visual work. URL: <[www.juergenclaus.de](http://www.juergenclaus.de)>.

**LABORATOIRE MUSIQUE ET INFORMATIQUE DE MARSEILLE.** Visit the website of Le MIM, one of the most active experimental and computer music organizations in France, at <<http://www.cosa-mentale.fr/MIM.html>>. Le MIM hosted the Intersenses Conference in December 2000. For more information, contact Marcel Frémiot <[mfremiot@wanadoo.fr](mailto:mfremiot@wanadoo.fr)>.

**THE CONCEPTUAL INFORMATION ARTS (CIA) PROGRAM AT SAN FRANCISCO STATE UNIVERSITY'S ART DEPARTMENT** stresses experimental art at the juncture of science, technology and culture, offering both BA and MFA degrees. Contact Steve Wilson or Paula Levine. Web site: <<http://userwww.sfsu.edu/~infoarts/>>. Tel: (415) 338-2291.

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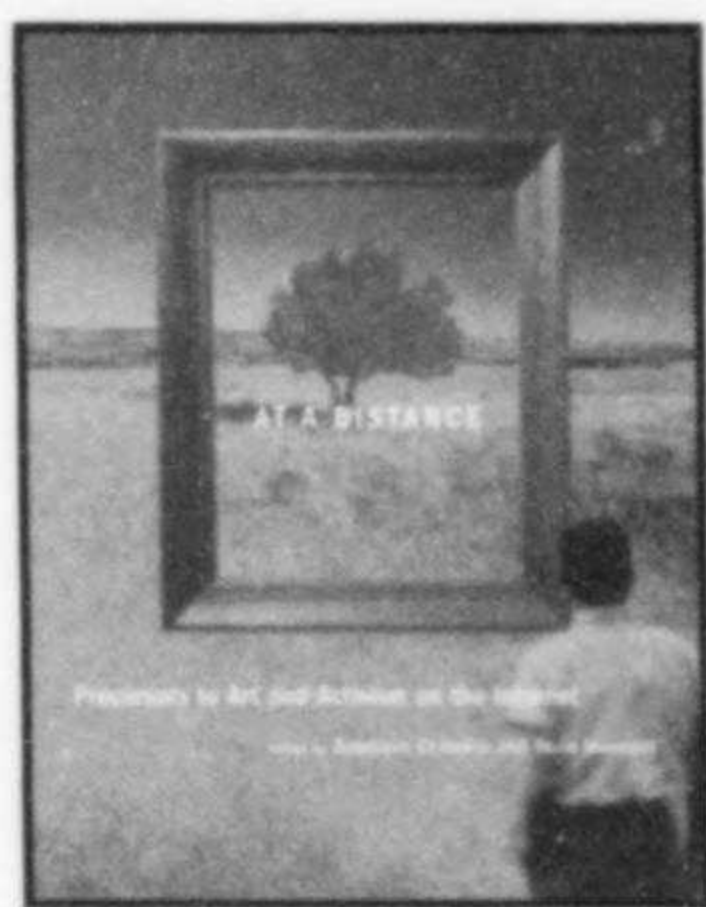
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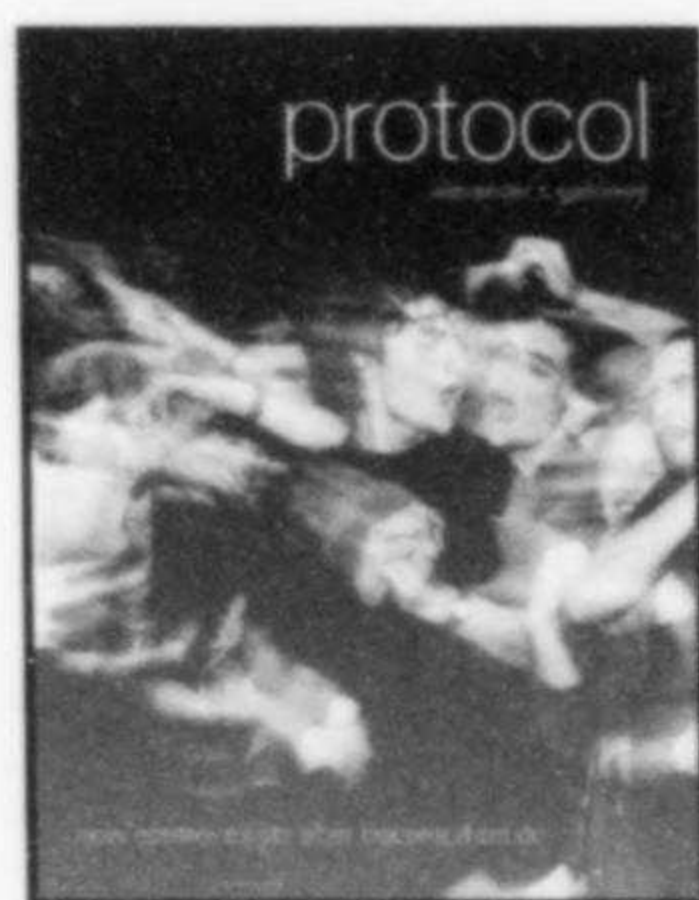
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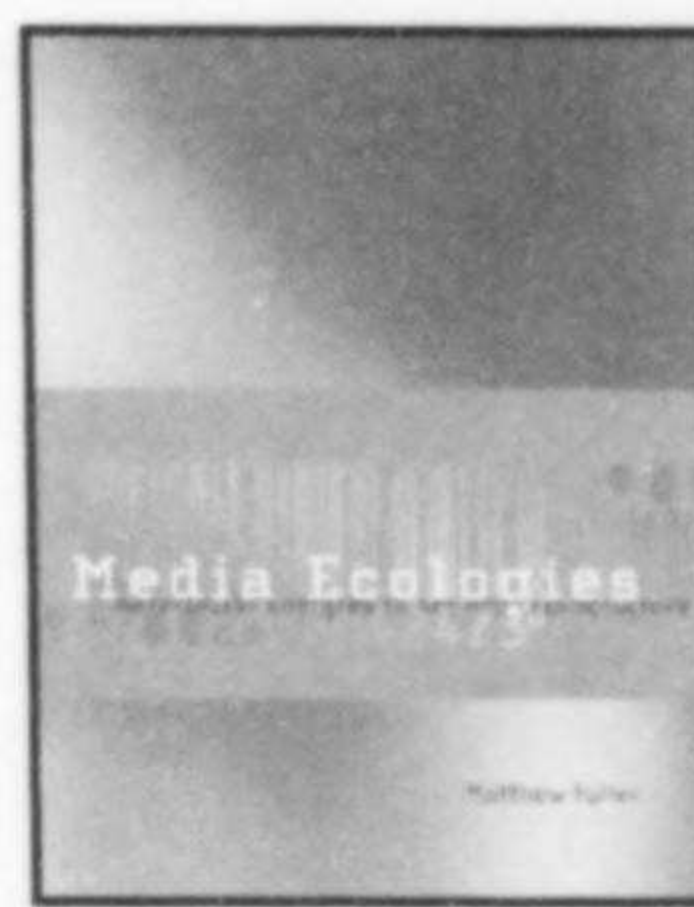
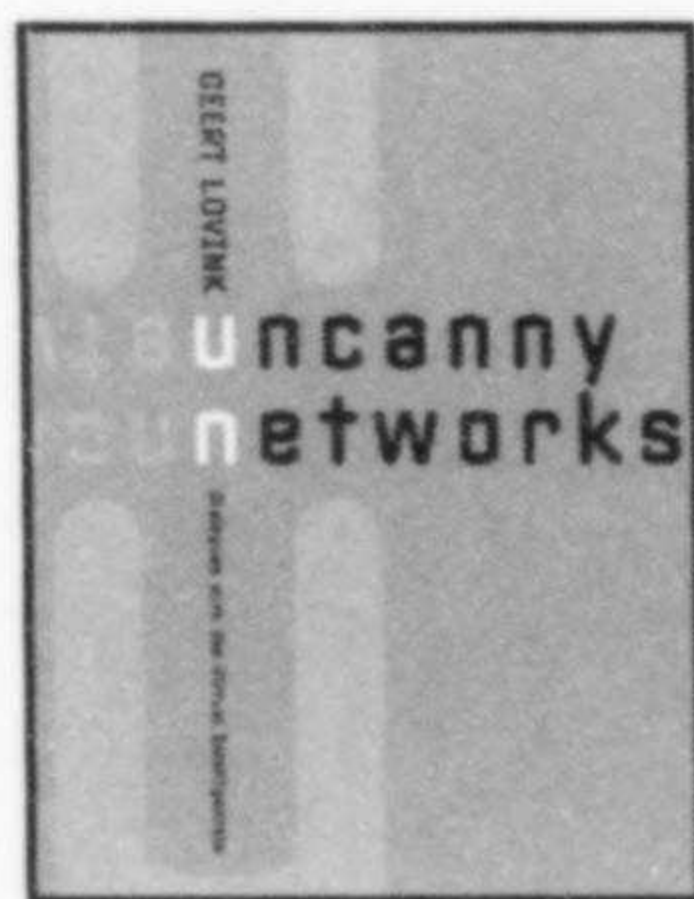
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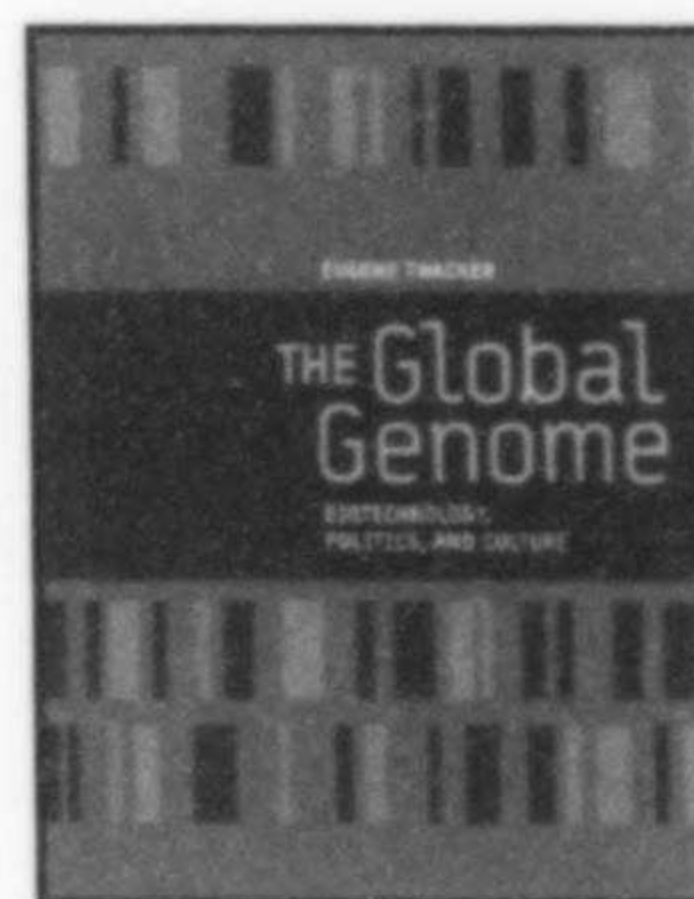
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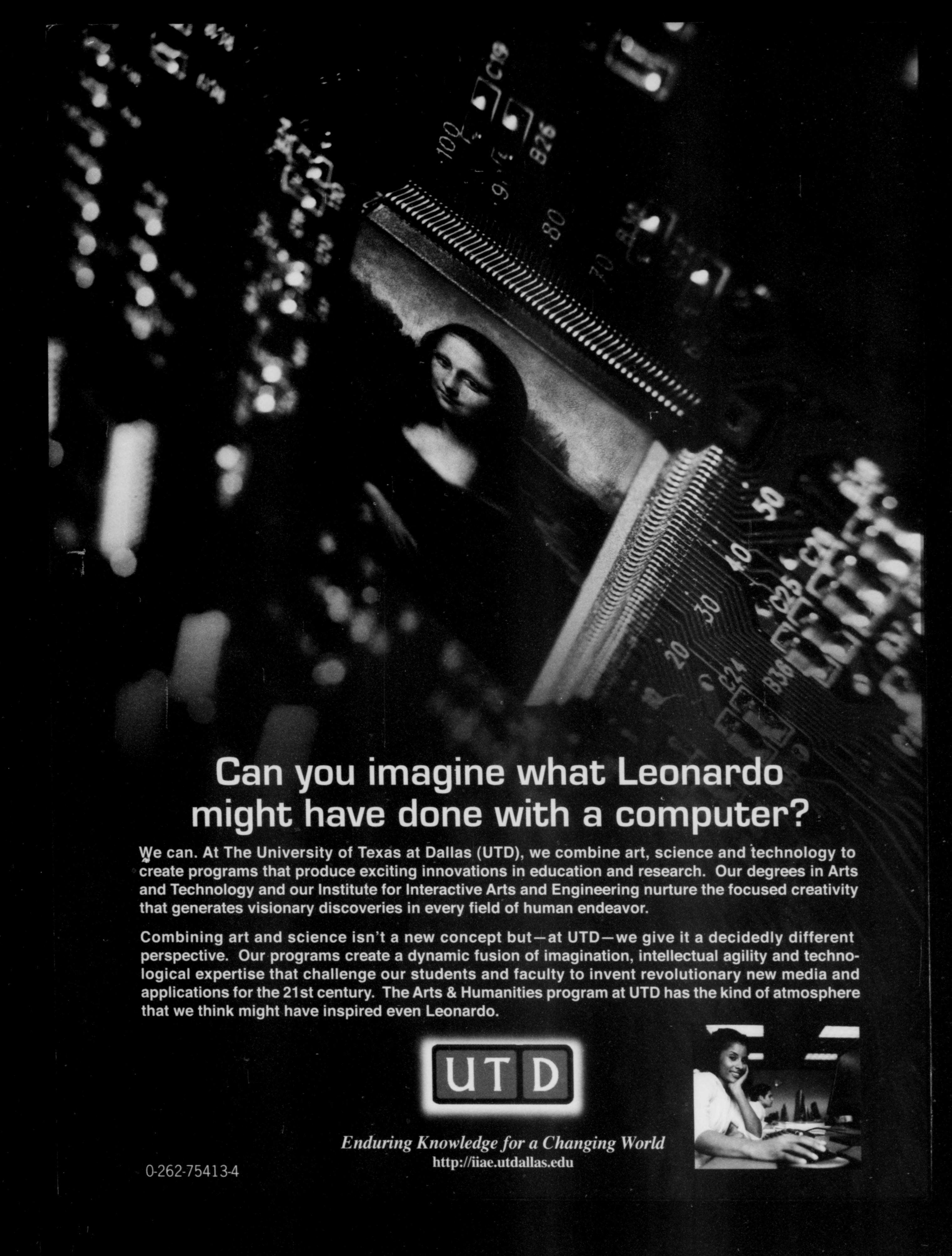
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