
Art, Life and Media Merge

Vibeke Sorensen¹

Abstract: In this essay, we look at some of the principal issues raised by advancements in digital technology in the light of global issues today, reflecting on our engagement with these issues through a range of artworks, from the 1970s to projects in progress. The works explore the potential of art to catalyze harmonious relations between life on earth and emerging technologies, in diverse fields such as digital multimedia and animation, interactive architectural installation, networked visual-music, plant-human interaction and ecology, social media, health and well-being, and wearable transmedia technologies. In these interactions, the artworks foreground our individual and collective experiences of interconnectedness, in our associations with technology as well as in our common interests and concerns as living species. They are based on an understanding of art as an essential form of mental and physical communication, and arise out of a deep concern — for the future of human and all other forms of life, and for the future of the planet. Through these reflections, the essay argues for and stresses the need for a responsible, ethical, humanistic, compassionate, and environmentally conscious approach to art and life in the Anthropocene.

Keywords: Transmedia Art. Wearable Technology. Bio-Art. Eco-Art. Anthropocene.

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Fusão entre Arte, Vida e Mídia

Vibeke Sorensen²

Resumo: Neste ensaio, analisamos algumas das principais questões levantadas pelos avanços da tecnologia digital à luz das questões globais da atualidade, refletindo nosso compromisso com estes problemas através de uma série de obras de arte, desde a década de 1970 até os projetos em andamento. As obras exploram o potencial da arte para catalisar as relações harmoniosas entre a vida na Terra e as tecnologias emergentes em diversos campos como a multimídia e a animação digitais, a instalação arquitetônica interativa, a música virtual em rede, a interação planta-humano e a colaboração, as mídias sociais, a saúde e bem-estar e as tecnologias utilizáveis do transmídia. Nessas interações, as obras de arte apresentam nossas experiências individuais e coletivas da interconexão, bem como nossos interesses e preocupações comuns enquanto espécies vivas. Elas são baseadas em uma compreensão da arte enquanto forma essencial de comunicação física e mental, e emergem de uma preocupação profunda – com o futuro das formas de vida humanas e todas as outras formas de vida, e com o futuro do planeta. Através dessas reflexões, o ensaio argumenta e ressalta a necessidade de uma abordagem ética, responsável, humanística compassiva e ambientalmente consciente da arte e da vida no Antropoceno.

Palavras-chave: Arte transmídia. Tecnologia vestível. Bio-arte. Eco-arte. Antropoceno.

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Introduction

Art, in my view, is research in communication; and technological art, by extension, is research into technological communication: it is, in a way, a compressed research and development cycle, where the results of the research are put directly into practice through sharing the artwork with a public. Through this activity, the ideas and techniques employed are transferred from the research environment to the wider academic and human community. And because it not only provides esthetic pleasure but seeks to solve problems and engage everyday life, it falls between media, art and design.

Digital media today transcend boundaries, extend and blend previously separate media, and engage an increasingly porous environment; as I started my academic career in architecture, work in this field has brought me “full circle,” to conceptions of an expanded architecture as an emergent and even sentient system, similar to *gesamtkunstwerk*, but moving beyond it, to the Anthropocene. Recognizing our relation to phenomena that surround us, including plants and living things, enables us to reconfigure our thinking and expand the capacity of our brains, to reflect and connect with the global environment and beyond, with the universe. This is literally possible today, with the development of sensors and computing systems that can translate environmental signals into human sensory modalities.

My personal artwork and individual and collaborative research is in new media art, and integrates art and science, physical and digital media, documentary photography and experimental film/video/animation, text/poetry and music. From the beginnings of my work in new media, including film and animation, in the 1970s, I wanted to redirect technology and media to “bring us back to nature and humanity,” to the “real world” with a sense of compassion; to use technology that had traditionally been used for simulations of war to do the opposite: to catalyze creativity and positive action, to elicit humanistic engagement, reflection and compassionate behavior. I found that music, poetry, performance, and visual art are the most effective means of doing this, and so my focus has been on integrating these forms with technology, to create motion painting/visual music as dynamic poetic experiences that include immersive, high-resolution dome works, networked visual

music performances, and multimodal interactive installations, that incorporate custom electronics and software, and also engage personal and shared memory. In recent creative work, I have focused on modes of plant-human interaction with music, animation and textiles that have applications to health and well-being, as well as on wearable computers for people in migration between cultures.

One of my early video artworks, *Temple* (1976), used analog computer animation and electronic music systems to create a meditative visual music work (Fig.1) [1].

Figure 1 - Freeze-frame from *Temple* (1976).



Source: Video art, computer animation and music by Vibeke Sorensen.

This, in a way, set the course for much of my future work in experimental digital art: currently, I am researching big data, wearable technologies and bio-art/design, in collaboration with experts in diverse related fields, such as Dr Marsha Kinder at the University of Southern California (neuroscience and narrative), Dr Frederic Zenhausern at the University of Arizona (medical research), Dr Alexander Melkozernov of Arizona State University (biochemistry), and colleagues at Nanyang Technological University, Dr. Galina Mihaleva (wearable technologies and fashion

design), Dr Erik Cambria (computer science), and Nagaraju Thummanapalli (research assistance), among others.

While I work in digital multimedia, my emphasis has been on developing creative works with a transdisciplinary and multicultural approach that includes the “two cultures” [2] of art and science, as well as people from diverse ethnicities and international influences. I have worked with diverse cultures, groups and individuals, including Native Americans, African Americans, and Latin Americans, as well as people from Asia and South Asia, Europe, the Middle East, and North Africa. The media I use include traditional and natural materials such as spices, plants, hand-woven textiles and musical instruments, as well as film, video, computer graphics and animation, interactive multimedia, online and embedded systems, physical computing, 3-D printing, and smart materials.

The Global Visual Music (GVM) Project—Lemma 1, Lemma 2

My earlier works began exploring human perception and memory, and their interconnections with music, gestures, text, and visual art, as well as their potential for expansion in geographical space. The *Global Visual Music Project* (GVM) (1997–1999), for example, was a collaborative performance experiment with Miller Puckette and Rand Steiger, involving structured improvisation on musical instruments and the performers’ interactions with sound, projection, and computer animations, based on the technology of the time.

This was inspired by travels to Morocco in 1973, where I had the idea to make a “liquid architecture” that would allow artists and musicians to “jam” together globally: I imagined improvising moving images and spaces accompanying the music, where all physical surfaces could be three-dimensional screens, semi-permeable membranes passing messages between interior spaces of the mind and exterior spaces of the physical world, and between people communicating in it. With electronic cameras and imaging devices, microphones and electronic musical instruments, it had become possible for the first time in history to perform moving images with music in real time. With digital technology, it would also be possible to

create and transform 3-D spaces in real-time, and share memory and intelligence of organized information contained within them. With telecommunications technology, it was possible to connect people all over the world with each other, and through these images, spaces and sounds, they would be able to play together. This technology would be an instrument, not just a tool, affirming life rather than destroying it.

All this was possible, but it would take many years to realize, considering the cost of technology and the poverty of so many around the world; in addition, the limitations of early computer graphics systems in the 1970s made them too problematic to use in real-time performance. I worked on various related projects in the '70s and early '80s: *Solstice* was a series of multi-media works which explored an ancient pagan summer solstice ritual in contemporary Scandinavia; *Concurrents*, and *NLoops* were respectively a multi-monitor computer-video installation, and a performance in collaboration with composers Gaylord Mowrey and Rand Steiger, exploring visual relationships to polyrhythmic musical structures. During 1989-1993 I collaborated with computer scientist Phil Mercurio at the San Diego Supercomputer Center to create a real-time stereoscopic animation system; this was the basis of *Maya*, a stereoscopic work inspired by the Hindu term for the conflict between illusion and reality, and structured musically in collaboration with Steiger.

The *Global Visual Music Project*(GVM), which I developed with support from the Intel Research Council and in collaboration with Puckette and Steiger, was based on developing technologies: Puckette had created "Max" software, which was in wide use in the computer music community, and was developing it into a new data processing package called "Pure Data"(PD); and his Ph.D. student Mark Danks was making GEM (Graphics Environment for Multimedia), that would bring the full capabilities of Open GL graphics into the PD environment. This was the first combination of computer graphics, animation, and digital video with computer music and physical computing; and we put the software, "PureData/GEM", into the public domain, as part of our commitment to enriching present and future telecommunications systems with the tools necessary to make long-distance artistic collaboration possible.

The *GVM* project developed in two phases, *Lemma I* and *Lemma 2*. *Lemma 1* comprised two simultaneous performances in September 1997 that were to be linked by ISDN networking, one at the International Computer Music Conference in Thessaloniki, Greece (Fig. 2) and the other, with different performers, at the University of California, San Diego. These featured improvisation by four performers, with two at each of the local sites on either side of a large video projection screen. In Greece, Steven Schick performed on drums, while George Lewis, on trombone, had a small video cameras mounted on his hand; microphones were attached to both performers' instruments. I was personally in Thessaloniki, where my collaborators and I operated the computers and associated video and audio devices, and the audio program was amplified through a quadraphonic speaker system.

Figure 2 - Lemma 1 (1997) in Thessaloniki, Greece with George Lewis (trombone and trombone-cam) and Steven Schick (percussion).

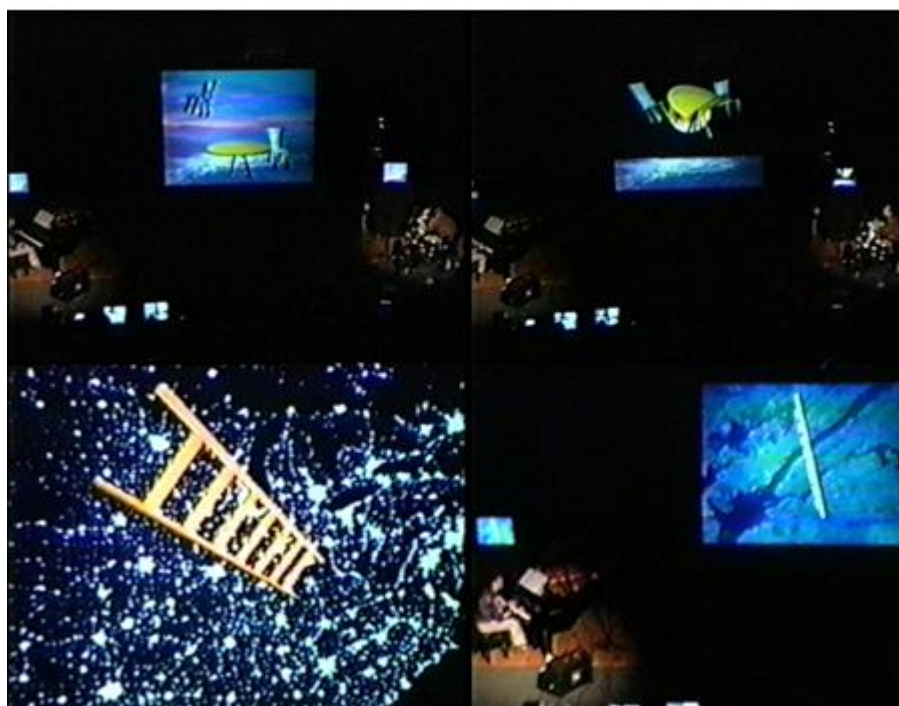


Source: Photographs by Vibeke Sorensen

During each stage of the two-site performance, the scores were based on approximate timings, flexibly determined by the performers so each section would create a natural trajectory towards the next, as graphics and animations were displayed on the screen between them. It was a form of structured improvisation, where the performers could interact with the animation, responding to it and the audience dynamically. Audio and gestural signals detected by the system were to be transmitted to the remote location; and there was a time offset due to the period it took these signals to traverse the Earth and arrive at the remote location in California: we used this time offset for rhythm timing.

While the two-site networked rehearsals were very successful, the final performance in Greece did not include the remote site, because of network problems there; and as a result, the local performance became the main event for the Greek audience. Nevertheless, it was extremely successful as a real-time, interactive visual music performance, as the cheering crowds confirmed.

Figure 3 - Lemma 2 (1999): Four freeze-frames from video documentation of the performance at the Miller Theater, Columbia University.



Source: Photographs by Vibeke Sorensen

The *Lemma 2* performance, which featured percussion and piano, took place in April 1999 at the Miller Theater in New York City (Fig. 3), and simultaneously at the Intel Conference Center in Hillsboro, Oregon, as part of the Columbia University Interactive Arts Festival. These simultaneous performances engaged with newly developing ideas of networking, and experimented further with transformations of sounds, images and gestures across geographical space: the piano and percussion sets were analyzed at each location so that the information emerged in various ways at the other site; for example, the sound of a cowbell in Oregon might appear as a tomtom or as middle C on a computer-controlled piano in New York. Real-time computer animation and video were projected at both sites; they responded in various ways to musical gestures at either location. The intention behind this work was to explore the transformations made possible by geographical connections as well as the relations between gestures, sounds, and moving images.

Often during rehearsals, the musicians became so excited with the extension of their instruments into the visual domain that their music became not only fortissimo (very loud), but prestissimo (very fast); however, the system allowed for great nuance at all speeds and in the fine details of the visual elements, and over time, the performers learned to explore the various ways their instruments were traversing the visual domain. This included not only abstract and representational images, such as doors, ladders, and furniture, but words as texts: I had requested that the performers write down their dreams, and these were used as references for the 2- and 3-D computer models, and also as graphical textual elements in the animation.

The goal was to create a “lucid dream” that employed logic and mathematics in service of the imagination—in its potential to extend beyond the limitations of logical thinking through mathematics and computing. I see computer graphics as Platonic, in that pure computer graphics is ideal, perfect, and even includes a “World of Forms” as a library of perfect models, while the “real world” is full of chaos, what Plato considered “imperfect.” Yet this very “imperfection” is the variation and cornucopia which we see as the diversity and unpredictability of life; which is present in thought and feeling, and shapes our human values, including feelings of compassion. It is the combination of the natural, chaotic and physical “real

world” and the ideal “Platonic” world of computer graphics that comes together or clashes in physical computing, art, technology and culture [3].

The Morocco Memory Project

These combinations and transformations, in their human, cultural and historical contexts, were the focus of *Morocco Memory II* (1999), an installation at the University of Southern California’s Fisher Gallery, part of the “Interactive Frictions” art exhibit of the Labyrinth Research Initiative, in June 1999 (Fig. 4). This was an interactive, sensory computer piece designed to explore individual and shared memories.

Figure 4 - Morocco Memory II (1999) installed at “Interactive Frictions”, Fisher Gallery, University of Southern California.



Source: Photographs by Vibeke Sorensen

The work was based on thousands of visual, aural, and textual documents describing my experiences in Morocco in the early 1970s, as well as other experiences recorded in popular media over the century. These included sixty-four “lexia”—to use a term coined by Marsha Kinder—or short stories, associated with images, texts, sounds, musical recordings and movie clips, each set up for reconfiguration in several different forms. Most of them, including fragments from popular media, or referencing Western and Moroccan artists whose work influenced me, were my own memories and documents: some were contributed by Marsha Kinder, the director of the Labyrinth Research Initiative.

The focal point of the installation was a small tent, made of wood and satin, and with a 6' x 8' back wall for rear projection from a data projector. The tent was set up like a house, with Moroccan rugs, pillows, and stools around a wooden table. On the table, six traditional wooden boxes could be opened and closed, or picked up and carried around.

The boxes contained Moroccan spices in the form of seeds, leaves, bark, and other plant materials which could be touched and felt—a physical memory of many historically intersecting cultures. When a box was opened, aromas were released, and custom chips in them sent signals to audio and graphics computers that generated patterns of colored lights and mixed sound, text, and real-time moving images which were projected on the back wall. This enabled participants to interactively associate memory fragments in realtime, producing an effect similar to what occurs when specific odors trigger individual memories as linked and layered fragments.

In addition, the remote receivers tracked the states of the boxes through radio signals from the chips in them, and these were transmitted and reflected on computers outside the tent; participants could, as a result, dynamically alter the layers of images, texts, movies and sounds while walking around inside the tent, holding, touching and smelling the boxes and their contents. By engaging with the layered and constantly shifting memory fragments, they explored the interplay of the senses, memory, and imagination; and while the context was within historical, cultural and geographical frames of North Africa, the focus was not only on the

perceptions and memories of western expatriates, many of whom were attracted to this geography and for various reasons resided there, but also on the fragmentary memories and perceptions of exiles from other countries, such as Muslims and Jews expelled from Spain during the Inquisition. The interactive experience reflected the way memory functions: not as a static collection of recorded experiences, but as a recycling, iterative and dynamic process that is constantly being updated and connected with other, new or recorded, related experiences and memories.

The effect of this “ubiquitous computing” environment—where most of the technology was concealed from view and inside objects made of natural materials, and where users freely associated and connected personal and cultural memory fragments triggered by various kinds of sensory input, including smell and touch—was to create a total sensory experience that engaged the entire body on an individual level. The working metaphor was “the mixing of smells is like the mixing of memories”—which I knew would allow visitors/interactors to “fill in” the gaps between media fragments with their own memories and actions. In practice, it worked so well that people stayed for hours, experiencing the piece uniquely as an emergent system: since there are so many related though distinct elements, their possible combinations were unrepeatable. And because the experience was activated by openings or closings of boxes, each participant could create a unique association of memories that only came alive when they interacted with them; at the same time, however, this engagement also constituted a collective experience, as up to six people could interact with the boxes and alter the layered memories at the same time.

Illuminations

The relations between individual and collective experience have become increasingly complex today, in the interrelated contexts of global social and environmental concerns and emerging technologies. Spontaneously drawing from our unconscious or conscious mind is especially relevant to any investigation of a changing environment; our technology must be increasingly adaptable, so that we can extend our bodies, minds, actions and thoughts, and allow for unpredictable

outcomes. Openness to experiment, to allow for disruption, feedback from the affected environment and receiver, is therefore an important aspect of any new technology that for human beings and also other living things, is meant to be expressive, sensitive, and communicative.

Through language, we express and communicate feeling, and feel communication; today, more than ever, we put ourselves in the place of the other, metaphorically and literally. Empathy, feeling what others feel, is the most important human quality we will need as we operate on or affect others around the world from a distance; the absence of empathy leads to remote control of people and cultures. This phenomenon—which we know as imperialism—is anti-democratic, and democratic principles are the values that are most at risk in technology. Preserving, and in fact, actively democratizing technology, has been one of my goals since I first entered the field in the 1970s: if we want to welcome people from diverse cultures into technology, we need to raise awareness of the connectedness of local and global, social and environmental concerns, and bring implicit knowledge into the field—a strategy I have used for many years [4], communicating through everyday objects and everyday media, such as plants, bowls, boxes, photographs, musical instruments, and writing, including notebooks, letters, and hypertext.

When I went to Southeast Asia in 2009, I was influenced by the rich heritage of the region, including the cosmologies of the people there; and my engagement with this experience led to the large-scale work, *Illuminations* (2013). This work (Fig. 5), inspired by Asian traditional folding screens, Tibetan medicine mandalas, and the atmospheric phenomenon of the Aurora Borealis (the Northern Lights), was designed to produce a reflective state, where we can recognize our connection to broader natural phenomena, and detect patterns in time and space across domains of life and nature, including our own biorhythms and those of other living things, and engage them together with other human beings.

Figure 5 - Illuminations (2013), installed in Singapore at the School of Art, Design and Media, Nanyang Technological University, with Christine Veras playing a Tibetan singing bowl.



Source: Photograph by Vibeke Sorensen

The work consists of a 30-meter-long, glowing, illuminated folding screen that employs thirteen networked computers projecting real-time abstract animation onto twelve, six-foot-tall screens, each different and networked through its own computer, traversing a long arched room with mirrors at either end reflecting the arched zigzag shape into ninety meters. It combines the Asian panorama with computer animation rear-projected onto the screens. Sensors under three Tibetan singing bowls spaced in front of the work, detect participants playing, and there are sensors in cushions that are activated when they are sat on; the installation also includes live plants with sensors that measure their CO₂ output (Fig. 6). All these are interfaced to the real-time system, and alter the animation and music.

Figure 6 - Illuminations (2013),
showing plant interaction using sensors and PureData/GEM.



Source: Photograph by Vibeke Sorensen

All the screens are related and share data, so they behave like individual voices in a musical ensemble playing together, and with input from the audience; the experience becomes both individual and social, as multiple people can “perform” the screens solo or together. The installation also—influenced by Indonesian, especially

Balinese, Gamelan music, and shadow puppet theatre (Wayang Kulit), which are highly polyrhythmic and meditative—includes original, real-time music as well as these moving images. This is improvisational, with musicians performing the visual imagery while performing on the musical instruments; it is polyrhythmic, and connected directly to the real-time (live) moving images by common physical-digital processes. The Singing Bowls invite the audience to play the instruments; they alter the colors and images at the same time as the music, so becoming part of the larger process.

The music and images of *Illuminations* reflect wave behavior fundamental to natural phenomena, and all the viewers and interactors are invited to reflect upon relationships between human beings, nature, and the universe. The installation functions, in this way, like a large visual-musical instrument for the audience to improvise upon as part of a collective, multimodal stream of consciousness. The result is a glowing river of coloured light, which becomes a huge rainbow when all the bowls are singing together with the plants; this is synchronized to the time of day, as it is determined by the plants' chronobiological characteristics.

For the installation in Singapore, the screens were attached to the floor, and reinforced connection to the Earth. Spiral forms referenced cosmologies of oneness in traditional Asian religions and philosophies. A stereoscopic version of this piece (Fig. 7) was also installed the same year at ZKM in Germany, where the screens were suspended from the ceiling and appeared to be weightless; in this way, they also reflected Plato's world of Forms and related ideas of perfection, stasis and chaos.

This "illuminated folding screen" seeks to transcend traditional "East-West", "Ancient-Modern", "Nature-Technology" relationships by translating data across species and modalities, producing a luminous environment for reflection, contemplation, and meditation, in which the audience is implicitly asked to reconsider relationships between material and digital cultures and organic systems, and discover new connections among them.

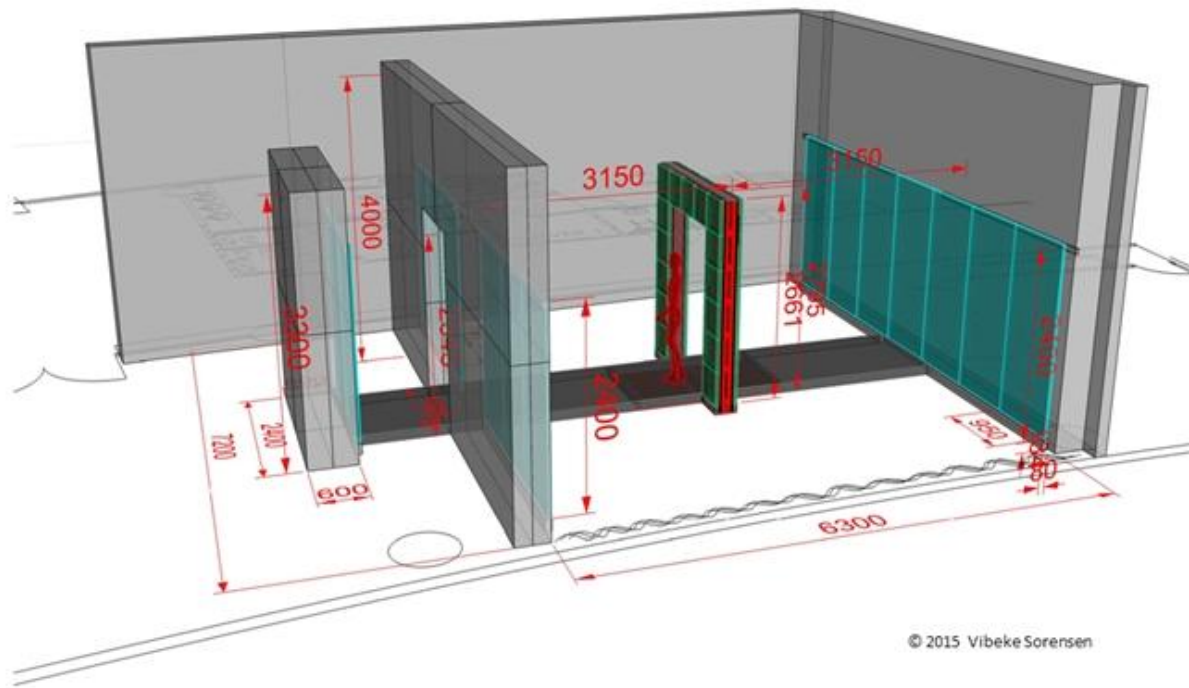
Figure 7 - Stereoscopic version of *Illuminations* (2013) installed at the ZKM Karlsruhe at “Beyond 3D” in 2013.



Source: Photograph by Elke Reinhuber

The purity and complexity of the colors, light and sounds in *Illuminations* are not meant to serve as a replacement for nature. Rather, the use of technology here is intended to illuminate our awareness of the fundamental elements of nature. The networking of the computer systems decentralizes and complicates the tendency to place the human being at the center of all nature. We are part of a huge, dynamic, mutating “fractal,” an ecology of many rhythms of life, constantly interacting and evolving, like interconnected spirals made of multi-, hyper-, and meta-cycles that repeat, but never exactly in the same way. We reflect upon the cycles in a reflexive process, as they are the basis of our neurological activity, our thoughts, memories, dreams, and actions. It is perhaps a reflection of this interconnectedness that the live plants used in *Illuminations* did not die after a week from lack of daylight, as biologists had predicted, but—enjoying the music, colored lights and biofeedback—flowered and flourished for the six weeks of the installation; and all but one survived when returned to a normal lit environment.

Figure 8 - Mood of the Planet (2015) installation diagram from “Everything is Data,” curated by Laurene Vaughan of the Royal Melbourne Institute of Technology, and installed in Singapore at the School of Art, Design and Media, Nanyang Technological University. Concept, animation and music by Vibeke Sorensen. Thanks to Marsha Kinder, Dennis Low, Ong Kee Sing, Fabrizio Galli and Nagaraju Thummanapalli.



Source: Vibeke Sorensen

Mood of the Planet, Mood of New York, and Mood of Singapore

Illuminations was followed by *Mood of the Planet* (2015), which employs big data, and was curated by Professor Laurene Vaughan for their exhibition “Everything is Data” at the Royal Melbourne Institute of Technology (Fig. 8); the exhibition also featured other works “focusing on digital technologies in art-making that permeate the boundaries between physical and virtual, and universal and personal,” by Adam Nash and Stefan Greuter, and the artistic duo of Ruth Gibson and Bruno Martelli [5].

Mood of the Planet is an interactive architectural installation of recycled crushed glass, steel, wood, custom electronics, Twitter feeds, real-time animation and music that has, as its centerpiece, a large “arch” or “doorway” which emits colored light and animates to reflect live emotions expressed by people all around the globe as they communicate through networks such as Twitter. The structure is based on traditional temple architecture, where a series of arched doorways must be traversed when entering, symbolizing passage of the person through different stages of life. At the original gallery installation in Singapore (Fig. 9), this “arch” or “doorway” was reflected within a mirrored room, so it was repeated into a tunnel-like shape, producing an infinity of doorways. A wooden pathway traversed the room through the arch, connecting the two mirrored walls opposite each other and creating an “infinite” pathway for the viewers/interactors to walk upon.

Figure 9 - Mood of the Planet (2015), with three small frames showing it installed from the front and side, and a larger image of its construction at the School of Art, Design and Media, Nanyang Technological University.



Source: Installation photographs by Nagaraju Thummanapalli; construction photograph by Vibeke Sorensen.

The arch sculpture was made of thirty building blocks of “smart tiles”, consisting of crushed recycled glass and custom electronics. These emitted colored light, and the colors and shapes changed in real time as live networked data was analyzed—including Twitter data representing human emotions, emanating from all

across our planet. The data was sampled for keywords representing moods—fear, disgust, happiness and pleasure, sadness, anger and surprise—in continuous real time from all around the world; this is a form of “sentiment analysis”, involving mining data for certain words that convey human emotion. In addition, the installation was updated every minute, with each minute divided proportionally according to the moods, which were translated respectively into color ranges: white/black, brown/yellow, green/gold, blue/grey, and red/black; surprise was represented by patterns and multiple colour combinations.

In *Mood of the Planet* and its developments—variations of the project were exhibited in April and May, 2016: *Mood of New York*, during Creative Tech Week, New York City at the “Experiments in Art and Digital Technologies (EADT) Exhibition” (Fig. 10); and *Mood of Singapore*, at Nanyang Technological University’s Experimental Medicine Building—these transformations reflect the moods of the people of the Earth through color and light, revealing their inner light as a luminous presence; while the iconic temple arch form of the installation references developmental transformation, the metaphoric passing from one state to another—growth and change analogous to the transformative effect that global communications technologies have upon our collective human condition.

Figure 10 - Mood of New York (2016) installed at the “Experiments in Art and Digital Technologies (EADT)” exhibition curated by Cynthia Goodman, at Creative Tech Week New York City. Concept, animation and music by Vibeke Sorensen. Thanks to Fabrizio Galli and Nagaraju Thummanapalli.



Source: Photograph by Suzanne Ball

Wearable Transmedia Technologies: Wear Art We?

My most recent work, *Digital Amulet: Smart Necklace* (2017), reflects this understanding, combining traditional Egyptian and South Asian cultural design elements with sensors, 3-D printing and networked Android communication devices (Fig. 11). This is a piece of wearable art, which is esthetic—through its design, it serves as a medium of cross-cultural communication—and also functional: it enables wearers to select music and animations (these are influenced by Indian mandalas and traditional instruments) reflecting biofeedback from their own bodies or a network, or to respond to environmental conditions.

Figure 11 - Digital Amulet: Smart Necklace (2017). Concept, design, animation and music by Vibeke Sorensen. Produced in Singapore at the School of Art, Design and Media, Nanyang Technological University. Thanks to Nagaraju Thummanapalli, Christine Veras, and Patrick Liew.



Source: Photograph by Nagaraju Thummanapalli

This is not just about wearable computers and technologies, but the concepts that shape them. We “wear” our thoughts, histories, stories, and these express our traversal through time, and the phenomena of the earth and universe: our bodies are screens, environments, sounds, for our minds and for sharing between each other.

All stories, marks, meanings, follow a thread back to what it means to be alive and together with other creatures in the universe: decoding this can help us understand how it works; and conversely, using the codes can allow us to create new narratives and meanings for expressive media, through connections between their new modalities. Strokes, drawing, letters, words, narratives, stories told with words, pictures, sounds, screens, environments, and also fabrics and clothes, are all part of this thread. In particular, language and meaning intersect with technologies that for

generations have evolved together with textiles—*text* and *writing*: the words “text” and “textile” share a common root and a common history through etymology. There is a literal and metaphorical weaving of the two, through connections that are, one might say, reflexively intertextual.

In wearable art, the primary medium and agent is the entire human body, including the brain, and its extensions that span oral and written languages, ideas and texts, and emerging forms of multimodal communication. A variety of “prosthetics” and “interfaces” encompass not only all of the senses and their modes of engagement with the environment, including the protective and the playful, but also recorded human history—since wearable art reaches back thousands, if not millions of years, through clothing and textiles.

Garments and clothing can be regarded as a synthesis of the arts, humanities, sciences, and engineering developments through the ages, since textiles, or *tech-styles* and *text-iles*, are a product of our bodies, brains, ingenuity and environment. As our hands freed our mouths to speak and write, they also allowed us to change our appearance and the world we inhabited. We tilled soil and wove the fibres into fabric, for protection and for the expression of culture. As a result, we have many metaphors related to thread: sewing, fabric, many types of garments. There are also social and industrial considerations, as for generations sewing and fashion were considered “women’s work,” and clothing denoted gender. Today, fashion is androgenous, and identity is expressed through the clothes that are worn. In the theater, actors change clothes—and cosmetics (a word derived from the Greek for “cosmos”) or makeup—to communicate changes in mood, time, context, story, and of course, to create some continuity or larger connection to the plot or meta-narrative, and environment.

Contemporary technology has not only brought this rich and varied history to our fingertips through the World Wide Web and networked archives; it has collapsed time and space, by bringing data from vast distances across the electromagnetic spectrum to our awareness for exploration and contemplation. From the furthest reaches of the Universe to the deepest details of molecular phenomena, we “wear” our feelings, thoughts, questions and knowledge, including of today’s Big

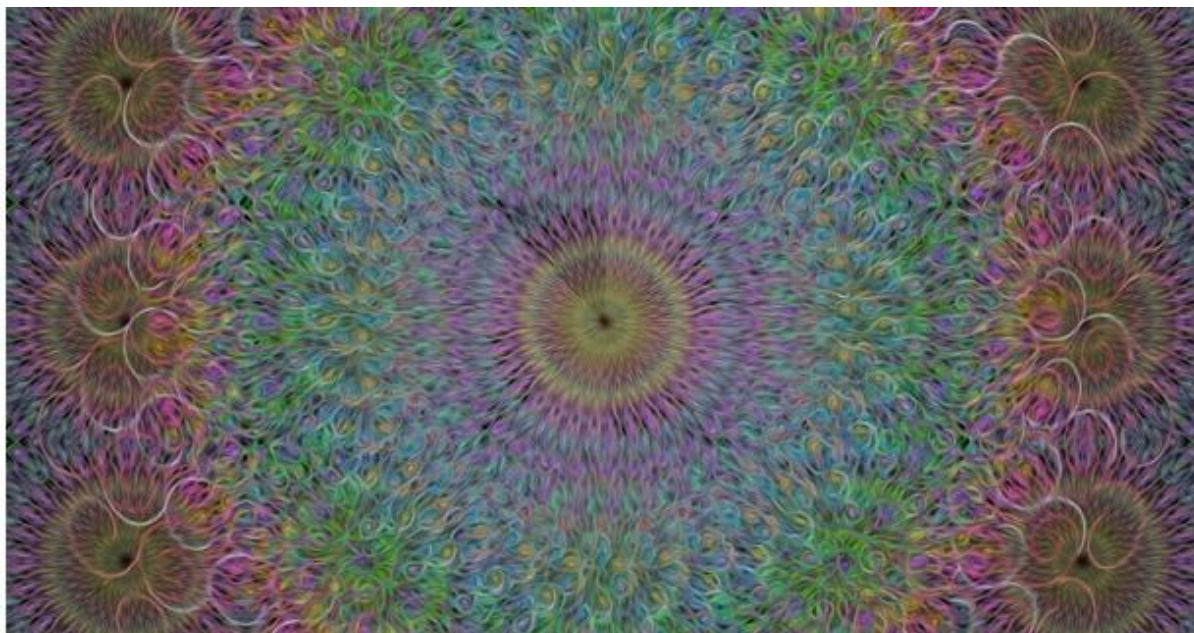
Data, in ever changing, challenging, and inspiring ways. Emerging forms of wearable art employ networks, embedded systems, ubiquitous computing, smart textiles, transmodal transmedia, augmented/virtual reality, DIY/maker culture, and 3-D printing, as well as bio-art/design. The potentialities, risks and limitations of technology—in particular as it affects societal power relations and the fundamental relations and responsibilities of understanding, compassion and empathy both between individuals and groups, and human beings and other living things—as well as alternative concepts such as co-embodiment, and current global circumstances, necessitate an active concern for the human condition, but also an ecological approach.

Animation as an extension of life

Art today—if understood as “expression” and “reflection”—can be considered as the exploration of phenomena, the encoding of complex information, or the transfer of knowledge into media that are refined through skill, experiment, critical thinking, and visionary imagination. In design, the goal is to improve life and “make the world a better place”, which means having an active concern—among other concepts, issues and activities—for sustainability, diversity, inclusion of global ethnic cultures, and the Anthropocene [6].

In this context, I consider animation to be not simply an illusion of life, given advances in technologies that “animate”, but an extension of life. What is fundamental is that the living trace of an artist, user, or living thing being engaged is transferred, through a system, to a medium which allows us to perceive and engage it in a fluid and transparent way, so that the output *becomes* an extension of life, reflecting and responding to the life in a sensitive and ethical way (Fig. 12).

Figure 12 - Freeze Frame from *Mayur* (2015), a 7 min 42 sec, 4K (4096 x 2160) resolution visual-music animated work inspired by Asian cosmologies, music and textiles. *Mayur* means “peacock” in Sanskrit: the digital animation features complex images that evolve from threads to roots and intricate vines, forming lace-like two- and three-dimensional structures, tiles, and living textiles in the colors of a peacock. Animation by Vibeke Sorensen. Music by Kartik Seshadri. Produced in Singapore at the School of Art, Design and Media, Nanyang Technological University.



Source: Photograph by Vibeke Sorensen

To give life to something is deeply mysterious, and raises the fundamental question: what is life? It is not a mechanical reduction or digital media replication (copy) of a living thing or biological phenomenon: in computer animation, when we compare digital capture to hand-made animation, there is always something lacking: “the uncanny valley”; and even today, using the most sophisticated computers, the hand of the artist is still needed to translate data from the unseeable to the seeable, and to refine digital animation aesthetically to make it “believable”. The artist is also needed because it is in part his or her life trace that “gives life” to animation, especially when the data is derived from sensors detecting phenomena across great scales and distances, from molecules and DNA to galaxies and distant planets. The process of producing animation is further complicated by the fact that animation which achieves the highest quality normally requires conscious awareness of unconscious or instinctive movements and perception, for it to be transferred to a

medium in such a way that it seems to be just as alive as the living thing that produced or originated it.

In real-time systems, similarly to what occurs with musical instruments, the potential to articulate nuance and virtuosity through dynamics of graphical and multimodal elements is further potentialized and extended. There are now even greater possibilities for animation than ever before, given innovations in sensing technologies, human-computer interaction (HCI), neuroscience, big data, the Internet of Things (soon to be Living Things), scientific computing, and innovations such as CRISPR. Important considerations include ethics, empathy, and the health and compassionate treatment of all living things.

One of my works in progress related to this is *The Colour Music of the Plants of the Planet*, which builds upon *Illuminations* and *Mood of the Planet* to create a real-time visual music installation and online work using live CO₂ and O₂ sensing of plants in different biomes around the world.

Another, *Turbulent Wor(l)ds* (2016-2017) is a series of very high resolution animated works that are printed onto fabric as wearable art, installation and performance (Fig. 13). They include interactive technology sewn into the fabric that responds to real-time, changing environmental conditions such as CO₂ and O₂.

Figure 13 - Turbulent Wor(l)ds (2016). Produced in Singapore at the School of Art, Design and Media, Nanyang Technological University.



Source: Photograph by Vibeke Sorensen

Here, through computed turbulence, generative computer graphics images based on script, writing and drawing, form animated abstract new worlds, words, and scripts as a result of the process of drawing. Like an electron beam, a point appears and starts to assume a form as it moves, becoming a thread or painted line—at times like calligraphy or script, at times turning into shaded surfaces that when moving behave like atmospheres, liquids, and underwater worlds. The line starts at a particular location in space and time, and ends beyond the edge of the canvas or screen. In some images, the beginning is in the middle of a vast empty space, and like a sun, radiates light outwards over the period of time that it draws: as it traverses space, dynamic forces bend and shape it into turbulent worlds. Each frame takes more than one hour to compute, due to its complexity and the time it takes for the line to complete its path; and each succeeding frame in the sequence is a transformation of the previous world. The images are very high resolution (18000 x

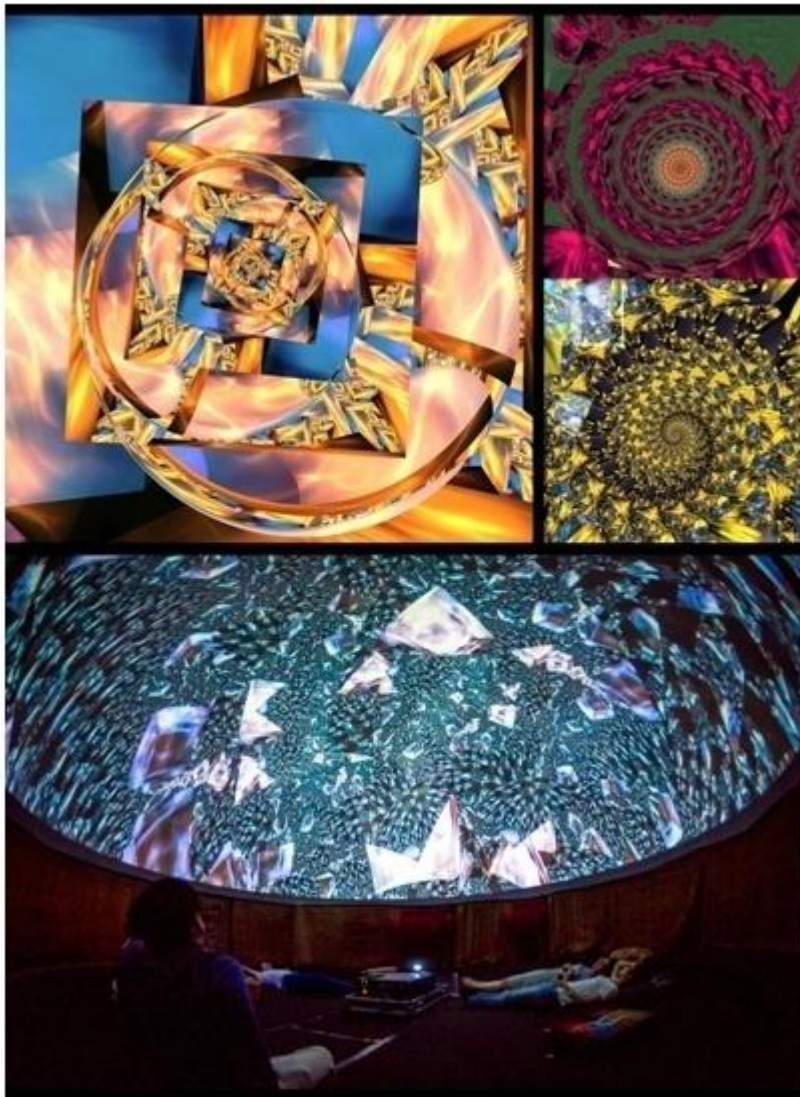
10000), and some have been printed onto fabric and made into couture fashion designs. Some are inspired by glass, which is also a liquid turned solid; some are more like textiles, or text-tiles. They work with poetry, meditation and dream—inner spaces of non-objective worlds. A close-up of one of the images is depicted on the cover of *Lumina*, showing the very center where, like a mandala, the image starts to draw; as it progresses further out from the center, other worlds appear within worlds.

I am also working with colleagues in the Center for Applied Nanobioscience and Medicine at the University of Arizona's College of Medicine in Phoenix, on Ambient Intelligence, and Advanced Design and Materials for Health Engineering and Fashion. These areas include projects in DNA gene editing for new kinds of textiles and displays for use in health care and fashion, with additional applications in a wide range of fields, spanning architecture, interior and product design, medicine, health care, media art and communications, and providing many new research opportunities for animation as an “extension” of life.

The Future: Privilege and Responsibility

For the past 40-50 years, our art and design has tended towards dematerialization, as physical entities have become digital and virtual. With 3-D printing and embedded systems, this trend is changing. We are now in a period of increasing re-materialization, including the emergence of the Internet of Things. Post-digital culture may be informed by similar recombinant “rematerialization” of multimedia, retaining some original meanings and functions within an accelerated evolution of diverse possibilities. Within the physical-digital metaverse, the ability to connect to and communicate with anything measurable becomes possible. The increased powers to sense and affect the physical condition of other living things through this technology highlights the responsibility and need for our interactions to be centered in empathy and ethics (Fig. 14).

Figure 14 - Vishwaroop (2014, 4:30, 4k digital dome film). This was premiered at the Reuben H. Fleet Science Center in San Diego, California as part of the NWEAMO Festival on March 23, 2014. The title (vishwa means “universe”; roop means “form”) is from Hindu philosophy, and means the appearance of God or Brahma in forms that incorporate the creation of worlds and the universe within them. The five main elements of the Universe in Hindu philosophy are fire, earth, air, water and ether (space): this animation is produced using Pure Data/GEM, and the process is a real-time emergent system that continuously generates new forms, including these elements as sources of data. Animation and programming by Vibeke Sorensen, with technical assistance from Nagaraju Thummanapalli. Live music performed by sitar virtuoso Kartik Seshadri, accompanied by tabla virtuoso Arup Chattopadhyay. Thanks to Biju Dhanapalan, Miller S. Puckette, Ben Shedd, Joseph Waters, and John Young.



Source: photographs by Vibeke Sorensen.

The goal today is to save humanity, life, and the planet. Ultimately, art is for thinking and prototyping solutions to problems. When I started in the 1970s, I

was affected by my parents' teachings: they had been in the Danish Resistance against the Nazis, and had experienced the traumas and dreams of the 1960s—the Vietnam War, and the Civil Rights, Women's and Human Rights movements—and the great potential of art to redirect, move, transform and heal the human heart. Have we succeeded? In 2008 I was the only academic invited to a conference entitled "Countering Violent Extremism" at the East-West Institute in New York City, where I was asked to read a paper called "Videopower" by Mroz [7]. I was told that most extremists are young men fascinated by technology; that creative people working with the same technology can redirect these people to humanistic uses of the same technology; and that art schools in particular play a very important role in humanizing technology, and perhaps most importantly, influencing young people. At the same time, I was approached by people connected with the US Military who wanted to know if virtual reality technology could be used to help soldiers returning from war to recover from PTSD, since they had prepared for war using the same technology, in the form of "war games." Since then, I have continued my work as an artist and educator; and I continue to believe that it is the human heart, and not only the head, that can change the world for the better.

It is urgent that we work to solve the problems of the survival of the planet. I sometimes wonder why people all over the world do not stop everything they are doing and work together to reverse global warming, and stop the human-induced mass extinction of species, as evidenced by the Millenium Ecosystem Assessment [8]. There is a wonderful documentary entitled "Earth on Edge" [9] that was produced in 2001 for WGBH Boston, with Bill Moyers. The scientists interviewed explained that within a hundred years, 50% of the biodiversity then in existence would be extinct due to human activity. Since then, the extinctions have been re-evaluated every few years; and today the rate of extinction has increased dramatically. We are at what some have called a "tipping point," as the Earth is dramatically affected by our stewardship of it, and each step we take has enormous consequences. As artists, scholars, and educators, each of us can contribute to solving the problems of survival, from the smallest decisions we make in our everyday lives to the larger works we undertake. It is a privilege to have been born human, to be healthy, receive a good

education, and have the possibility of pursuing our interests during the short time we inhabit this beautiful Earth; and because of this, we have a responsibility, through our collective work, to do this with intelligence and compassion for all living things. Art directed in this way is bio-art and eco-art; its medium and message is the life on the planet and of the planet.

Notes

- [1] See Vibeke Sorensen's website, <http://vibeke.info/temple/>, and Victor Ancona, "Vibeke Sorensen: Demystifying Video Technology," in *Videography Magazine* (United Business Publications), Volume 4, Issue 2 (1979), <http://www.experimentaltvcenter.org/vibeke-sorensen-demystifying-video-technology-0>.
- [2] See C. P. Snow, *The Two Cultures and the Scientific Revolution*. The Rede Lecture, 1959 (New York: Cambridge University Press, 1961), http://sciencepolicy.colorado.edu/students/envs_5110/snow_1959.pdf.
- [3] See Vibeke Sorensen, "Visions of Reality." Keynote speech delivered at the International Conference on Visuality and Cultural Literacy, *Visual Culture Research Center, National Central University, Taiwan*, 20 November, 2010, <https://digitum.um.es/jspui/bitstream/10201/41858/1/191951-692161-1-SM.pdf>.
- [4] See Vibeke Sorensen, "Rewiring Culture, the Brain, and Digital Media." 239-248 in Thomas Bartscherer and Roderick Coover, eds. *Switching Codes: Thinking Through Digital Technology in the Humanities and the Arts* (Chicago: University of Chicago Press, 2011), <https://books.google.com.sg/books?id=ZbPV88ioIWkC&pg=PA239&dq=Vibeke+Sorensen+Switching+Codes&hl=en&sa=X&ei=fL6UUMv6L8bRrQfzZoHABg&ved=0CC4Q6AEwAA#v=onepage&q=Vibeke%20Sorensen%20Switching%20Codes&f=false>.
- [5] "Everything is Data." Collaborative exhibition with the Centre for Game Design Research, Royal Melbourne Institute of Technology. *ADM Gallery, The School of Art, Design and Media, Nanyang Technological University*, 14 August – 26 September 2015, <http://www.adm.ntu.edu.sg/NewsnEvents/ADM-Gallery/Pages/EVERYTHING-IS-DATA.aspx>.
- [6] See Vibeke Sorensen, "DATA: Design, Art, Technology and the Anthropocene," Video Documentary at "3D-Festival BEYOND," *ZKM Center for Art and Media*, Karlsruhe, Germany, <http://zkm.de/en/media/video/3d-festival-beyond-vibeke-sorensen>.
- [7] Jonathan Rami Mroz, "Countering Violent Extremism: Videopower and Cyberspace." Policy Paper, 1/2008. (New York: East West Institute, February 2008), https://www.files.ethz.ch/isn/90544/2008-02-17_Countering-Violent-Extremism_Videopower.pdf
- [8] Millennium Ecosystem Assessment Reports, <https://www.millenniumassessment.org/en/index.html>
- [9] "Bill Moyers' Reports: Earth on Edge," PBS (Public Broadcasting System), http://www.pbs.org/earthonedge/eoe_sneakpreview/index.htm

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