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Alchemists of the Future

Ars Electronica Futurelab The First 25 Years and Beyond

ARS ELECTRONICA
FUTURELAB

25 Years of
Ars Electronica Futurelab

The creation of the Futurelab was in equal measure an accident or a stroke of luck (right people, right time, right place) and the unavoidable consequence of the original Ars Electronica idea of a merging of art, technology, and society. It was certainly also an urgent necessity—actually the only chance—to make the planned Ars Electronica Center with its groundbreaking innovations, high artistic standards, and clear didactical goals a fully functioning "Museum of the Future."

In mid-1995, entrusted with this task, we were faced with so many technical and creative challenges that there was simply only one way forward: putting together a team of ambitious and visionary artists and technicians and striving to turn this great vision, which up to that point had existed only on paper, into reality.

To realize his idea of an Ars Electronica Center, Hannes Leopoldseder had in advance invited experts and artists from all over the world to develop visions for this new kind of center and, not surprisingly, the invitees outdid themselves with spectacular scenarios ranging from LED wallpaper with which all walls would be covered (at that time there were not yet LED flatscreens on the market) to kinetic components that would change the building constantly. Alas, there was then the reality, a reality in which it was not enough to cobble these kinds of prototypes together for a short demonstration at a fair or art exhibition, but rather one in which they had to stand up to the real world of permanent exhibitions where they were on show six days a week, with only one day for maintenance and repair.

Thus, there was the necessity of developing most of the exhibition themes and exhibits in-house, but also the necessity of having a suitable team for their continual maintenance and further development, and one that was directly on-site so that appropriate measures could quickly be taken if computers crashed, mechanical interfaces broke down, or self-made hardware melted down.

Faced with all these challenges, in retrospect it seems almost a miracle that we did not lose heart and that the responsible authorities from the City of Linz continued to back us. But what other choices did we have? After all, it was clear to everyone that the Ars Electronica Center could not become just another science center that also dealt with digital technologies. No, it was to become a prototype, a Museum of the Future in which one could work with and reflect on the possibilities of the new digital technologies—and not merely in groups of experts but together with the general public.

It was therefore particularly important to have people for whom the commonality of art and technology was a given, and who also did not shy away from taking on projects for which there were no existing models, such as the elevator-floor projection, the bold brainchild of Roy Ascott. This project could be realized only shortly before the opening of the Ars Electronica Center, as a few months before, a new projector had come on the market that could be installed in the small niche under the elevator floor with a deflection mirror and special rear-projection film. The greatest challenge, however, would be to convince the technicians from the elevator company to give us an interface for the elevator control to enable us to synchronize the projections with the movements of the elevator. The cost that the company initially quoted us for the few lines of additional code in the elevator control exceeded that for the projector. Without the technical expertise of our in-house team, we could probably never have negotiated a reasonable price. Our own team ended up developing the animation, soundtrack, synchronization, and controller.

An even greater adventure was the journey to one of the top attractions of the first Ars Electronica Center, the flight simulator *Humphrey.* No one remembers how this name came about, but it stuck. The bold design, the impressive electromechanical lifting mechanism, and the combination of helicopter flight images with virtual 3D models in a specially constructed VR helmet became a trademark, as did Ken Goldberg's *Telegarden* and, of course, the CAVE—the first of its kind, incidentally, to go into operation in Europe and the first in the world that was made available to the general public in the context of a regular exhibition.

It was also the CAVE that provided the key to establishing a permanent team and with it the formal founding of the Ars Electronica Futurelab. For it was only the great interest that industry had in utilizing the expertise of the Ars Electronica Futurelab to test the practical applications of virtual reality, internet-based services, new user interfaces, and much more that provided us with the financial resources necessary to realize the idea we had nurtured from the very beginning: making the Ars Electronica Center not only an exhibition space but also a venue for research and development and thus also a place for shaping the future.

That a world-renowned laboratory and atelier for the synergy between art, technology, and society has developed from this starting position—one that also has become an important factor for the economic success of Ars Electronica, is due to Horst Hörtner and his tremendous staff, to whom this book is dedicated.

Gerfried Stocker
Artistic Director Ars Electronica

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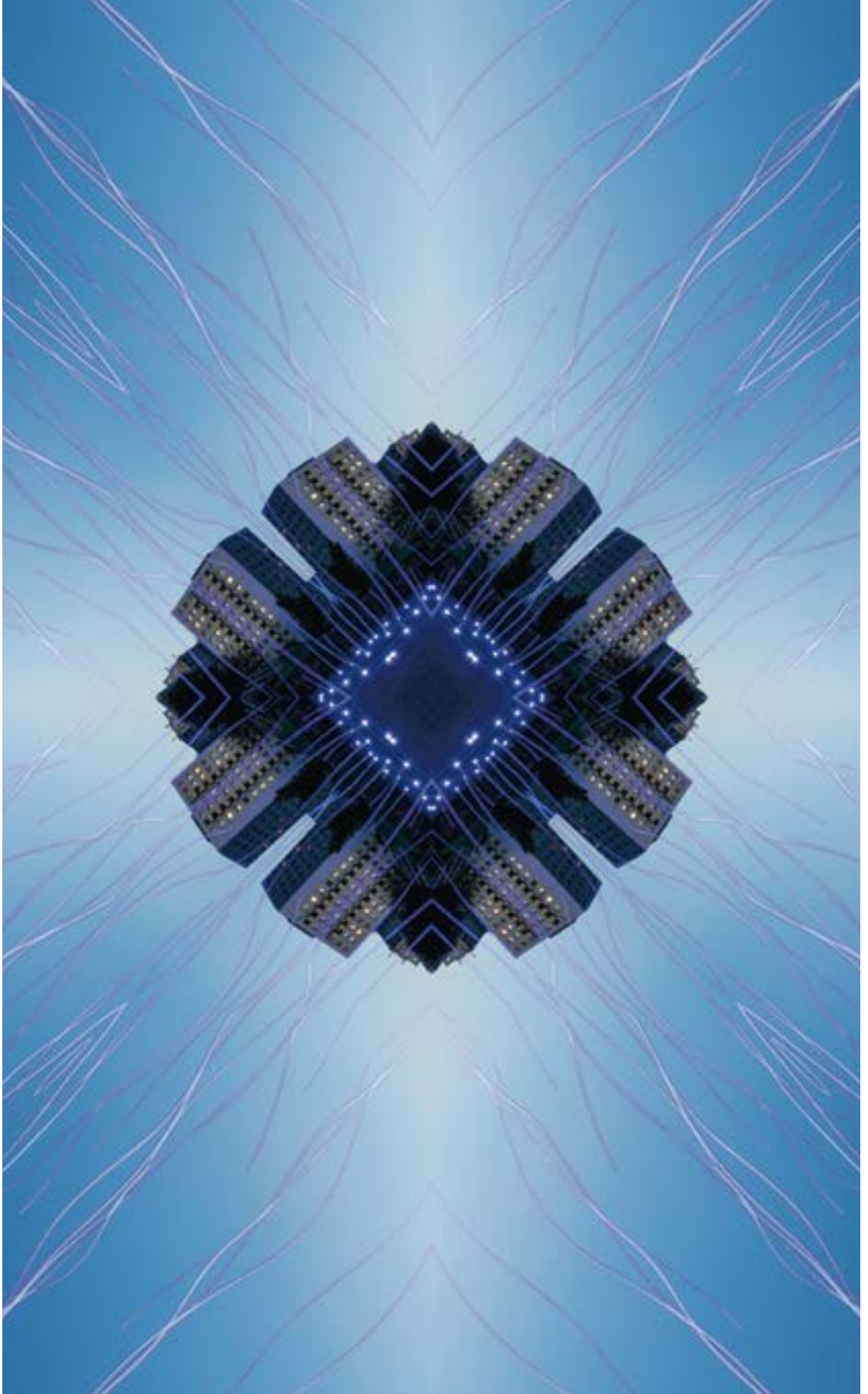


Into Unknown Territory: Alchemists of the Future

Into Unknown Territory: Alchemists of the Future

In the dimly lit laboratory space, two drones ascend into flight. Their lights flare, and in midair they begin to sketch the lines of *Vitruvian Man,* the human being in proportions, similar to what had been drawn by Leonardo da Vinci more than 500 years earlier. Some 9,000 kilometers to the east, a young woman stands amidst a swarm of ground bots, their LED screens facing upwards. She holds an Olympic Fire torch and—in an inherently Promethean gesture—shares the light with the swarm, whose displays readily pick up and pass on the virtual flame. In the blink of an eye, another space, containing unfathomable dimensions of virtuality, turns into a modern version of a dissecting theater, with a human heart, rendered in huge dimensions from a living patient's real-time medical data, beating in the middle of the space. Crossing a bridge between two buildings, people on their way through a corporate compound, by their very movements turn this bridge into a musical instrument, letting their working day resound. On a late summer night on the banks of a river in the heart of Europe, a huge swarm of drones become airborne for their first public performance, turning the dusk skies into a canvas full of moving images, their lines drawn from the drone's dots of light.

All of this—and an incredible amount more—originates from an atelier-laboratory that is located right on the bank of that river, the Danube. It is an institution like no other, with an eventful history of 25 years now behind it. Compared with the common academic or industry research and development lab, this unit is rather small, comprising a staff of a mere three to five dozen people. It is neither an academic institute nor a corporate department, but a hybrid of artistic atelier and research laboratory. And there is a special third element, a philosophical and profane form of modern "alchemy," which allows for the team at the "Futurelab" to also be considered as "Alchemists of the Future." In fact, the people working there embody that fruitful dialogue between art and science, which often leads to astonishing and unconventional results. An ongoing dialogue between art and science is taking place among their team, which is assembled from artists, programmers, and engineers, as well as within the individual Futurelab members, their working biographies, and the multiple skills that they bring to their creations. This group of remarkable people have developed their own brand of steep learning curves into unknown territory and a culture of boundless curiosity and keen-eyed risk-taking. Although they rarely do so, they could well point to the fact that they have been far ahead of the times with many of their visionary ideas, which they turned into working prototypes and realized projects. The Futurelab team is embedded in the "biotope" of a much larger cultural organization and a global network of partners and clients, which include many of the big names from industry and academia worldwide. This atelier-laboratory, founded in 1996, displays a somewhat paradox combination of openness and opaqueness, and—quite befittingly—bears a hybrid name, composed from two languages, Latin as a long-time lingua franca of classical educated discourse, and English, the language of science today: "Ars Electronica Futurelab."

Future Ink Research project, Ars Electronica Futurelab and Wacom
Exploring the *Space Ink* technology, 2020

Ars Electronica Soirée 2020. Hannes Leopoldseder, founder of Ars Electronica, and Christine Schöpf, artistic co-director of Ars Electronica together with Gerfried Stocker

The elderly gentleman is sitting on a bench in a park. When he turns towards us and we hear him speaking, it could be an old broadcast video or a holographic telepresence. He is well versed in the art of patiently but insistently explaining his ideas to those who do not immediately share his vision of the future. In the beginning, in the late 1970s, his vision of creating a festival at the nexus of art, technology, and society seemed simply too far ahead of its time for many. Hannes Leopoldseder (1940–2021) had written his doctoral thesis about the "nocturne" in Romanticism and then began to embrace technology as the culture of the future. After he had become regional director of the public broadcasting corporation ORF, he began—together with the scientist and science-fiction writer Herbert W. Franke (*1927) and the musician Hubert Bognermayr (1948–1999)—to develop ideas for a festival in the city of Linz, capital of the Austrian province of Upper Austria. Quite in tune with his humanist education, he gave the new festival for art, technology, and society the Latin name "Ars Electronica."

"The purpose of Ars Electronica is not to take stock of the past; it is oriented instead to the developments of tomorrow. Thus this event for electronic arts and new experience assumes a character of incalculability, of risk, and of daring to try something new."

Source: Leopoldseder, Hannes (1979). *Ars Electronica 1979 im Rahmen des Internationalen Brucknerfestes 79*. Druckerei und Zeitungshaus J. Wimmer Ges.m.b. H & Co., Linz, 1979, p. 5.

Hannes Leopoldseder (1940–2021, AT). Television journalist and director of Austrian broadcasting company ORF. 1974–1998 managing director of ORF Upper Austria, 1998–2002 information director of ORF. Co-founder of Ars Electronica (together with Herbert W. Franke and Hubert Bognermayr) in 1979.

Swarm Arena at Japanese National Museum of Emerging Science and Innovation, Miraikan, Tokyo, 2019, Ars Electronica Futurelab + NTT

Elegantly, he brings the conversation to one of the guiding insights that fueled his vision: "The purpose of Ars Electronica is not to take stock of the past; it is oriented instead to the developments of tomorrow. Thus, this event for electronic arts and new experience assumes a character of incalculability, of risk, and of daring to try something new. At the same time, however, Ars Electronica poses a challenge to artists, technicians, cultural critics, and ultimately to the public encountering new forms of expression in art."[1] The small industrial town of Linz, at that time still plagued by the smog from a huge steel plant within the city limits, at first glance seemed an unlikely setting for such a visionary cultural institution. But in 1979 the first Ars Electronica Festival opened—in front of a crowd of 100,000 visitors—with the *Linzer Klangwolke* (Linz Cloud of Sound) flowing along the banks of the Danube and across the city, letting Anton Bruckner's *Symphony No. 8 in C minor* sound over huge PA systems and from numerous radios, which the population had been asked to place in their windows for the event. On the day before the opening, the mayor of Linz, Franz Hillinger, had welcomed a special guest at the city's airport: The robot SPA 12 had been flown in from New Jersey to hold the opening speech of the festival, to mingle with the crowds on the city's main shopping street, and also to participate in live discussions on radio and TV. Even at this very inception of Ars Electronica, several defining characteristics of the entire organization—later also formative for the Futurelab—were already visible: pioneering "computer art," as it was then called, met with music and visual arts. Robots met with the population, which actively involved itself in large-scale participatory projects.

Ars Electronica 1986. Benoît Maubrey, Hans Peter Kuhn, *Audio-Uniform* concerts

1 Leopoldseder, Hannes transl. in: Schwarzmair, D. & Stocker, G. (eds.), *der zeit voraus – Kommentare und Analysen zum digitalen Wandel von Kunst, Technologie und Gesellschaft,* Ars Electronica, Linz, 2020, p. 13.

Ars Electronica 1979. Opening of the first Ars Electronica Festival with Robot SPA 12

Ars Electronica

1979
First Ars Electronica Festival and
first Linzer Klangwolke
(Linz Cloud of Sound)

1987
Inception of Prix Ars Electronica,
International Competition for
Computer Arts

1996
Opening of Ars Electronica Center—
Museum of the Future and founding
of Ars Electronica Futurelab

1996
Founding of Ars Electronica Futurelab

2004
Start of Ars Electronica Export

2009
Opening of new and expanded
Ars Electronica Center

2012
Start of Ars Electronica Solutions

2015– 2019
Ars Electronica Festival at POST CITY

2016
Start of Ars Electronica Japan

2019
40th anniversary of Ars Electronica

2020
Ars Electronica Festival in
Kepler's Gardens at JKU Campus Linz
plus 120 locations worldwide

2021
First edition of *Transform your World*—
The Festival University by Ars Electronica
and Johannes Kepler University

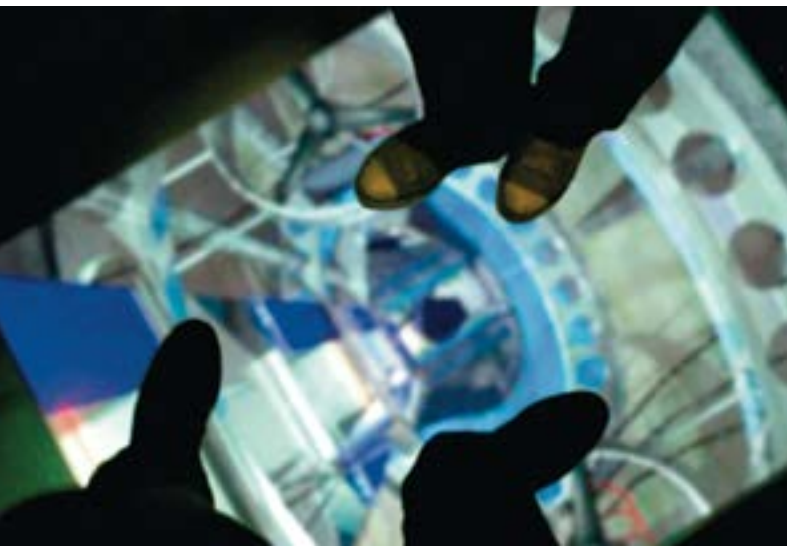
“Every idea and every project needs allies, people who believe in visions, and others who allow themselves to be inspired by these visions. At certain times, natural born fighters with a dash of guerilla mentality are needed, and a certain degree of tenacity and the power of conviction. Ars Electronica has been blessed with all of these … .”

Source: Schöpf, Christine (2009). “The Making of …,” in *The Network for Art, Technology and Society. The First 30 Years. Ars Electronica 1979 – 2009.* Hatje Cantz Verlag, Ostfildern, p. 21.

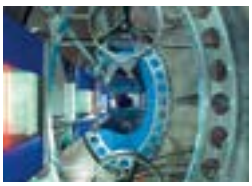
Christine Schöpf (AT). Radio and television journalist, 1981–2008 head of the culture and science department at ORF Upper Austria, 1987–2004 responsible for conceiving and organizing the Prix Ars Electronica, 1996–2020 artistic co-director (together with Gerfried Stocker) of the Ars Electronica Festival.

Ars Electronica quickly gained worldwide renown, and in 1987 the festival was complemented by an international competition for computer arts awarding prizes for creative achievements in computer graphics, animation, and computer music, and–later–also interactive art, the "Prix Ars Electronica." Christine Schöpf, head of the department for culture and science at the ORF in Upper Austria and involved in Ars Electronica almost from the very beginning, became responsible for conceiving and organizing the Prix Ars Electronica, which increased the international outreach of Ars Electronica and served as a stage for emerging art scenes and as a sensorium for new trends at the intersection of creativity and technology. Due to his conviction that from time to time you need to add a new element, at the beginning of the 1990s Hannes Leopoldseder began to promote the idea of a permanent home for Ars Electronica, lending it more institutional weight than an annual festival and award could ever gain. Backed up by the success of more than a decade of Ars Electronica and its transformatory effects on the city, which hoped to replace the image of the "steel city" with that of a future-oriented community, he managed to win the city's politicians for his vision of a "Museum of the Future." He secured a prominent site at the northern bridgehead of the Nibelungenbrücke, which connects the historic city center with another part of town, called Urfahr. In the early summer of 1995, a director to head the new institution was found in the person of media artist Gerfried Stocker (*1964) from the southern Austrian province of Styria. He quickly absorbed Hannes Leopoldseder's original vision and transformed it into his own vision of the new institution: "The aim was to provide a real-world proving ground for the vision of a new quality of participation and of empowerment of the individual via open networks and systems. This was a matter of emancipated enlightenment … . Enthusiasm not for the technology itself but for what you could do with it when you made the leap from the position of consumer to that of designer and producer."[2] Participation and empowerment of the people in their encounter with future technologies not only became a guiding line for the new Ars Electronica Center, which was due to open in September 1996, but was also to influence the vision of the Ars Electronica Futurelab, which would soon enter the scene.

2 Stocker, Gerfried, "Nothing Is As Fascinating As The Future," in: Leopoldseder, H., Schöpf, C. & Stocker, G. (eds.): *The Network for Art, Technology and Society—The First 30 Years. Ars Electronica 1979–2009,* Hatje Cantz Verlag, Ostfildern, 2009, p. 232.



Ars Electronica Center 1996. Elevator car with its floor projections showing a flight from the interior of the AEC into outer space. Original concept: Roy Ascott, realization: Ars Electronica Futurelab, Offenuber/ Palmetshofer



“The birth of the Futurelab was to a certain extent preprogrammed in Ars Electronica’s DNA, and it was probably just a matter of time until the right people came together at the right place and time to make it happen.”

Source: Stocker, Gerfried (2009). “Experimentation for the Sheer Enjoyment of It,” in *The Network for Art, Technology and Society. The First 30 Years. Ars Electronica 1979 – 2009*. Hatje Cantz Verlag, Ostfildern, p. 276.

Gerfried Stocker (*1964, AT). Media artist and engineer for communication technology. Co-founder of artists’ group x-space (together with Horst Hörtner) 1991–1995. Artistic director and co-CEO of Ars Electronica since 1995.

“The Ars Electronica Futurelab is a platform for outstanding talents. Keeping them on board with interesting projects and constantly attracting new people is key to the success of the Futurelab.”

Source: Diethard Schwarzmair and Markus Jandl in a conversation with the author, December 2020.

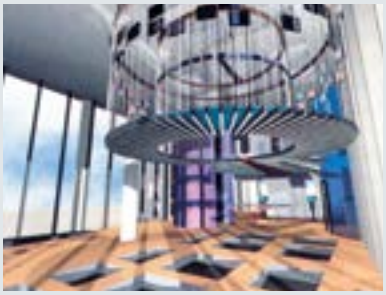
Diethard Schwarzmair (*1955, AT). Studied Economics at the University of Linz, completed Harvard Business School’s Advanced Management Program. He was secretary general of Austria Tabak AG and has held various positions on the advisory boards of companies. From 2009 – 2020 he was Co-CEO of Ars Electronica Linz GmbH.

Markus Jandl (*1982, AT). Studied Economics at Johannes Kepler University Linz. He has held various positions at Ars Electronica over many years. Since September 2020, he has been chief financial officer (CFO) and, together with Gerfried Stocker as Co-CEO, he manages the business of Ars Electronica Linz GmbH & Co KG and Ars Electronica International GmbH.

When he was appointed director of the new Ars Electronica Center in 1995, Gerfried Stocker asked the engineer and musician Horst Hörtner (*1965) to join him in Linz. "When, in 1995, I was presented with the once-in-a-lifetime opportunity to take on this assignment, it was crystal clear to me that I would need Horst Hörtner to do it."[3] Horst Hörtner, like Gerfried Stocker, came from Styria, and the two had met at their students' dormitory in Graz, where Hörtner was studying telematics and civil engineering at the time. Horst Hörtner's first computer was an Apple II, which may be significant regarding his approach to technology. The Apple II, developed by Steve Wozniak and introduced in 1977, was able to display color graphics and had—somewhat contrary to the later products from the same company—a remarkably open system design, ideal for the kind of hands-on experimentation that Horst Hörtner is dedicated to. Together, Horst Hörtner and Gerfried Stocker formed the artists' group and workshop x-space in 1991[4] and soon created projects, which they presented at such high-profile occasions as documenta IX in 1992 and EXPO'92 in Seville, at the Venice Biennale in 1993[5], at SIGGRAPH 94 in Orlando, Florida, and SIGGRAPH 95 in Los Angeles, California.[6] At Prix Ars Electronica 1993 they received Honorary Mentions for two of their projects[7], and at Prix Ars Electronica 1994 they won an Award of Distinction for their project *realtime.* They had soon found out that they shared not only an endless curiosity and a keen interest in technology, but also the disposition to go readily beyond their limits and to always seek new challenges. The project *horizontal radio,*[8] a 24-hour simultaneous radio network event about the topic of "migration," which combined radio and Internet to create an interactive communication network instead of traditional distribution media, was the final activity of x-space before they "migrated" to Linz for the "Ars Electronica adventure." When entering the one-year-long tunnel of intense work for turning the Ars Electronica Center into reality, they brought with them their varied skill sets, which complemented each other, as did their very different personalities. With these two media artists, who themselves embody the hybrid abilities and mindsets of artist-engineers in an exemplary way, the story of the Ars Electronica Futurelab commences, also proving true a thought expressed by Hannes Leopoldseder: "Within the computer artist, the scientist meets the artist."[9]

3 Stocker, Gerfried, "Experimentation for the Sheer Enjoyment of It," in op. cit., Hatje Cantz Verlag, Ostfildern, 2009, p. 276.
4 http://www.kunstradio.at/GERFRIED/kurzportrait.html
5 With "Winke winke," an "interactive communications project for one robot and many people" – http://www.kunstradio.at/GERFRIED/winke/index.htm
6 http://www.kunstradio.at/GERFRIED/theyears.html
7 The project trilogy "ein ohr allein ist noch kein wesen" and the project "Chipradio"
8 Coordinated by Gerfried Stocker in cooperation with the European Broadcasting Union (EBU), the ORF Kunstradio in Vienna, and TRANSIT in Tyrol – http://www.kunstradio.at/GERFRIED/horrad/horrad1.html
9 Leopoldseder, Hannes, "Foreword," in: Druckrey, T. & Ars Electronica (eds.): *Ars Electronica: Facing the Future—A Survey of Two Decades,* The MIT Press, Cambridge, Massachusetts / London, England, 1999, p. 7.

Ars Electronica Center



1991
First concepts and proposals
by Hannes Leopoldseder

1995
Gerfried Stocker appointed director, Horst Hörtner becomes technical director

1996
Opening of Ars Electronica Center—
Museum of the Future

2008
Move to temporary location during extension work on the old building and preparation of completely new exhibitions and installations

2009
Opening of new, extended
Ars Electronica Center
Lab Infrastructure

2015
Upgrade of Ars Electronica Center's Deep Space to 8K projection technology

2019
Complete thematic redesign of the Ars Electronica Center, opening of the exhibition "Understanding Artificial Intelligence"

At first, there was full concentration on finishing the Ars Electronica Center, and no talk yet about creating a "Futurelab." Horst Hörtner was appointed technical director of the Center and thus put in charge of technological matters, including conceptualizing, developing, and implementing the installations on all of the five floors of this new "Museum of the Future," as well as the technical infrastructure of the servers and network to run such an institution. Several things had been predefined before Stocker and Hörtner took over, but little was actually prepared for. This gave them the freedom to unfold their own vision of an institution that aimed at nothing less than becoming the prototype of a new kind of museum in the digital era, which it did. Horst Hörtner quickly began assembling a crew from a "new generation of hacker-artists,"[10] which would later become the core team of the Futurelab. Years later, when the success of the Ars Electronica Futurelab was already evident, Hörtner would sum up the role of his team from those early years: "The Futurelab is the ongoing proof of the fact that the dedication of a handful of people, their creativity and will to innovate, were able to turn groundbreaking ideas and ideals into a tangible reality, and a loose-knit crew of obsessed individuals could turn into an institution that has made a name for itself on the global media landscape."[11] Team members of the first hour included Chris Mutter, Oliver Frommel, Manuel Schilcher, Tom Teibler, Vaclav Cizkovsky, Dietmar Offenhuber, Gerda Palmetshofer, and Matthew Smith. What perhaps best describes the intense working atmosphere of those early months of the "Futurelab before the Futurelab" is their space on the first floor of a small building ducked behind the towering construction site of the Ars Electronica Center. There was only a single room covering the entire floor, with walls lined with tables. Everybody worked there facing outwards, with several computers and monitors in front of each person simultaneously running different jobs. At certain times during the day as well as the long nights, a meeting would be called by someone from the team, and everybody would turn inwards and roll their swivel chairs towards a huge table in the center of the room. That table bore the traces of this rapid-prototyping marathon, cluttered with empty coffee cups, full ashtrays, and the usual cans of energy drinks. Gerfried Stocker remembered that situation in 1996: "Even in the months prior to the official inauguration, the working atmosphere at the Ars Electronica Center was not one of sterile process control—it was more like an open workshop in which intelligences tested the capabilities of the equipment … ."[12]

10 Stocker, Gerfried, "Vector in Open Space," in: Stocker, G. & Schöpf, C. (eds.): *Memesis—The Future of Evolution,* Ars Electronica 96, Springer Verlag, Vienna/New York, 1996, p. 22.

11 Hörtner, Horst, "The Ars Electronica Futurelab—From Server Crash to Atelier/Laboratory," in op. cit., Hatje Cantz Verlag, Ostfildern, 2009, p. 288.

12 Stocker, Gerfried, "Vector in Open Space," in op. cit., Springer Verlag, Vienna/New York, 1996, p. 22.

"The Futurelab is the ongoing proof of the fact that the dedication of a handful of people, their creativity and will to innovate, were able to turn groundbreaking ideas and ideals into a tangible reality, and a loose-knit crew of obsessed individuals could turn into an institution that has made a name for itself on the global media landscape."

Source: Hörtner, Horst (2009). "The Ars Electronica Futurelab—From Server Crash to Atelier/Laboratory," in *The Network for Art, Technology and Society. The First 30 Years. Ars Electronica 1979 – 2009.* Hatje Cantz Verlag, Ostfildern, p. 288.

Horst Hörtner (*1965, AT). Media artist, musician, and researcher. Expert in Human Computer Interaction. Co-founder of artists' group x-space (together with Gerfried Stocker) 1991–1995. 1996, technical director of Ars Electronica Center. Co-founder and Managing Director of Ars Electronica Futurelab since 1996. Since 2020 he is also CTO of Ars Electronica.

The Ars Electronica Center opened in September 1996 during the first Festival shaped by Gerfried Stocker as artistic director of Ars Electronica, which had the title *MEMESIS—The Future of Evolution.* The "Museum of the Future" impressed an international audience as well as the population of Linz and Upper Austria with an array of cutting-edge installations including virtual reality and simulation, robotics and online community, and aspects of the city of the future. Several of the later research topics of the Futurelab could be traced from their starting points in the installations of the Center. So both in terms of areas of research as well as in terms of the historical flow of events, the Ars Electronica Center can be seen as a kind of incubator of the Futurelab. Ironically, it was the "pre-natal" Futurelab itself that stood behind the installations of the Ars Electronica Center, thus in a way engineering its own incubator. "The birth of the Futurelab was to a certain extent preprogrammed in Ars Electronica's DNA, and it was probably just a matter of time until the right people came together at the right place and time to make it happen," is how Gerfried Stocker described the situation.[13] There were discussions about what "future" should mean in the context of their work.[14] And then, someone said "Futurelab," and the name stuck.[15] In the fall of 1996, the "Ars Electronica Futurelab" was officially founded, joining Festival, Prix, and Center as the "fourth pillar of Ars Electronica."[16]

Ten years previously, Hannes Leopoldseder had characterized exactly the kinds of people who would now form the Ars Electronica Futurelab: "Painters, designers, composers, graphic artists working as computer programmers in their relevant spheres of art do not only receive a new tool—the computer also demands a new way of thinking. The computer brings forth a new type of universal artist—in the sense of Leonardo da Vinci."[17] The founding of the Ars Electronica Futurelab was not only a logical consequence of the insight, gained during the preparation of the Ars Electronica Center, that in order to keep this institution state-of-the-art in a world of quickly moving technological development they would need their own laboratory to come up with ever new installations. Futurelab researcher Peter Freudling indicates that there is more to it: "It is vital to have a 'living organism' behind a museum like this, so that people can 'feel' that there is somebody taking care."[18] In fact, the entire cultural system of Ars Electronica—with Festival, Prix, and Center—needed such a special kind of laboratory in order to fulfill its mission of working at the nexus of art, technology, and society.

13 Stocker, Gerfried, "Experimentation for the Sheer Enjoyment of It," in op. cit., Hatje Cantz Verlag, Ostfildern, 2009, p. 276.
14 Victoria Vesna, in a conversation with the author, February 2021.
15 Christopher Lindinger, in a conversation with the author, November 2020.
16 For a summary of the incubation phase of the Futurelab also see the chapter: "Finding Out What the Future of the Laboratory and a Laboratory of the Future Could Be," in: Hirsch, A. J.: *Creating the Future—A Brief History of Ars Electronica 1979–2019,* Hatje Cantz Verlag, Berlin, 2019, p. 163ff.

Ars Electronica Team 2009

Christine Schöpf, who served as a co-director of the Ars Electronica Festival for many years, put it in a nutshell: “Every idea and every project needs allies, people who believe in visions, and others who allow themselves to be inspired by these visions. At certain times, natural born fighters with a dash of guerilla mentality are needed, and a certain degree of tenacity and the power of conviction. Ars Electronica has been blessed with all of these … .”[19]

17 Leopoldseder, Hannes, “Ten Indications of an Emerging Computer Culture” (1986), in op. cit., The MIT Press, Cambridge, Massachusetts / London, England, 1999, p. 69.

18 Peter Freudling, in an exchange with the author, December 2020. It should be mentioned that there is another “human factor” with a crucial role for the success of the Ars Electronica Center: the crew of “infotrainers,” who, since the beginning, have formed a human interface of the Center for visitors.

19 Schöpf, Christine, “The Making of …,” in op. cit., Hatje Cantz Verlag, Ostfildern, 2009, p. 21.

Milestones in the History of
Ars Electronica Futurelab

1995/96
Incubation phase of designing, creating, and implementing installations for Ars Electronica Center—Museum of the Future including implementation of the CAVE

1996
Founding of Ars Electronica Futurelab—Ars Electronica's 'fourth pillar'

1997
First collaborations with academic institutions and first industrial commissions

2002
Ars Electronica Futurelab moves into its own premises and laboratory space in a commercial building close to the Ars Electronica Center

2004
First commissions from international corporate clients

2008
Work on the creation of the relaunch and architectural expansion of Ars Electronica Center, including Deep Space, a spacious projection aera for ultra-high-definition worlds of imagery which features 8 stereo HD projectors, projecting on a 16x9-meter wall and floor surface.

2009
Ars Electronica Futurelab moves into its own premises in a separate part of the new Ars Electronica Center building and undergoes a restructuring process

2012
Key role of Ars Electronica Futurelab in the creation of Klangwolke 2012 (Cloud of Sound), including the first public performance of Spaxels

2012
Ars Electronica Solutions is established as a spin-off of Ars Electronica Futurelab to bring the creations and prototypes that emerge from the Ars Electronica ecosystem to the market

2014
Start of *Art Thinking* program in cooperation with Japanese agency Hakuhodo

2015
Upgrade of Ars Electronica Center's Deep Space to 8K projection technology

2019
Complete thematic redesign of Ars Electronica Center with a clear focus on AI, featuring the *Understanding Artificial Intelligence* exhibition

2020
Start of Ars Electronica Futurelab's Ideas Expedition program as it prepares for its 25th anniversary in 2021

2021
25th anniversary Ars Electronica Futurelab

Quite in tune with the spirit of Ars Electronica, the Futurelab became an agile, ever-changing and self-reinventing "Laboratory of the Future," and thus also a kind of self-reflecting prototype making it possible to explore what "the future of the laboratory" should look like. The key for achieving such a daring task may lie—as Ars Electronica co-founder Herbert W. Franke put it—in understanding the arts themselves as the actual laboratory: "In fact the arts have a special role to play—as a laboratory for the innovations of the digital age, where new ideas are developed and tested in all their potential applications."[20] Art may in fact be the "prima materia" in the alchemical processes taking place inside the Ars Electronica Futurelab, which lead to new insights and fresh approaches. Hideaki Ogawa, Futurelab co-director and director of Ars Electronica Japan, points in this direction, also quoting from the French artist Marcel Duchamp (1887–1968), a key figure for Surrealism and Modernity in general: "Alchemy is a kind of philosophy: a kind of thinking that leads to a way of understanding." Ogawa notes: "Alchemy used to be a practice derived from a mixture of art and science. If we follow Duchamp's definition, it is alchemy, a philosophy that leads to a way of understanding, that is most called for in this era."[21]

Meanwhile, over a quarter of a century, the Ars Electronica Futurelab has cultivated the art of asking important questions about the implications of new technologies on our lives and our societies and thus dived into one area of research after the other. Over the last couple of years, the dynamic advances of key drivers of technological development—like digital media, artificial intelligence, and genetic engineering—have led to extremes in public perception, ranging from enthusiastic expectations to alarmist apocalyptic scenarios. Enabling a balanced and fact-based understanding beyond utopia and dystopia, always grounded in personal experience with the actual technology, is a main concern in the work of the Ars Electronica Futurelab. This includes questions about desirable ways of humans' collaborating and co-existing with autonomous machines or of relating to the world through various kinds of digitally created realities. All those numerous and challenging questions ultimately lead up to the core question of how we want to live in the future. "The special role of the Futurelab lies in finding an intuitive approach to the different topics and through this triggering innovation processes,"[22] as Roland Haring, technical director of the Futurelab, points out. Due to the transdisciplinary character of the Ars Electronica Futurelab and its hybrid identity as an atelier-laboratory, the different research areas are not mapped to strictly defined categories or even departments, but rather form a swarm of constantly self-reconfiguring threads of key research.

20 Franke, Herbert W., "From the Ars Ex Machina to the Ars Electronica Center," in: Stocker, G., Janko, S. & Leopoldseder, H. (eds.): *Ars Electronica Center—Museum of the Future,* 1996, p. 58.

21 Ogawa, Hideaki, "the alchemists of our time," in: Stocker, G., Schöpf, C. & Leopoldseder, H. (eds.): *RADICAL ATOMS and the alchemists of our time,* Hatje Cantz Verlag, Berlin, 2016, p. 68.

22 Roland Haring, in a conversation with the author, October 2020.

“Ars Electronica Futurelab is a laboratory and atelier for the future systems of the world. Creating tangible results using the artistic approach has always been a consistent element in our projects. The projects are presented widely to the public and society. The feedback promotes dialogue to discuss the future of technology in society. That is our mission.”

Source: Hideaki Owaga, in a conversation with the author, December 2020.

Hideaki Ogawa (*1977, JP). Creative catalyst, artist, educator, curator, and researcher in the field of art, technology, and society. Artistic director of the media artist group h.o. Member of Ars Electronica Futurelab since 2007. Founding director of Ars Electronica Japan since 2016. Co-director of Ars Electronica Futurelab since 2019.

The attempt to chart the unknown territories of future technology and their emerging implications, which the Ars Electronica Futurelab—often far ahead of its time—has been exploring for a quarter of a century, is of course almost as daring as so many of the Futurelab's own projects. The Futurelab draws, as former co-director Christopher Lindinger put it, "its credibility from being a seismograph for future topics."[23] Gerfried Stocker links this with the special role of media art: "Media art is inseparable from the technological developments of the age, and that makes it into a laboratory for the future."[24] So the journey will take us across a thematic landscape of co-immersion in virtual worlds and cooperative interaction in digital cities, of human encounters with well-informed swarms of autonomous vehicles, of bio-coding new and smart materials, of enabling a critical knowledge-based understanding of artificial intelligence, and of reflecting on the human condition of creativity when confronted with music or writing originating from an AI.

With this, naturally, comes the wish to decode the DNA of the phenomenon "Ars Electronica Futurelab" itself, to learn about its inner workings, and to tune into a "Futurelab state of mind"—in other words, to get a glimpse inside that laboratory of the "Alchemists of the Future." It would not be the Ars Electronica Futurelab, had it not—due to its inherent ability of self-reflecting and self-reinventing—been led to develop a mindset format for grasping the essence of this way of working. The Futurelab calls this mindset "Art Thinking," based on an understanding of art that Hideaki Ogawa describes as "a catalyst for shaping a better future society, a way to open up new perspectives, encourage curiosity to look at what is behind the scenes and to stimulate creative solutions."[25] Before we actually reach that meta-level of the Ars Electronica Futurelab, our exploratory journey begins by diving into deep immersion in the manifold virtual worlds that it has created over the years.

Inside Futurelab (2020). Hide Ogawa explaining the concept of "Art Thinking."

23 Christopher Lindinger, in a conversation with the author, November 2020.

24 Stocker, Gerfried, "CODE—the Language of Our Time," in: Stocker, G. & Schöpf, C. (eds.): *CODE—the Language of Our Time,* Ars Electronica 2003, Hatje Cantz Verlag, Ostfildern, 2003, p. 11.

25 Ogawa, Hideaki, "Art Thinking," in: Leopoldseder, H., Schöpf, C. & Stocker, G. (eds.): *In Kepler's Gardens—A global journey mapping the 'new' world,* Hatje Cantz Verlag, Berlin, 2020, p. 379.

Virtual Worlds

The Promise of Shared Immersive Insight

Together with the mind, the human hand is the embodiment of what human beings are about. “The hand is the window on to the mind,” as Immanuel Kant (1724–1804), the German philosopher of the Enlightenment, remarked.[1] The idea of the “intelligent hand” refers to its importance in the development of *Homo Sapiens* and used to find its most prominent realization in the mastery of traditional handcrafts, the virtuoso playing of a musical instrument, personal handwriting, or a surgeon guiding a scalpel through a body. The anatomical drawing shows a hand in meticulous detail, fruit of the study and dissecting of corpses, a taboo until the Renaissance. Leonardo da Vinci made this picture in the second phase of his anatomical drawings, which not only instructed his work as a painter, but also were driven by an immense curiosity, which made him conduct wide-ranging studies of nature. “His quest for knowledge across all the disciplines of arts and sciences helped him see patterns. … this cross-disciplinary thinking and pattern-seeking was his hallmark as the quintessential Renaissance Man, and it made him a pioneer of scientific humanism,” his biographer Walter Isaacson observed.[2]

More than half a millennium later, da Vinci’s anatomical drawing of a human hand is projected unto a huge scale, seconds before the sepia-toned picture fades away and is replaced by a digitally created image of a human hand, this time intensely colorful and three-dimensional, hovering in mid-air, and ready to be inspected from all sides in photorealistic detail. One by one, all the layers of the hand in a living body are rendered visible, including skin, filled blood vessels, muscles, organs, and bones. The scene of this anatomy lecture is the Deep Space 8K at the Ars Electronica Center, where Professor Franz Fellner, at the time head of radiology at Linz General Hospital, explains this new and revolutionary form of *Virtual Anatomy.*

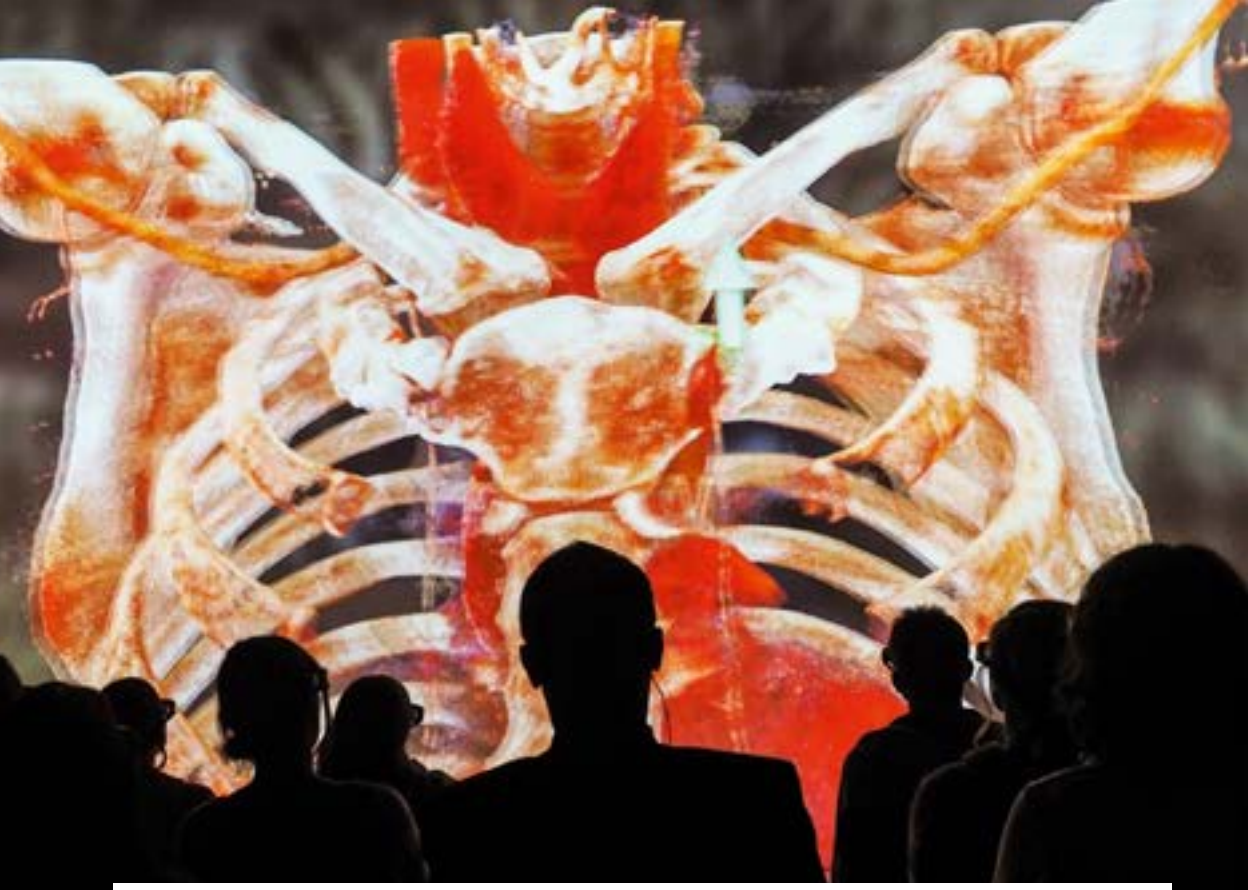
Cinematic Rendering, Siemens Healthineers, Deep Space 8K, Ars Electronica Center

1 Quoted from: Sennett, Richard, *The Craftsman,* Yale University Press, New Haven / New York, 2008, p. 149. Sennett himself quotes Kant from a quote in a book by Raymond Tallis, so this may be a somewhat remote attribution, which does not seem to diminish the relevance of the statement. In his chapter “The Hand,” Sennett goes much deeper into the concepts referred to here.

2 Isaacson, Walter, *Leonardo da Vinci—The Biography,* Simon & Schuster, London, 2017, p. 400–401.

On this day in 2015, the simulation environment of the Deep Space 8K—with its live rendering of stereoscopic, high-resolution images—turns into a huge, modern-day version of an anatomical theater. There is no corpse on a faraway dissecting table being sliced apart; rather, everything can be regarded close up and in great detail as often as needed. Professor Fellner explains the method for visualization of radiological imaging data behind this: *Cinematic Rendering* resulted from a combination of medical imaging technologies like magnetic resonance imaging (MRI) and computer tomography (CT) with technologies from digital filmmaking, which turn the gray-scale data clouds into 3D models appearing in realistic lighting, with coloring added to help differentiate the structural components of the human body. Virtual anatomy surpasses the 1,500-page tome of *Gray's Anatomy,* which has been the standard for the study of anatomy since the publication of its first edition in 1858. The British anatomist and surgeon Henry Gray (1827–1861) and the anatomical artist Henry Vandyke Carter (1831–1897) had based their anatomy on 18 months of dissecting unclaimed bodies from workhouse and hospital mortuaries and thus created a standardized view of the human body, as did later digital tools for anatomical studies. *Virtual Anatomy* replaces such standard models with images based on the medical imaging data from living patients, and thus brings the study much closer to the experience of an actual medical practice.

Virtual Anatomy at the Deep Space 8K of the Ars Electronica Center was developed by the Ars Electronica Futurelab in cooperation with Professor Fellner and Siemens Healthineers. Fellner had taken the initiative to bring together the Ars Electronica Futurelab and Siemens Healthineers, where Klaus Engel and his team had developed *Cinematic Rendering. Virtual Anatomy* is an excellent example of the kinds of alliances the Ars Electronica Futurelab frequently enters, having followed a path of open-minded cooperation with both academia and industry since the early days of its history. *Virtual Anatomy* made use of the ability of the Deep Space 8K simulation environment to become all kinds of spaces, including an anatomical theater, and thus offer a shared immersive experience for up to 120 visitors at the same time. Medical students from the Johannes Kepler University came to the Ars Electronica Center for their lectures in anatomy, and members of an interested public also attended the presentations held by Professor Fellner with great enthusiasm for the subject and the revolutionary method of teaching it. Deep Space 8K is one of the major achievements of the Ars Electronica Futurelab, a prototypical piece of infrastructure for far-reaching and in-depth exploration of many aspects of immersion in virtual worlds and of collaboration in virtual environments. First inaugurated in 2009 and upgraded to 8K projection technology in 2015, Deep Space 8K is a core instrument in the quest of the Ars Electronica Futurelab to push the envelope ever further into the "virtual worlds" of the future.



Virtual Anatomy

Type: Immersive Environment, Deep Space 8K
Location: Ars Electronica Center, Linz, Austria
Year: Since 2014

Special features / key technologies:
VR, real-time graphics, CGI, 8K,
higher education

Ultra-high-resolution projections of anatomical CT and MRI data in 16×9-meter format. Rendered in stunning visual quality, the images can also be displayed in 3D stereo. *Virtual Anatomy* was developed in collaboration with Professor Franz Fellner of the Department of Radiology at Kepler University Hospital Linz, as medical scientific director, and Siemens Healthineers. Virtual reality technology and medical science come together to depict anatomical information stereoscopically and with an unprecedented depth of field. An “Anatomy for All” lecture series makes scientific achievements accessible to a wider audience and medical training is enhanced by three-dimensional, visual learning experiences in addition to the traditional anatomy book.

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The Virtual Reality Theater of the CAVE

The entanglement of the Ars Electronica Futurelab with the entire range of what may be considered "virtual worlds"—from virtual reality (VR) to augmented reality (AR) onwards to mixed reality (MR) and their summarization in concepts of extended realities (XR)—goes right back to the early days of the Futurelab in 1996, making it one of the key areas of its work through this entire quarter of a century. Within this span of time, however, virtual reality underwent numerous cycles of hype and de-hype, of heightened attention from industry and media followed by times of stagnation. But the Ars Electronica Futurelab, due to its special disposition at the nexus of art and science and its integration into the cultural system of Ars Electronica, always had the benefit of taking a separate path, as Roland Haring, technical director of the Futurelab, points out: "The Futurelab does not follow the hype-cycles of certain technologies, since it does not focus on consumer products. We were working with virtual reality and augmented reality at an early stage, long before the technologies for a mass market arrived. The topics continue to be interesting, but the Futurelab always keeps its highly individual approach to them."[3] This individual approach, among other factors, is nourished by a kind of meta-topic, which has been guiding the research interests of the Ars Electronica Futurelab until today: the question of social interaction and cooperation in virtual spaces and, ultimately, the vision of a future co-existence of humans and machines.

CAVE, Architectural Visualization, Ars Electronica Futurelab

3 Roland Haring, in a conversation with the author, March 2021.

“The Futurelab does not follow the hype cycles of certain techologies, since it does not focus on consumer products. We were working with virtual reality and augmented reality at an early stage, long before the technologies for a mass market arrived. The topics continue to be interesting, but the Futurelab always keeps its highly individual approach to them.”

Source: Roland Haring, in a conversation with the author, March 2021.

Roland Haring (*1975, AT). Media technologist, designer. Studied media technology and design at Hagenberg University of Applied Sciences. Member of the Ars Electronica Futurelab since 2003, technical director since 2014.

The story of virtual worlds and the Ars Electronica Futurelab began with the installation of a milestone development in VR, the so-called CAVE (Cave Automatic Virtual Environment) at the Ars Electronica Center in 1996. Daniel J. Sandin—together with Thomas A. DeFanti—had developed the CAVE in the early 1990s at the Electronic Visualization Laboratory (EVL) at the University of Illinois at Chicago and first presented it at SIGGRAPH '92. The CAVE broke new ground for VR in two key aspects: By allowing up to a dozen people in the space—a cube of a mere 3 x 3 x 3 meters—and by replacing bulky head-mounted-displays (HMD), which had isolated the user from the surroundings, with projections on three walls and the floor and only slim shutter glasses needed for perceiving the stereoscopic projection, the CAVE turned VR into a shared experience. As Daniel J. Sandin explains, CAVE, "the name selected for the virtual reality theater, is both a recursive acronym (Cave Automatic Virtual Environment) and a reference to 'The Allegory of the Cave' found in Plato's 'Republic', in which the philosopher explores the ideas of perception, reality, and illusion. Plato used the analogy of a person facing the back of a cave alive with shadows that are his/her only basis for ideas of what real objects are."[4] Both aspects, the experience of virtual worlds and the urge to dive deeper into questions of perception and reality, made the CAVE a perfect match for the new Ars Electronica Center and for the Futurelab. In fact, this first public installation of the CAVE—outside the United States and in a cultural institution—not only swiftly turned into a key attraction for the audiences of the "Museum of the Future," but also became a tool for artistic creation and experimentation as well as for research at the Ars Electronica Futurelab, and turned out to be a most valuable platform for their collaborations with academia and industry. For the city of Linz and the surrounding province of Upper Austria, the CAVE—together with other facilities at the Ars Electronica Center—quickly proved itself as a highly innovative public infrastructure, stimulating digital technology development and literacy in the entire region.

CAVE (1996), *Crayoland,* Dave Pape

4 Sandin, Daniel J., "CAVE—The Virtual Theater," in: Stocker, G., Janko, S. & Leopoldseder, H. (eds.): *Ars Electronica Center—Museum of the Future,* 1996, p. 85.

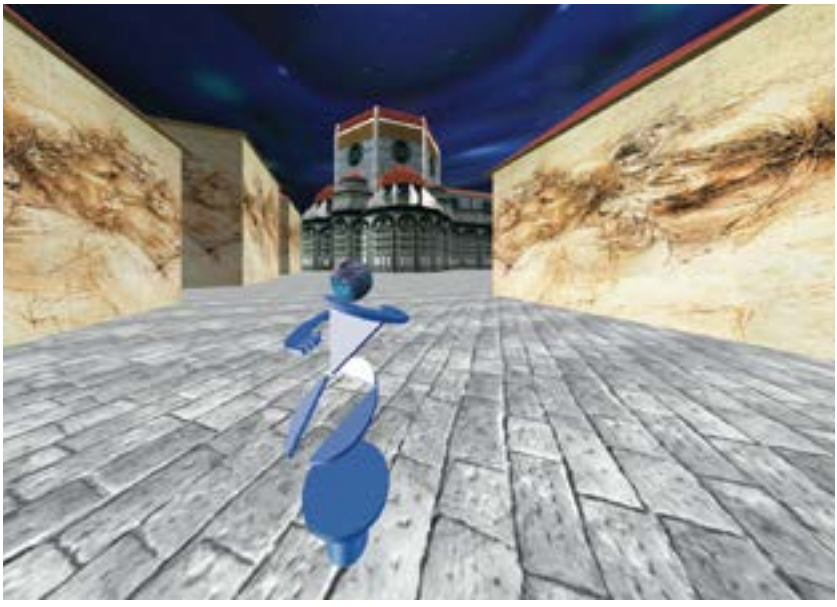
“We really thought that having access to these tools would change the way we saw the world, change our relationship to people and things, and change how we viewed ourselves.”

Source: Interview with Dan Sandin by Tobi Jonson, in: Video: The Center for New Television, Chicago, November/December 1992, https://mediaburn.org/document/ video-the-center-for-new-television-novdec-92

Daniel J. Sandin (*1942, US). Video and computer graphics artist. Co-founder of the Electronic Visualization Laboratory (EVL) in 1972 (together with Thomas A. DeFanti), professor at the School of Art & Design, University of Illinois Chicago. Inventor of the “Sandin Image Processor” (1971–1973) and the CAVE (together with Thomas A. DeFanti and Carolina Cruz-Neira) in 1992.

Dan Sandin visiting the CAVE (1996) at the Ars Electronica Center

CAVE, *Gesichtsraum,* Johannes Deutsch



CAVE, *Multi Mega Book,* Franz Fischnaller

CAVE

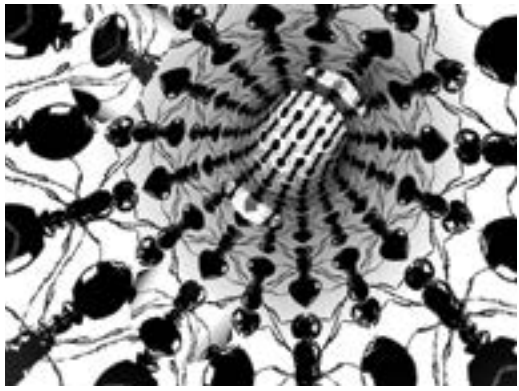
Type: Immersive Environments
Location: Ars Electronica Center, Linz, Austria
Year(s): 1996–2007

Special features / key technologies:
VR, real-time graphics, CGI, education

CAVE (acronym for “Cave Automatic Virtual Environment”), an immersive virtual reality installation with 3D-stereo projections on three sides plus the floor of a 3x3m cube. Visitors to the CAVE were not merely spectators: they became immersed in the projected worlds and interacted with the environment.
This was the first CAVE outside of the US and the first to be continuously open to the public and used by media artists and artist-developer teams.

https://u.aec.at/D80C8F99

While many virtual reality projects at the time were clearly striving to create environments that would feel as "real" as possible, the CAVE project designed by Austrian multimedia artist Peter Kogler in 1999 in cooperation with the Ars Electronica Futurelab deliberately went in a different direction. It contained a system of underground spaces with narrow tunnels and caves, all populated by giant ants. The environment let users wander through a maze that ultimately appeared to be the artist's brain, all the time feeling explicitly "unreal." On a different note, the project *World Skin* resulting from a collaboration of the French artist Maurice Benayoun and the French composer Jean-Baptist Barrière with Ars Electronica Futurelab immersed users in photographic scenes of war, allowing them—while roaming a battlefield—the interactive option of removing parts of the scene by taking pictures, which were subsequently handed to them as printed "cutouts." In 1998, *World Skin* became the only CAVE project ever to win a Golden Nica in the category Interactive Art of Prix Ars Electronica. Both applications created immersion not only through the visual sense, but also through spatial sound and the physical presence of one's own body and position in the simulation space. Additionally, the human hand—at least for the one person in the group operating the controller—was needed to navigate the virtual environments in the CAVE. Christopher Lindinger, who had joined the Ars Electronica Futurelab in its early years, describes the CAVE as an "environment for aesthetic experimentation, a virtual space free from the laws of physics, subject only to the psychology of the user."[5] In such an environment, you could wander around through an artist's brain and explore your own notions of reality and self. Eventually you might also hold your breath to ponder a remark that Derrick de Kerckhove, a close collaborator of the Canadian philosopher Marshall McLuhan (1911–1980) and head of the McLuhan Program, had made in 1990 at the Ars Electronica Festival: "Virtual Reality could just as well have been called 'Artificial Imagination'."[6]



CAVE, *CAVE* (1999),
Peter Kogler, Franz Pomassl

5 Christopher Lindinger, in a conversation with the author, December 2020.

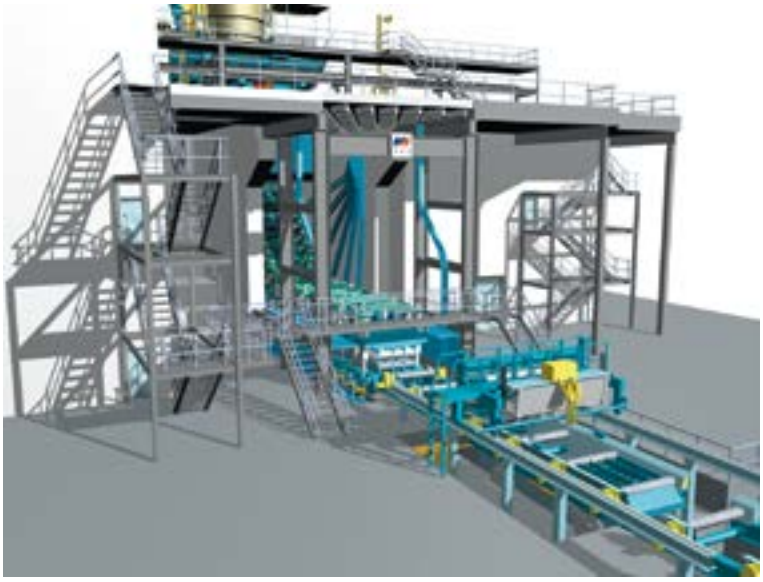
6 de Kerckhove, Derrick, "Virtual Reality for Collective Cognitive Processing," in: Hattinger, G. & Weibel, P. (eds.): *Virtual Worlds,* Vol. 2, Ars Electronica, Linz, 1990.

CAVE, *World Skin, a Photo Safari in the Land of War* (1997), Maurice Benayoun, Jean-Baptiste Barriere

CAVE, *Karma* (2004), Kurt Hentschläger

The Art of Making a Name with Academia and Industry

It had always been one of the arguments for a broader use of VR, that in a VR simulation you could do things you would not—or at least not in a safe or economically sound way—be able to perform in reality. This ability also predestined the CAVE to become a viable tool for prototyping and design, and thus a door-opener for the Ars Electronica Futurelab when approaching industries. In those first, formative years of the Ars Electronica Futurelab, following 1996, a very diverse team had formed, with a wide range of educational backgrounds. Gerda Palmetshofer remembers: "It was 'being active' in a field on the cutting edge, with desires and possibilities translated into their formation and realization. I experienced it as pioneering work in a flat hierarchy, with a component that allowed for trying things out, for experimenting, and for playing with ideas. Discovering that I was the first woman in the lab: it simply did not make a difference. An open approach, a networked way of thinking across different disciplines, and a fundamental understanding of the technological level within society shaped my attitude and outlook." Throughout those early years a key aspect soon became apparent, as Horst Hörtner noted: "The concept of an atelier/laboratory as a proving ground and workshop for solutions exhibiting the application of both artistic and technical skills was also connected with the idea of implementing an economically sustainable model."[7]



CAVE
VAI Training Simulator (2000)

Virtual Reality simulator for a continuous casting plant for steel processing.

7 Hörtner, Horst, "The Ars Electronica Futurelab—From Server Crash to Atelier/Laboratory," in: Leopoldseder, H., Schöpf, C. & Stocker, G. (eds.): *The Network for Art, Technology and Society. The First 30 Years. Ars Electronica 1979–2009,* Hatje Cantz Verlag, Ostfildern, 2009, p. 280.

“It was ‘being active’ in a field on the cutting edge, with desires and possibilities translated into their formation and realization. I experienced it as pioneering work in a flat hierarchy, with a component that allowed for trying things out, for experimenting, and for playing with ideas. Discovering that I was the first woman in the lab: it simply did not make a difference. An open approach, a networked way of thinking across different disciplines, and a fundamental understanding of the technological level within society shaped my attitude and outlook.”

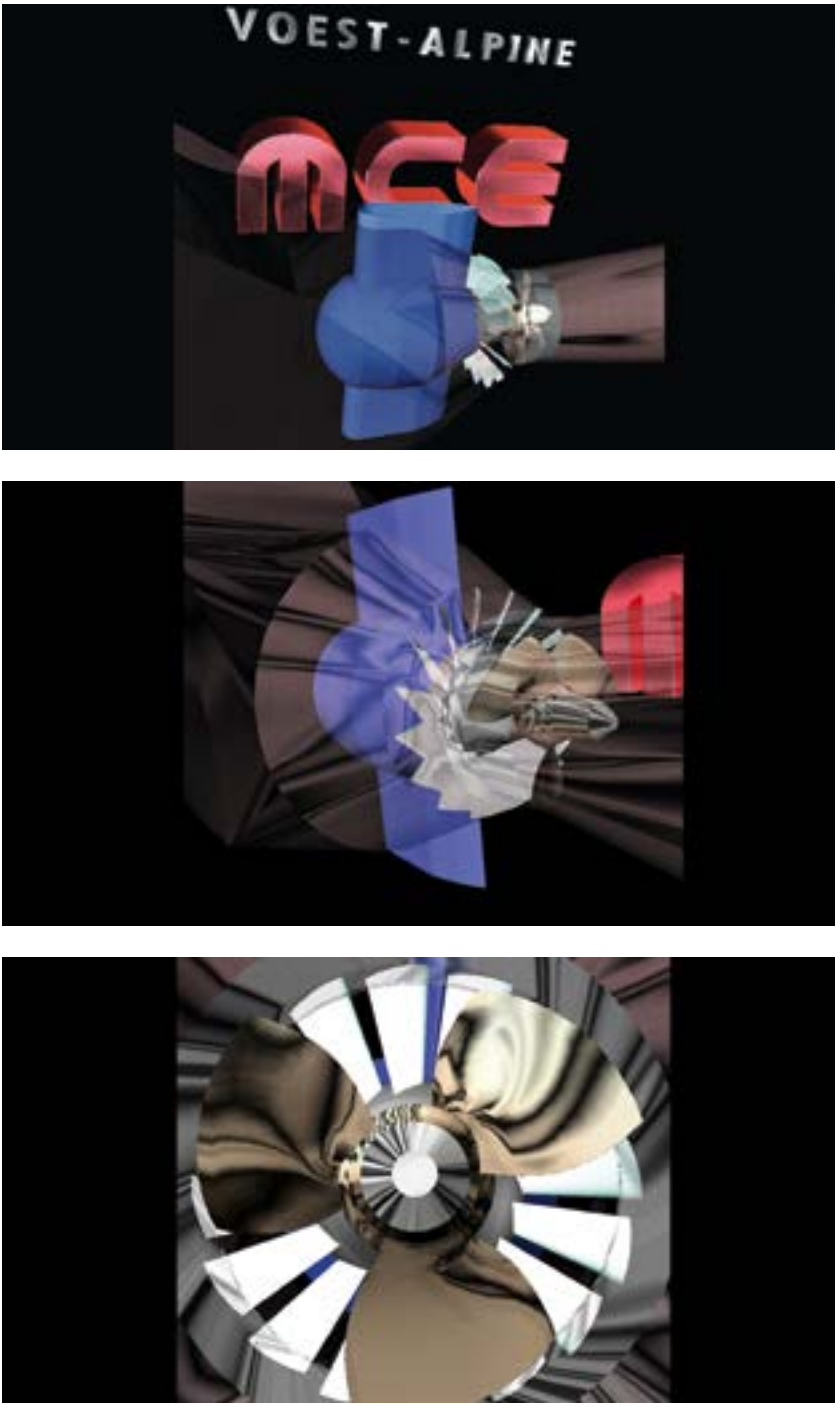
Source: Gerda Palmetshofer, in a conversation with the author, July 2021.

Gerda Palmetshofer (AT). Studied architecture. Founding member of Relais—interface solutions and member of the Ars Electronica Futurelab from 1996–2000. Active since 2003 in the fields of visual communication, theory, and process design at the nexus of sustainability/transformation research and society. 2010–20: co-creator of the initiative Growth in Transition and member of the Advisory Board of HuBIT for Responsible Research Innovation since 2018.

“Sensitivity to the necessity of invention, to transformation and synergies of the technically feasible and the intuitively conceivable—insights and capabilities that are, by definition, the artist’s forte—will be increasingly important for (technological) innovation in the future.”

Source: Pomberger, Gustav, “Elective Affinities,” in: Leopoldseder, H., Schöpf, C. & Stocker, G. (eds.): *The Network for Art, Technology and Society. The First 30 Years. Ars Electronica 1979–2009,* Hatje Cantz Verlag, Ostfildern, 2009, p. 296

Gustav Pomberger (*1949, AT). Computer scientist. 1987–2017 head of the Department of Business Informatics—Software Engineering at Johannes Kepler University Linz. Since 2018, chairman of the University Council of the Art University Linz and academic head of the University of Applied Sciences Upper Austria.



CAVE, simulation of turbine flows (1996), MCE, voestalpine

Those first steps into the market were fortunately also aided by a human "door-opener." Gustav Pomberger had been a friend of Ars Electronica since the day he joined the delegation that had driven out to Linz Airport to welcome the robot SPA 12 in 1979. Over the years, the professor of software engineering at Johannes Kepler University in Linz turned into a close ally of the organization and then into a mentor for the young team of the Ars Electronica Futurelab. At an early stage, Gustav Pomberger had developed an understanding that would require some time to be also accepted in the wider circles of academic researchers and industrial research and development laboratories: "Sensitivity to the necessity of invention, to transformation and synergies of the technically feasible and the intuitively conceivable—insights and capabilities that are, by definition, the artist's forte—will be increasingly important for (technological) innovation in the future."[8] Gustav Pomberger and Horst Hörtner, belonging to different generations, shared an attitude of liberality, which gave the younger members of their teams support and encouragement to work freely with the ideas of those who came before them.[9] Consequently, Pomberger showed no fear of contact with Horst Hörtner's group of "hacker artists," but rather enjoyed exchange and collaboration with them. It was Pomberger's own standing with his partners from industry that helped open doors for the long-haired crew of the Ars Electronica Futurelab. Surely, their superb command of the CAVE and their—also internationally sought-after—development know-how concerning advanced virtual reality applications lured the white-collar engineers of large companies into giving the young Futurelab a try. In their very first year, they were able to obtain a commission to realize a CAVE project for the simulation of turbine flows for MCE, a subsidiary company of the leading industrial plant in Linz, the voestalpine steelworks.

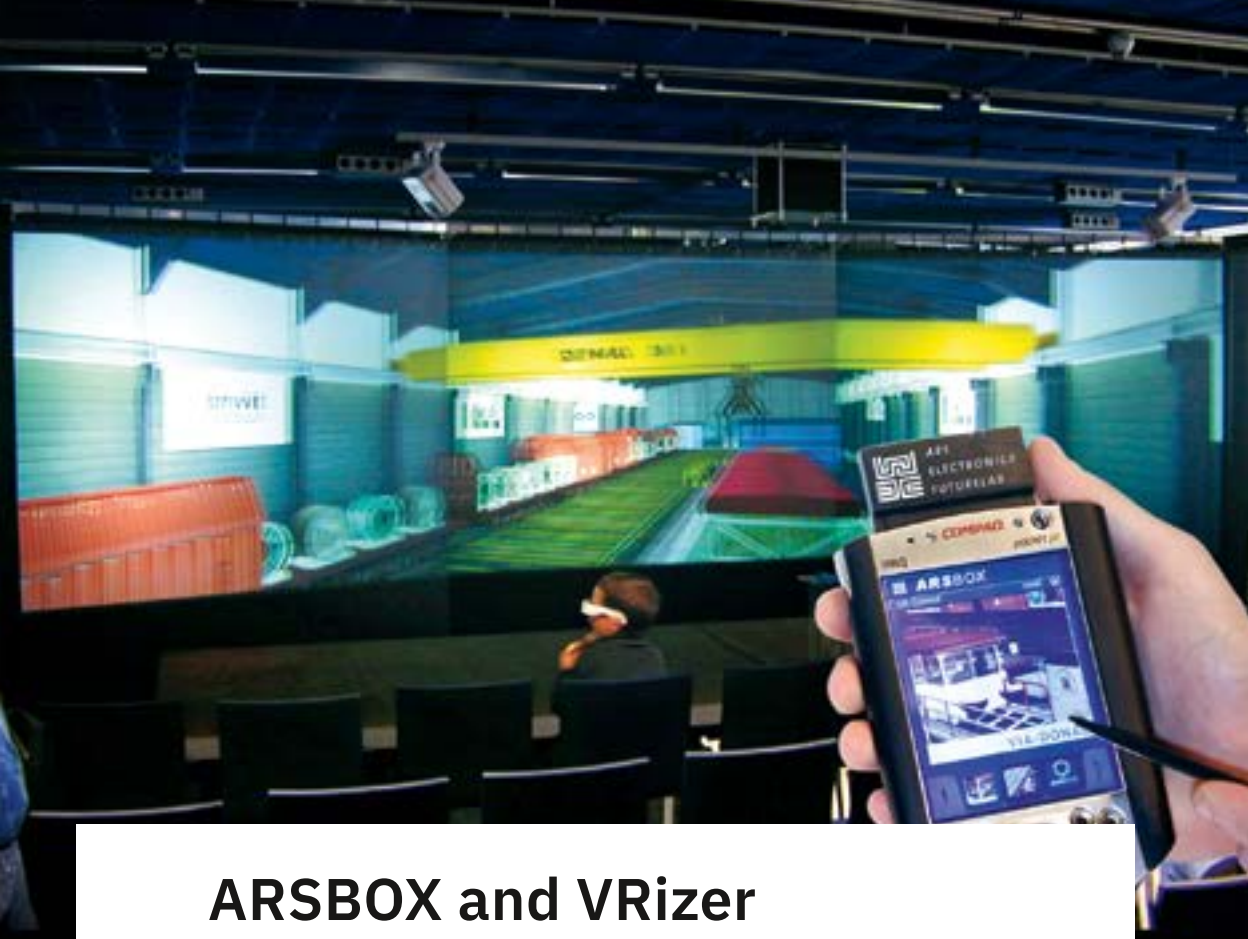
Mobile Workshop (1996). One of the world's first network-linked CAVE environments was created on the occasion of Siemens' 150th anniversary celebration. Users in Berlin and Linz could jointly assemble a cell phone and then use it to set up an audio/video linkup between the two locations.

8 Pomberger, Gustav, "Elective Affinities," in op. cit., Hatje Cantz Verlag, Ostfildern, 2009, p. 296.

9 Horst Hörtner, in a conversation with the author, March 2021.

Within a few years of working on new installations for the Ars Electronica Center as well as for a growing clientele of industry partners, the Futurelab was able to close the circle back to the scenes around SIGGRAPH and the world of EVL, where the CAVE had originated. One of the strengths of the CAVE had proven to be also one of its shortcomings. It was a highly advanced tool with only a limited number of developers available worldwide to create new programs for it, therefore well in demand. This exclusiveness also had to do with the CAVE's being based on a proprietary system, which required an array of expensive supercomputing hardware. For a long time, the virtual reality scene favored the opinion that it would not be possible to provide the computing power required for the functionalities of the CAVE with off-the-shelf PC hardware, which of course was available at a fraction of the costs. In the meantime, the SGI Onyx machines Ars Electronica had been able to obtain in 1996—through a spectacular and presumably unrepeatable sponsoring deal with Silicon Graphics—were aging, and it seemed unrealistic to hope to get the funds for replacements even near that price range. Besides those quite pressing economic factors, it was also their unconventional and daring mindset that made Horst Hörtner and his team accept this challenge. They finally came up with a sensational solution for a PC-based VR platform for the CAVE in 2001, called PC CAVE, which in the same year was followed by the development of the ARSBOX as a stereographic multimedia presentation unit.

ARSBOX (2001), a PC-based, stereographic, multimedia presentation unit



ARSBOX and VRizer

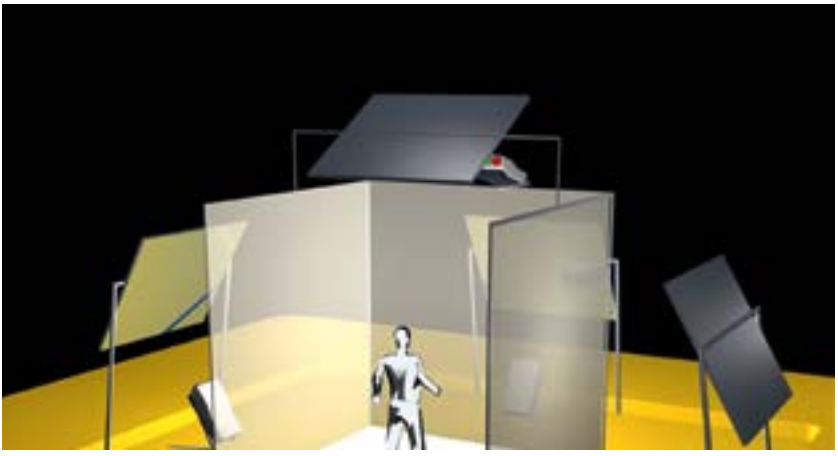
Type: Immersive environments
Location: Ars Electronica Center, Linz, Austria
Year(s): 2001, 2003

Special features / key technologies:
openGL, rendering, renderpipe, VR, linux, low-cost VR

The ARSBOX was not simply a PC Cave; it was a PC-based, stereographic, multimedia presentation unit, designed as a form of cross-media infrastructure for the presentation, development, and manipulation of a wide range of media contents. VRizer is a software that allowed early Game Engines to run on PCs utilizing active stereo, across several PCs and displays. VRizer was also used for the ARSBOX 2003: a 3D visualization infrastructure that used the latest technology for a graphical representation of data, setting new standards in the field of real-time computer graphics.
With the development of the software framework VRizer, Ars Electronica Futurelab closed the gap between applications based on game engines and high-end platforms like the ARSBOX and other elaborated VR devices. The software framework enables the user to make any OpenGL application compatible with any configuration of the ARSBOX in active and passive stereo mode.

https://u.aec.at/72E793F5

It was around this time that Horst Hörtner joined Daniel J. Sandin on a discussion panel at SIGGRAPH 2001 in Los Angeles, where Hörtner announced that they would be going to showcase the ARSBOX some four weeks later during the Ars Electronica Festival in Linz. After the panel, Hörtner called Christopher Lindinger in Linz and told him what he had just announced to the public. So they simply had to swiftly finish the already quite advanced development work and get the CAVE environment running on a cluster of PCs in time for the Festival. And they did. Hörtner proudly remarked later about this achievement: "... it was exactly 10 years after Dan Sandin and his team unveiled their CAVE at the world's largest conference for experts in computer graphics, SIGGRAPH 1992 in Chicago, that 'the guys from Linz' presented the first PC variant of the CAVE at SIGGRAPH 2002 in San Antonio, Texas: the ARSBOX (2001)." Daniel J. Sandin displayed a laid-back, community-oriented attitude, which in fact had provided the intellectual background for his work: "With the CAVE we had the concept of sharing the information and enabling others to build it themselves, rather than trying to simply sell it. Community was the most important thing for us. We would not get anywhere without users. We were also inspired by different cultural improvement ideas, like those you could find in the *Whole Earth Catalogue.* We were using technology to make art projects. Technology would educate you about images, and images would teach you about technologies."[10] There were apparent similarities between this approach at EVL and the spirit of the Ars Electronica Futurelab. Consequently, Sandin reacted to the ARSBOX as the Ars Electronica Futurelab would later react to others building upon their prototypes: "We were in fact pleased to learn about the ARSBOX, because you are successful when others pick up your ideas and carry them further."[11]



Rendering *ARSBOX* (2001)

10 Daniel J. Sandin, in a conversation with the author, March 2021.

11 Daniel J. Sandin, in a conversation with the author, March 2021.

Florian Berger, who had studied theoretical physics and joined the team of the Ars Electronica Futurelab in 2001, developed "VRizer," a software framework bridging the gap between widely used game engines and the hardware platform of the ARSBOX. "Ever since the Ars Electronica Futurelab was founded, an essential aspect of [the] agenda has been to come up with hardware and software that facilitates artists' access to extremely flexible, high-performance Virtual Reality systems."[12] Together, ARSBOX and VRizer opened up immersive, interactive, stereoscopic 3D worlds to a wider community of developers. This impulse in the work of the Ars Electronica Futurelab to enable access for wider circles of developers, and to make broader audiences acquainted with advanced technology, was a motivation well in sync with the overall ideas behind Ars Electronica ever since its beginnings in 1979. Moreover, ARSBOX and VRizer have since been used by the Ars Electronica Futurelab on various occasions and belong to an array of their developments, which are still in use up to this day.

ARSBOX (2001) virtual prototyping using a PALMIST, which allowed users not only to change static parameters but also to control the dynamics of a VR-world.

12 Berger, Florian, *VRizer – Using Arbitrary OpenGL Software in the CAVE or other Virtual Environments,* 2004.

“Ever since the Ars Electronica Futurelab was founded, an essential aspect of [the] agenda has been to come up with hardware and software that facilitates artists’ access to extremely flexible, high-performance Virtual Reality systems.”

Source: Berger, Florian, “VRizer—Using Arbitrary OpenGL Software in the CAVE or other Virtual Environments,” 2004

Florian Berger (*1972, AT). Studied theoretical physics at Johannes Kepler University Linz. Member of the Ars Electronica Futurelab since 2001. Applied research on realtime computer graphics, simulation, signal processing, and embedded systems.

ARSBOX (2001) virtual prototyping using a PALMIST, which allowed users not only to change static parameters but also to control the dynamics of a VR-world.

Art and Science Team Up to Navigate and Fly

Repeatedly during its history, the Ars Electronica Futurelab had created prototypes that were massively ahead of their time. Some of the Futurelab's visionary concepts were lacking the technology to be realized, others could be implemented as prototypes, but only with devices that still had a long road ahead of them to actually reach the market. But the Futurelab's focus on prototypes instead of products for the market has a clear conceptual background, as Christopher Lindinger explains: "The constant emphasis on creating prototypes is the key discovery strategy of the Ars Electronica Futurelab. These prototypes answer questions you wouldn't have asked in a purely theoretical discourse and provide an important anchor for discussing implications of technology."[13] The Futurelab team's mentor Gustav Pomberger, who in 1996 had published a seminal book[14] on prototyping, also proved to be the right partner to join them in making the step from virtual reality to augmented reality and in creating one of the exemplary prototypes in the history of the Ars Electronica Futurelab, the INSTAR navigation system. It all began with an invitation from Siemens to visit their department for "Corporate Technologies" in Munich. In the dialogue between those two highly different organizations—one with around 1,000 developers and the other with a total of 15 team members—they soon identified a shared area of interest, the unsatisfactory status quo of car navigation systems. INSTAR was created in 2002, a time when navigation systems still used maps in 2D, which many people had difficulties interpreting while driving; Google Maps would not appear until 2005, and smartphones with navigation apps even later, in 2007. During the development of INSTAR, the Ars Electronica Futurelab of course did not instruct Siemens on how to master their technology, but came up with an innovative solution for a simple and intuitive way of augmenting the actual road ahead and the information about the route to be taken.

13 Christopher Lindinger, in a conversation with the author, December 2020.

14 Pomberger, Gustav & Blaschek, Günther, *Software Engineering: Prototyping und objektorientierte Software-Entwicklung,* Hanser Verlag, 1996.

“The constant emphasis on creating prototypes is the key discovery strategy of the Ars Electronica Futurelab. These prototypes answer questions you wouldn’t have asked in a purely theoretical discourse and provide an important anchor for discussing implications of technology.”

Source: Christopher Lindinger, in a conversation with the author, December 2020.

Christopher Lindinger (*1977, AT). Computer scientist. Early member of the Ars Electronica Futurelab team, co-director of the Ars Electronica Futurelab from 2002–2019. Since 2019, vice-rector at Johannes Kepler University Linz.

Digital Graffiti (2003). Just as a graffiti artist sprays his messages on walls, the user of the *Digital Graffiti* system could leave behind information virtually in the public and private spheres and address it to a particular group of recipients.

INSTAR

Type: Research project
Location: Ars Electronica Center, Linz, Austria
Year(s): 2002

Special features / key technologies:
openGL, rendering, renderpipe, VR, linux, low-cost VR

INSTAR—Information and Navigation Systems Through Augmented Reality—was a research project to develop augmented reality applications for car navigation. A monitor on the driver's instrument panel displays a real-time video image from the driver's perspective that is overlaid with graphic route recommendations that help the driver to navigate intuitively. Siemens CT approached the Department of Business Computing at Johannes Kepler University Linz and Ars Electronica Futurelab about creating a VR application that would be of interest to the general public. Together they came up with the concept of INSTAR, which was then developed by a network of cooperation partners.

https://u.aec.at/A6536DDC

Heimfahrt (2001), Acrylic on wood 25×35 cm, Stefan Mittlböck-Jungwirth-Fohringer.
360 painted frames that describe the journey from Linz to Nebelberg resulted in a short video animation.

The peculiar way in which the Ars Electronica Futurelab arrived at this solution is significant for the close collaboration between art and science, which serves as a nourishing ground of their innovation capabilities. The artist Stefan Mittlböck-Jungwirth-Fohringer had joined the team of the Ars Electronica Futurelab in 2001, and kept his personal artistic production alive, which includes such "analog" art forms as painting and sculpture. Resident in a small village outside of Linz, he created an animated short film about his drive home from the city, with all the frames of the movie—showing the view of the road and landscape through the windshield—painted in acrylic colors on wood. It was this animated art movie, entitled *Heimfahrt* (Driving Home), with its roots in painting and its analogies to the situation of car navigation, that provided the decisive impulse for the final solution of augmenting a live camera image of the road ahead with a colored carpet-like arrow "paving" the route to be taken by the driver.[15] INSTAR was decidedly created to be used not only in car navigation, but also for other forms of mobility including pedestrians, who at that time did not have the attention they would later gain due to climate change. The system preceded today's standard use of augmented reality in navigation tools by several years and pioneered the completely intuitive interface model for it. The triangle of cooperation partners working together on this prototype in fact proved prototypical for future kinds of project architectures that the Ars Electronica Futurelab would enter with academia and industry.

15 Narzt, Wolfgang, Pomberger, Gustav & Ferscha, Alois, Johannes Kepler University Linz; Kolb, Dieter, Müller, Reiner & Wieghard, Jan, Siemens AG; Hörtner, Horst & Lindinger, Christopher, Ars Electronica Center Futurelab, "Pervasive Information Acquisition for Mobile AR-Navigation Systems," in: Stocker, G. & Schöpf, C. (eds.): *GOODBYE PRIVACY,* Ars Electronica 2007, Hatje Cantz Verlag, Ostfildern, 2007, p. 309.

The presence of virtual reality in the work of the Futurelab at the Ars Electronica Center in 1996 was not confined to the CAVE alone. Even before descending to the basement of the Ars Electronica Center in order to queue for the CAVE, visitors came across a flight simulator hovering above the lobby. *Humphrey* combined virtual-reality flight simulation—in this case using a head-mounted display—with a special suit that enabled the user to be suspended in a flying position in mid-air and thus also have the physical sensation of flying over Linz, intensified by force feedback devices ensuring the feeling of weightlessness. *Humphrey* was the Ars Electronica Futurelab's answer to the age-old human dream of being able to fly like a bird, putting virtual reality in the service of a highly immersive personal experience. As Horst Hörtner recalls, this installation, prominently placed on a platform above the lobby, must have been among the final ones to be up and running for the festive opening of the Ars Electronica Center: "The mayor and the governor entered the building and we were sitting up there and were still finishing the code for *Humphrey* … the foyer filled with people and then they came up and we'd just got ready, but we acted like we had been waiting for them ready-to-go, acting super calm and prepared."[16] At a lecture he held in 1982 at Carnegie Mellon University, Ivan Sutherland, one of the pioneers of virtual reality, had spoken about "Technology and Courage." Regarding the importance of deadlines and, in particular, the feverish activity immediately preceding a deadline, he recalled an architect friend's teaching him the term "charette." "The term comes from the French name for the horse-drawn carts in Paris that carried architectural students with their architectural models from their workshops to their examinations, still feverishly finishing the models 'en charette'."[17] Working against deadlines supposedly impossible to meet, thus making the impossible possible after all, would not only be descriptive of the one-year-tunnel of creating the installations of the Ars Electronica Center in time for its opening in September 1996, but also has turned out be a recurring characteristic of certain phases and events in the history of the Ars Electronica Futurelab in the following 25 years. As Ivan Sutherland put it: "Without a deadline there can be no charette." It was the days after this rush "en charette" that provided Horst Hörtner and his team with the deeply satisfactory experience of massive positive feedback to their work. Not only had they managed to finish all the new and mostly prototypical installations in time for the opening, they also convinced audiences and stakeholders of the quality and significance of their work, from the population of Linz and the regional decision makers to the international "Ars Electronica crowd." So this inaugurational moment of 1996 provided important additional psychological backing for the formation of the Ars Electronica Futurelab.

16 Horst Hörtner, in a conversation with the author, December 2020.

17 Sutherland, Ivan, "Technology and Courage," Sun Microsystems Laboratories, Mountain View, California, 1995, p. 8 (based on a lecture held at Carnegie Mellon University in 1982).

Humphrey I (1996) + *Humphrey* II (2003), flight simulator that didn't simulate a flying machine but the flying itself.

Humphrey I & II

Type: Immersive environment
Location: Ars Electronica Center, Linz, Austria
Year(s): 1996, 2003

Special features / key technologies:
Unreal engine, simulator, pneumatic muscles, icarus, HMD, VR, specially reinforced overalls resembling a pilot's jumpsuit

A prototype that let users fly through virtual worlds. *Humphrey I* (1996) was a mechatronic device that worked in conjunction with a pair of data glasses to simulate flight in a 3D environment. *Humphrey II* (2003) used a combination of virtual reality and force feedback technology to simulate a feeling of weightlessness that was as realistic as possible. With conventional flight simulators, you would probably find yourself inside a cabin environment, but *Humphrey* allowed you to fly almost as freely as the movie characters *Superman* and *Supergirl.* By means of force feedback devices, even physical forces could be mechanically simulated in these virtual worlds. As the outcome of R&D work in which Ars Electronica Futurelab engineers utilized an empirical design process, *Humphrey* mutated into the prototype of an apparatus that combined virtual reality and force feedback technologies to simulate a feeling of weightlessness and the centrifugal force generated by flying.

https://u.aec.at/0270282B

The Mixed Reality of Gulliver's World

Seven years later, the Ars Electronica Futurelab opened the door to a new kind of virtual world experience. The CAVE had proven its power to immerse people in numerous virtual worlds and *Humphrey* had made the dream of flying over the land come true, but there had always been the idea of exploring the terrain beyond such interactive immersive virtual environments, which seemed to be waiting behind the horizon. So, in the early years of the new millennium, the Ars Electronica Futurelab came up with a profoundly new kind of multi-user, mixed-reality installation, which would turn out to be one of the long-time favorites—not only—with the younger audiences of the Ars Electronica Center. This finally became a series of projects unfolding over the years that were inspired by the desire to go well beyond previous concepts of virtual reality by positioning the new medium of mixed reality (MR) in an experiential creative space at the nexus of theater, movies, and media art installations. At first there was the idea of letting users go back and forth in a "reality-virtuality continuum" and thus breaking through the boundaries between the real and the virtual. Long after the first ideas came the project's name, derived from the title character of the satirical novel "Gulliver's Travels" by the Irish author Jonathan Swift (1667–1745), an early protagonist of the Enlightenment. What began with *Gulliver's Box* in 2003 was followed by *Gulliver's World* in 2004 and finally expanded by the extension *City Puzzle* in 2006. *Gulliver's World* ultimately covered an entire exhibition floor of the Ars Electronica Center with a characteristic architecture, specially designed by the American-Austrian architect Scott Ritter (1962–2018), who had created numerous exhibition designs for the Ars Electronica Center since 1996. Visitors were not simply confronted with a predesigned simulation, but enabled to create—in a pleasantly playful way—their own worlds, design characters, and develop stories for them. Multiple tools and interfaces were at hand: a World Editor, resembling the spherical model of a globe, a 3D scanner to insert figures formed of plasticine modeling clay into the virtual environment, a Green Box to record video sequences of little acting or dancing scenes, and Magic Boxes, where the characters lived. Although pretty much immersed in playing *Gulliver's World,* users were frequently required to go back and forth between acting in the simulation and doing things in the real world, which in turn influenced the virtual environment. Due to this mixed-reality setting, *Gulliver's World* was also a hands-on experience in the truest sense. For *Gulliver's World* the human hand was needed—far more than in the conventional virtual-reality simulation or computer game—to not only handle a virtual world through a controller device, but to physically work with different materials and haptic components, with effects in both realities.





Gulliver's Box (2003), multi-user mixed reality system







Gulliver's World (2004), follow-up project of *Gulliver's Box,* in which users are called upon to actively design their artificial world and the characters that populate it.

Gulliver's World

Type: Mixed reality environment
Location: Ars Electronica Center, Linz, Austria
Year(s): 2004–2005

Special features / key technologies:
VR, AR, MR, tangible interfaces, tracking

A mixed reality installation in which visitors don't simply interact with prefab environments and standard characters but actively participate in the design of the artificial world and its components. They become intuitive editors who individually customize and continuously reconfigure the environment. In their dealings with the individual interfaces, visitors are conducted through the various levels of interaction in the mixed-reality environment.
The project is based on *Gulliver's Box* (2003), which was originally conceived as an experimental platform that could be used to test new interfaces and approaches to interaction in both a lab setting and in everyday operations involving the general public. Despite the installation's prototype nature, *Gulliver's Box* developed into one of the Museum of the Future's top attractions. Motivated by this success, the lab's staff took up the concept and spun it off in several directions.

https://u.aec.at/6C77AF9C

Former Ars Electronica Futurelab member Daniel Leithinger points out what made this project unique: "*Gulliver's World* was one of those rare projects where different ideas, which you usually find only separately, were brought together in one consistent experience, including 3D scanning, placing yourself in a virtual world and augmented reality to explore it. *Gulliver's World* integrated all those ideas in the flow of an interesting story."[18] Those were stories that the installation enabled and encouraged you to create yourself. Presumably, Jonathan Swift would have enjoyed parallels between the World Editor and the flying island of Laputa, where he had imagined a society promoting scientific progress—a notion evidently resonating with the philosophy behind *Gulliver's World,* where playful learning and collaboration flourished. *Gulliver's World* was perhaps the first of the long range of projects created by the Ars Electronica Futurelab that not only broke through barriers between real and virtual worlds, but also put an end to the notion of the single omnipotent creator by turning the members of the audience into co-creators or even the main creators of worlds of their own design.

Gulliver's World (2004), follow-up project of *Gulliver's Box,* in which users are called upon to actively design their artificial world and the characters that populate it.

18 Daniel Leithinger, in a conversation with the author, March 2021.

"*Gulliver's World* was one of those rare projects where different ideas, which you usually find only separately, were brought together in one consistent experience, including 3D scanning, placing yourself in a virtual world, and augmented reality to explore it. *Gulliver's World* integrated all those ideas in the flow of an interesting story."

Source: Daniel Leithinger, in a conversation with the author, March 2021.

Daniel Leithinger (*1980, AT). Studied at the University of Applied Sciences, Hagenberg, and at the MIT Media Lab, Massachusetts Institute of Technology, Boston. Worked at the Ars Electronica Futurelab in 2004 and in 2007. Since 2018 assistant professor at the ATLAS Institute and the Department of Computer Science, University of Colorado Boulder.

Although mainly populated by young visitors, *Gulliver's World* also offered additional experience and insight to the parent or grandparent generation accompanying them. For instance, RFID (Radio-Frequency Identification) was used to provide the link between the real and virtual objects and the participant's story. This made *Gulliver's World* the first public museum installation to present the emerging technology of RFID as a topic for adults, who were provided with additional background information about potentials and risks of near-field communication (NFC). When, in 2006, the interactive simulation environment *City Puzzle* was added, it showed that this mixed-reality platform had "come of age" by also enabling personal experimentation with city planning. A decade after the first version of the *Cybercity* installations at the Ars Electronica Center in 1996, the Ars Electronica Futurelab had pushed the envelope to arrive at far more sophisticated mixed-reality simulations. During this first decade of the 21st century, the Ars Electronica Futurelab would embark on explorations of urban life that reached even further.

In the early years after the turn of the millennium, it had also become clear that the Ars Electronica Center had outgrown the building in which it had been housed since 1996, in terms of the ever-growing numbers of visitors as well as in the light of technology—due to Moore's Law—advancing at an accelerating speed. This also applied to the CAVE, which could welcome only a handful of visitors at a time, resulting in long queues of people waiting to immerse themselves in the famous virtual worlds offered there. With the CAVE's technical system also reaching its limits, concepts emerged for an expansion of the building with more exhibition space and a larger, new kind of simulation environment. At this point the story of Ars Electronica Center's Deep Space began.

The Deeper the Space, the Greater the Immersion

The entire story of the Ars Electronica Futurelab and virtual worlds in all their manifestations may be seen as roughly containing two different periods: the period of the CAVE from 1996 until 2008 and the period of the Deep Space from 2009 until today. To paraphrase the famous dictum attributed to the former British prime minister Winston Churchill (1874–1965) about architecture[19]: First the Futurelab shaped its tools and afterwards their tools shaped them, or, respectively, their work.

19 https://www.parliament.uk/about/living-heritage/building/palace/architecture/palacestructure/churchill/

Inside Futurelab: *Immersify—The translucent St. Stephen's Cathedral* (2020), Space 8K, Ars Electronica Center

While on a trip to a conference in Italy, Gerfried Stocker and Horst Hörtner also visited Florence Cathedral and the Basilica di Santa Croce. As the quest for the new Ars Electronica Center was the burning issue at that time, they did not really embark on sightseeing, but never stopped discussing the many open questions around the concept and design of a successor for the CAVE. Florence Cathedral proved to be the perfect setting for those discussions, as the dome, created by the Italian architect and designer Filippo Brunelleschi (1377–1446), is one of the largest churches in Italy. There, of all places, the spirit of the Renaissance could be felt with great intensity and it was difficult not be impressed by the sheer size of the interior space and the dome of the Cathedral. Ars Electronica lore has it that on that very day they decided to go for a significantly larger dimension of a completely new projection space for interactive, stereoscopic, and high-definition content. Thus, the Ars Electronica Deep Space was born out of the spirit of the Renaissance, and around it would unfold a complete "rebirth" of the Ars Electronica Center only thirteen years after its initial opening.

In different guises, the Renaissance is a recurring motif across the entire history of the Deep Space. A gigapixel photograph of Leonardo da Vinci's *Last Supper* in the Convent of Santa Maria delle Grazie in Milan[20] belongs to the first set of programs offered in the Deep Space at its opening in 2009. The gigapixel image made it possible to zoom into the smallest detail of the painting, to the point where the traces of the nail became visible that da Vinci had put into the wall in order to attach strings for creating the geometrical perspective. The central perspective was an invention of the Renaissance, in fact resulting from a collaboration of art and science, and now revived as a symbolic "vanishing point" in the developments of the transdisciplinary Ars Electronica Futurelab. Thus, Ars Electronica in the 21st century drew several strings of reference back to the (Italian) Renaissance, but we should be careful not to overstress the metaphorical liaison with that period, as Derrick de Kerckhove called to our attention in his contribution to Ars Electronica Festival in 1990: "I was asked ... whether virtual technology would herald 'a new Renaissance.' My answer was no. Why would we start all over again the same old story when we had such interesting new ones to tell? Collective cognitive processing is bound to change the basis of Renaissance psychology. What we need is a sense of expanding, flexible self, inclusive rather than exclusive, environmental rather than frontal, collaborative rather than confrontational, conscious of its bionic extensions rather than resolutely ignoring any suggestion that we are not made of flesh alone."[21] Those words sketch a trajectory for several of the questions that the Futurelab was to ask in its research and projects to come.

In the meantime, preparations started for a complete relaunch of the Ars Electronica Center, due to open its doors at the beginning of 2009, in time for the 30th anniversary of Ars Electronica and for "Linz 09": Linz becoming a "European Capital of Culture." With Futurelab co-director Christopher Lindinger as project manager, the Ars Electronica Center received a complete makeover of its premises, resulting in a far larger exhibition space and the opportunity to create the Deep Space as a successor to the CAVE. In a way, the vision of realizing something like the Deep Space had been a key driver in the thrust for the new museum building. The Ars Electronica Futurelab would be given its own wing of the building, and of course in 2008 it entered another intense phase of development and implementation of a complete set of new installations for the Ars Electronica Center, again employing the focusing and intensifying aspects of working "en charette."

20 Realized by the Italian firm Haltadefinizione

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21 de Kerckhove, Derrick, "Virtual Reality for Collective Cognitive Processing," in: Hattinger, G. & Weibel, P. (eds.): *Virtual Worlds,* Vol. 2, Ars Electronica, Linz, 1990.

Leonardo da Vinci's *Last Supper* in Deep Space 8K, Ars Electronica Center. Gigapixel image by Haltadefinizione. Even the smallest details can be explored by means of a gigapixel image.

Pantheon in: *Rome's Invisible City* in 3D: A BBC Film in Deep Space 8K, Ars Electronica Center.

Unlike the CAVE, which had originated from EVL in Chicago, the Deep Space was a completely new development done by the Ars Electronica Futurelab. Consequently, there was not a pre-existing repository of content for this new virtual reality platform, but the need to adapt existing projects and—rather—to develop completely new applications that made proper use of the impressive scale and the high resolution of the stereoscopic projections at the Deep Space. "The characteristic L-shape of the Deep Space, with projections on the huge wall and on the floor, was in fact inspired also by experiences from the collaboration with Dan Sandin when installing the CAVE in 1996. We had then first understood the fundamental importance of being immersed by literally stepping into an environment."[22] Those new possibilities, including the larger number of up to 120 people that could be simultaneously present in the 3D virtual environment, also stimulated efforts to develop new forms of collaborative storytelling.

Human Bodies: The Universe Within (2015), an application developed by Ars Electronica Futurelab to exploit the full potential of Deep Space 8K and make the exploration of the human body a fascinating experience.

Deep Space 8K

The Next Generation of Visualization Technology

Type: Immersive environment
Location: Ars Electronica Center, Linz, Austria
Year(s): Since 2015

Special features / key technologies:
VR, 8K, real-time rendering, laser-tracking system Pharus, Point Cloud Renderer

Deep Space has been famous for its 16x9m wall and 16x9m floor projection, laser tracking, and 3D animations since 2009. An all-out upgrade of the venue's technical infrastructure in August 2015 now allows audiences to enjoy up to 8K resolution projections—a new generation of visualization technology that sets new standards of technical feasibility. The pixel rate of 4096 x 2160 for each of the eight projectors, which is calculated 120 times per second respectively and sent via four separate signal lines, yields a compound picture. Over 4.2 billion times per second, a pixel darts via those conduits. To operate both surfaces, floor and wall, the high power performance is double, as both systems are synchronized: a transport capacity of more than 23 Gigabyte/s.
And most importantly: the content is constantly being improved, updated, and expanded to include new applications that exploit the technical possibilities of Deep Space 8K—including developments created in the Ars Electronica Futurelab as well as projects realized in collaboration with many international partner institutions, e.g. the Japanese broadcasting company NHK, Siemens Healthineers with its medical application *Cinematic Rendering,* and *Immersify,* an EU research project funded under Horizon 2020.

https://u.aec.at/E63645F9

It’s Not Only a Paper Island

In this scenario, the mixed reality project *Papyrate’s Island* was born. With *Papyrate’s Island,* the Futurelab brought experiences from *Gulliver’s World* to the new environment of the Deep Space. Again, the intention was to make new technologies accessible and tangible by means of interactive storytelling. People without any previous training in computer science or related areas of research were to be enabled to understand how those new technologies can be put to use and—perhaps even more important—how they are already changing our world. *Papyrate’s Island* also stood for taking the step forward from immersion in and interaction with a virtual world to co-immersion and, ultimately, collaboration with other people, a shift from simulation towards shared experiential worlds. This shift characterizes an arc of conceptual development that would guide many extended reality projects for the Deep Space environment in the years to come.

Papyrate’s Island (2009), Ars Electronica Futurelab, Deep Space, Ars Electronica Center

22 Horst Hörtner, in a conversation with the author, March 2021.

Papyrate's Island

Type: Immersive environment, interactive storytelling, mixed reality storytelling, mixed reality
Location: Deep Space, Ars Electronica Center, Linz, Austria
Year(s): Since 2009

Special features / key technologies: VR, MR, digital pen & paper, tangible interfaces, non-linear storytelling, edutainment

A multi-user interactive narrative on the Deep Space platform that was developed in collaboration with the Media Interaction Lab at the University of Applied Sciences Upper Austria, Hagenberg Campus. Technically speaking, *Papyrate's Island* is a cross between a VR environment and a nonlinear animation film. In terms of content, it is first of all an edutainment application (not only) for children that offers a playful hands-on approach to virtual reality. The players find themselves on a South Sea island that consists totally of drawings that have come to life. They must collaborate to prevent the destruction of this paper world by a villain named Pyrate. Participants can navigate the island and get involved in the creation process by making drawings on real paper, which are then transferred to the virtual reality world. With just a pen and paper, they can create objects and living creatures that will help them get the situation under control.

https://u.aec.at/CAF2C21D

The digitally created virtual world of *Papyrate's Island* is made from the epitome of "analog" drawing in the real world: paper. On *Papyrate's Island,* objects and creatures are drawn on virtual paper by a painter, who has the role of world creator as well as mediator of the participants in the environment. The known properties of paper—that it can burn or that drawings will fade when the paper becomes wet—are replicated in the virtual reality of the island. Participants can navigate the island and involve themselves in the creation process by making drawings on real paper, which are then transferred to the virtual-reality world. However, although *Papyrate's Island* may seem like a southern idyllic ambience at first glance, it also houses an antagonist, a villainous pirate, whom the painter has drawn into that world at an inconsiderate moment. The pirate soon discovers the destructive impact of fire on a world made of paper and the participants are busy performing a rain dance to extinguish the fires. Unfortunately, the rain lets drawings on paper fade and catapults them back to the two-dimensional world from which they came. *Papyrate's Island* does not require computer literacy, but instead makes good use of the familiar cultural technique of using the human hand to draw, this time with the aim of enabling interactivity and transition: "Drawing and sketching come into play here as traditional cultural techniques that enable people to express ideas, visions, and images and to engage in storytelling."[23] Thus, mixed reality became part of the Deep Space experience early on, breaking open the illusion of the virtual world, encouraging users to look underneath the simulation model and to playfully reflect the transitions between virtual and real. A paper by several members of the Ars Electronica Futurelab written in 2009 emphasized the importance of the Deep Space for their research work: "Deep Space has the character of an open lab: it makes use of the museum's regular operations to put prototypical scenarios to the test. A flexible system design makes it possible to conduct a wide range of experiments in terms of interactive and collaborative digital storytelling."[24] Former Futurelab senior researcher Daniela Kuka, who played a key role in conceptualizing *Papyrate's Island,* later pointed out the transdisciplinary aspect that also applies to such projects, as well as to the Deep Space environment as such: "As the future will not stop at today's frontiers between disciplinary fields, we should develop tools that can bring together actors from heterogeneous backgrounds."[25]

23 Kuka, Daniela, Elias, Oliver, Martins, Ronald, Lindinger, Christopher, Pramböck, Andreas, Jalsovec, Andreas, Maresch, Pascal, Hörtner, Horst & Brandl, Peter: *DEEP SPACE – High Reso-lution VR Platform for Multi-User Interactive Narratives,* Ars Electronica Futurelab, Linz / Me-dia Interaction Lab, Upper Austria University of Applied Sciences, Hagenberg, 2009.

24 Kuka, Daniela, et al. in op. cit., Ars Electronica Futurelab, Linz / Media Interaction Lab, Upper Austria University of Applied Sciences, Hagenberg, 2009.

25 Kuka, Daniela, "Games as a Source of Future Memory—A Typology," 2017, p. 22.

“As the future will not stop at today’s frontiers between disciplinary fields, we should develop tools that can bring together actors from heterogeneous backgrounds.”

Source: Kuka, Daniela, “Games as a Source of Future Memory—A Typology,” 2017, p. 22

Daniela Kuka (*1983, DE). Studies in cultural engineering, Master’s degree in media culture and art theory from the University of Art and Design Linz. Member of the Ars Electronica Futurelab from 2005–2009, senior researcher for interactive dramaturgy. Lecturer at Berlin University of the Arts. 2015 Founder of goolin—Studio for Transformation with focus on game format development, interactive tools, and hybrid storytelling.

Papyrate’s Island (2009), Ars Electronica Futurelab, Deep Space, Ars Electronica Center

Beyond the Frame: 8K Future Project, in 2019 Ars Electronica Futurelab and Japanese Broadcasting Company NHK jointly examined how 8K, the next generation of ultra-high definition TV technology, can be integrated in everyday life.

The Next Level

The development work on Deep Space as a prototypical machine never stops; rather, through intense experimentation and also impulses from new artistic, scientific, or educational projects, it is being continuously improved, and its features and capabilities are frequently expanded in several directions. The upgrade of the Deep Space to 8K projection technology, which took place in 2015, was far more than a routine update of technical equipment. It lifted the already impressive capabilities of the Deep Space onto a completely new level. In virtual reality applications, probably with the exceptions of computer games and use in product marketing, the highest possible resolution was not considered the decisive factor for the immersiveness of the experience. However, in a simulation environment of the size of the Deep Space, also the level of detail rendered visible on 16 x 9 meters of projection wall plus 16 x 9 meters of projection floor massively contributed to the immersion. Especially from 2015 onwards, the Deep Space 8K would also serve as a laboratory for pushing the boundaries of immersion and expanding the limits of the medium of television and video. With the program *Immersify,*[26] the Ars Electronica Futurelab entered into cooperation with a number of international institutions working on transforming immersive media from a niche phenomenon into a widespread practice. To explore the future of high-definition television, usually referred to as 8K Ultra HD, the Ars Electronica Futurelab worked together with the Japanese broadcasting corporation NHK on the project *Beyond the Frame.* Roland Haring led research in both projects on behalf of the Ars Electronica Futurelab and explained his enthusiasm for the opportunity to explore the future of the medium: "I find it exciting that attempts are made to develop the medium of video itself. The medium is decades old in terms of its basic conceptual structure … . It is very difficult to change it … because the entire television broadcasting infrastructure is attached to it."[27] Among the exemplary prototypes of "True Scale TV" presented in this cooperation project with NHK was a true-scale weather forecast, in which a life-size presenter could be seen amidst the unfolding weather situation of a typhoon approaching the Japanese coastline. Such true-scale presentations of weather phenomena, where a seven-meter wave coming towards you is actually displayed in a size of seven meters, showed their potential to—ultimately—also foster an understanding of the effects of climate change. They also made clear that this kind of prototyping work goes far beyond a merely technology-driven approach to "improve" a medium like television, but ponders the potentials of this new technology. Also, questions of infrastructure were explored in *Beyond the Frame.* On August 28, 2019, the first intercontinental 8K live

26 https://ars.electronica.art/aeblog/en/2019/05/28/immersify/

27 Beyond the Frame: The future of broadcasting?, Interview with Roland Haring and Nicolas Naveau, Ars Electronica Blog, 2019, https://ars.electronica.art/aeblog/en/2019/09/04/beyond-the-frame/

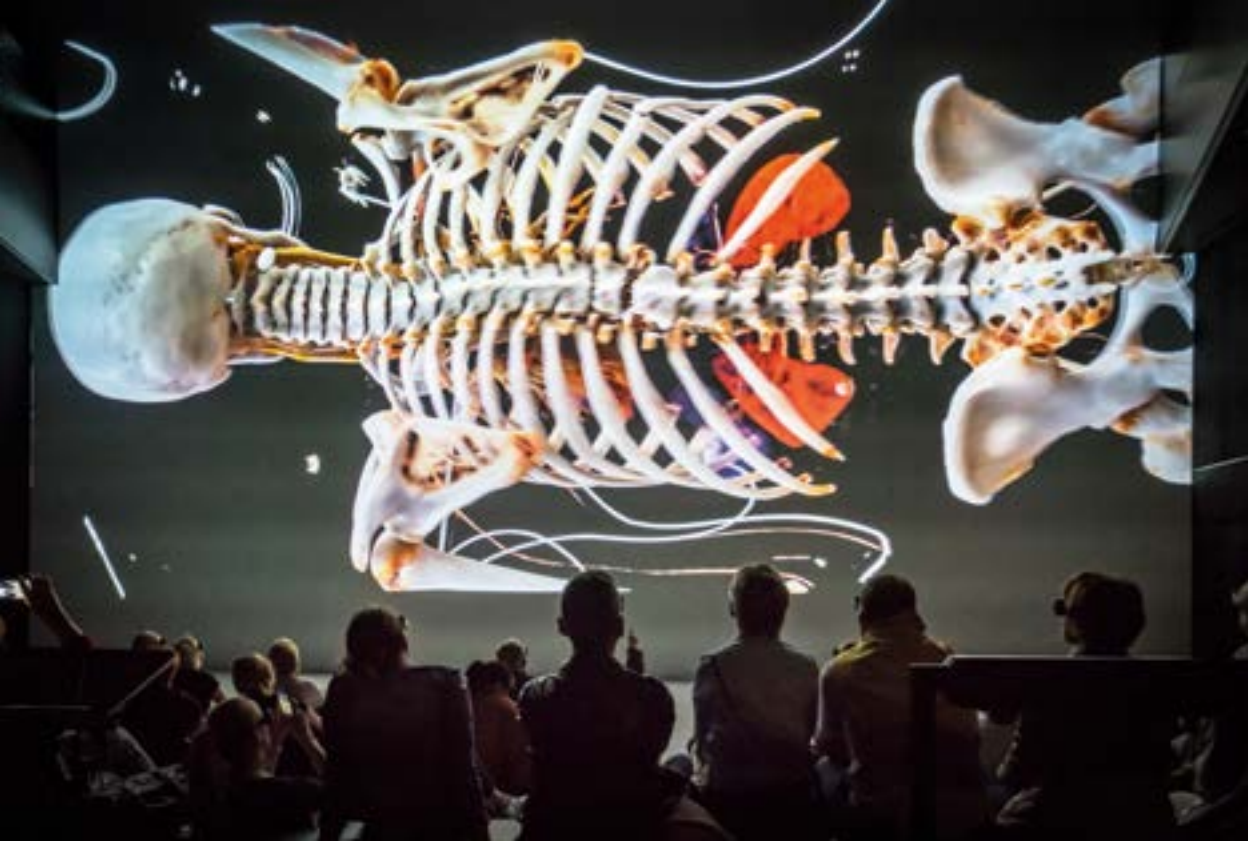
stream over a distance of 9,223 kilometers was realized between the Deep Space 8K in Linz and a traditional Sanbasō dance performance taking place in Tokyo. Instead of the dedicated network links that are usually utilized by TV stations, the public Internet was used for this: "The fact that we use the public Internet for this purpose [not only] makes the technology … tangible for media producers or other interested parties, but also generally increases availability."[28]

However, with the involvement of 8K technology for stereoscopic projects in the framework of the initiative *Immersify,* availability remains an issue. While many areas of digital media production—from imaging and audio to filmmaking and game creation—have become broadly available and thus been "democratized," there is still a significant gap between producers and users of immersive media. At this point lies a challenge for the Ars Electronica Futurelab team and their intention to provide platforms not only for experiencing, but also for creative work with new media technologies. Mastering such challenges in exploring new technologies for and with people touches the core of the strength and relevance of the work of the Futurelab and of Ars Electronica as a whole.[29] Reaching out to and involving ever new groups of users worked successfully, for instance, with *Virtual Anatomy,* which had become possible only through a fusion of *Cinematic Rendering,* medical image processing, and the stereoscopic capabilities of Deep Space 8K. Medical students came to the Ars Electronica Center for their lectures in anatomy until the Faculty of Medicine of the Johannes Kepler University in Linz opened its own version of a Deep Space, called "JKU medSPACE," in 2021, installed by the Ars Electronica Futurelab. In the years before that, Deep Space 8K had "gone abroad" repeatedly. In 2015 at Science Center Singapore, Ars Electronica Solutions contributed the knowledge for a "Deep Space Theatre." When in 2018, the German multinational science and technology company Merck celebrated its 350th anniversary, the Ars Electronica Futurelab created for them a "Curiosity Space" in the form of a walk-in 3D projection based on the Deep Space 8K technology, including interactive experiences utilizing the *Pharus* laser tracking system from the Futurelab. Named "Cubo Negro (black cube)," a Deep Space 8K was installed by Ars Electronica Solutions at the Sinaloa Science Center in Mexico and opened in 2020.[30] Meanwhile, in Linz, the Ars Electronica Futurelab took the next step into the future of Deep Space 8K by developing a new VR system called "Deep Virtual," which pushes the illusion of a virtual space a decisive step further by putting protagonists in an immersive setting matching their presentations. Again, as with *Cinematic Rendering,* methods from state-of-the-art digital filmmaking come into play, including camera tracking creating dynamic perspectives on protagonists moving in front of virtual settings.

28 World premiere: 8K Live Stream from Japan to Linz, Immersify, Interview with Roland Haring and Ali Nikrang, 2019—https://immersify.eu/2019/08/23/world-premiere-8k-live-stream-from-japan-to-linz/

29 Hideaki Ogawa, in a conversation with the author, December 2020.

30 https://ars.electronica.art/solutions/en/cubo-negro/



Cinematic Rendering (2015), Siemens Healthineers, Deep Space 8K, Ars Electronica Center

Universum Mensch—Cinematic Rendering (2015), Prof. Dr. Franz Fellner, Kepler University Hospital, presents the current status of teaching human anatomy

Bird Song Diamond (2018), Victoria Vesna, Charles Taylor, Takashi Ikegami, Hiroo Iwata, Reiji Suzuki

Noise Aquarium (2018), Victoria Vesna, Alfred Vendl, Martina Fröschl, utilizes 3D-scans of oceanic micro creatures obtained with unique scientific imaging techniques and immerses the audience in the 3D “aquarium” of diverse plankton projected as large as whales.

Connecting Worlds

Over the years, audiences have become more and more sophisticated and general media literacy has increased, which of course also has helped to expand the range of possibilities in a simulation environment like Deep Space 8K. “Societies have learned to perceive in a far more abstract manner. They have gotten used to interacting with virtual worlds and today crave less for the most realistic depiction, but rather for qualities of experiential worlds,” as Horst Hörtner has observed[31]. While sceptics of virtual reality had warned against a loss of connection with reality resulting from an overdose of VR, it became clear, at the same time, how virtual worlds can—productively—change the way we see and understand the world around us. Virtual worlds, therefore, are not about illusion replacing our connection to the world, but about finding additional and meaningful ways of relating to it. This becomes apparent in our knowledge of vanishing or inaccessible parts of humankind's cultural heritage and in our realization of the destructive impact of our actions on basically all parts of the biosphere, including the decline of biodiversity as well as disrupted cycles of life and balances in ecosystems and the global climate. It is often projects by interdisciplinary teams of artists and researchers that offer significant insight into those issues. Victoria Vesna, an artist and researcher and the founder and director of the UCLA Art |Sci Center in Los Angeles, has meanwhile led a series of such projects, which are based on long-term research and which bring together multiple disciplines like evolutionary biology, artificial intelligence, spatial sound, mathematics, and mechatronics. Audience participation is a crucial factor for creating strong experiences with certain complex topics, which were implemented at the Deep Space 8K in cooperation with the Ars Electronica Futurelab. In *Bird Song Diamond,* the members of the audience at the Deep Space 8K were engaged by inviting them to mimic bird songs. Through their collective behavior they influenced, for instance, flocking behavior of the birds, and in turn began to understand how birds see us. *Noise Aquarium* immersed visitors in a submarine world populated by enlarged plankton creatures, which reacted to the noise created by humans in the environment, allowing the visitors to experience the destructive impact of noise pollution on life in the oceans. Victoria Vesna points to the role of immersion, which makes it possible to turn the Deep Space 8K into an environment with the potential to raise awareness and change the course of action: “To immerse people in the sounds and images that they influence with their behavior is in my opinion the most effective way to deliver an urgent message. … Many media artists now are responding to the call and (re)connecting with the complexity of our own biology and ecology. We feel an urgency right now as we are on the brink of environmental disasters and only when we see ourselves as animals will we start to shift our habits and check our value systems.”[32]

31 Horst Hörtner, in a conversation with the author, March 2021.

32 Victoria Vesna, in an interview with Magdalena Sick-Leitner, Ars Electronica Blog, 2018, https://ars.electronica.art/aeblog/en/2018/08/27/noise-aquarium/

The translucent St. Stephen's Cathedral (2020), St. Stephen's Cathedral in Vienna was spatially measured with more than 20 billion laser points. At this unique level of detail, they correspond to a data volume of almost 400 gigabytes and form the basis of *The Translucent St. Stephen's Cathedral,*

The adverse effects of human behavior not only show in the biosphere, they also endanger humankind's own cultural heritage. This goes from the wanton destruction of cultural sites through war and terrorism to the collateral effects of overtourism or large-scale infrastructure projects. The Deep Space 8K is an ideal setting for working with results from digital conservation efforts, which include gigapixel photography and, more recently, 3D laser scans of buildings and entire environments. The huge data clouds from 3D laser scans are adapted by the Ars Electronica Futurelab for display at the Deep Space 8K, allowing visitors an in-depth interactive exploration of cultural sites like the Great Pyramid of Giza in Egypt, which was built more than 4,500 years ago, or St. Stephen's Cathedral in Vienna, Austria, created in medieval times. On the lighter side of human behavior

33 Quoted by de Kerckhove, Derrick, "Virtual Reality for Collective Cognitive Processing," in: Hattinger, G. & Weibel, P. (eds.): *Virtual Worlds,* Vol. 2, Ars Electronica, Linz, 1990: "According to Jaron Lanier, 'the essence of virtual reality is that it's shared.' He proposes that VR is 'the first new level of objectively shared reality available to humanity since the physical world.'"

34 Haring, Roland, "Coimmersive Spaces," https://ars.electronica.art/futurelab/en/research-coimmersive-spaces/

which is part of the European R&D project *Immersify.* Rendering: ScanLAB Projects, Scans: RIEGL Laser Measurement Systems; Dombauhütte St. Stephan zu Wien; Concept: Ars Electronica Futurelab

lies the ability for cooperation, which in turn enabled many achievements of human culture and science and development in societies. Looking at virtual worlds and cooperation, a thought attributed to the virtual reality pioneer Jaron Lanier comes to mind: "The essence of virtual reality is that it's shared."[33] The work of the Ars Electronica Futurelab on "Co-Immersive Spaces" deepened the understanding of ways in which interaction in co-located multi-user virtual environments works. Roland Haring explains one of the key aspects: "Even the perception of actively interacting users in a shared co-located VR space can create and intensify the feeling of one's own immersion. Users need to be able to intuitively verify and understand the agency they have in this space."[34] In a cooperation program between the University of Art and Design Linz and the Ars Electronica Futurelab, students developed a series of projects, entitled *Cooperative Aesthetics,* which used the Deep Space 8K as a setting for playful cooperation in creating collective audiovisual experiences. Visitors move across the projection space and jointly modify giant sinus waves or collectively define a particular shade of color. Results are achieved by cooperating with others instead of competing against them, thus creating positive experiences of constructive and peaceful coexistence.

“We placed a high value on putting the technology into a social context through an artistic approach. I actually view technological innovations whose social value lies solely in wanting to go further and higher, faster and faster, quite critically. Where people meet, and where a shared experience happens, social interaction and a zone for social encounter can also be created. The shared experience can help people participate in the lives of others, feel understanding and empathy, and better empathize with the experiences of fellow human beings.”

Source: “Resonant Media—How 8K can affect human perception and emotion,” Interview with Nicolas Naveau, Ars Electronica Blog, 2021, https://ars.electronica.art/aeblog/en/2021/03/16/resonant-media

Nicolas Naveau (*1970, FR). Artist, designer, and researcher. Studied at the School of Fine Arts in Angers, France. Member of the Ars Electronica Futurelab since 2006. Senior researcher for information design. Co-founder of the Happy Collapse Group.

In 2020, an unofficial team within the Ars Electronica Futurelab—the "Happy Collapse Group" formed by Nicolas Naveau, Johannes Pöll, and Peter Freudling—developed the project *Deepandemia,* which makes use of Deep Space 8K to provide a gamified learning environment about the prevention of infection chains in a pandemic. "The COVID-19 pandemic ... represents a powerful example of how societal collaboration and individual actions can change the world for the better or the worse."[35] *Deepandemia* is conceptualized as the first part in a framework called *DeepChanges,* focusing also on environmental issues such a human-made climate change. Nicolas Naveau, senior researcher at the Ars Electronica Futurelab and member of the "Happy Collapse Group", emphasizes the broader vision behind working with Deep Space 8K for co-immersion: "Where people meet, and where a shared experience happens, social interaction and a zone for social encounter can also be created. ... Not only does technology support a deeply human need to always go the extra mile, it also allows an urban society to leave its isolation and anonymity behind, to some extent. The shared experience can help people participate in the lives of others, feel understanding and empathy, and better empathize with the experiences of fellow human beings."[36]

Deepandemia (2020) is envisioned as the first entry of a larger modular simulation framework called DeepChanges by Ars Electronica Futurelab.

35 Naveau, N., Pöll, J. & Freudling, P.: "Deepandemia / DeepChanges," in: Leopoldseder, H., Schöpf, C. & Stocker, G. (eds.): *In Kepler's Gardens—A global journey mapping the 'new' world,* Hatje Cantz Verlag, Berlin, 2020, p. 377.

36 Resonant Media—How 8K can affect human perception and emotion, Interview with Nicolas Naveau, Ars Electronica Blog, 2021, https://ars.electronica.art/aeblog/en/2021/03/16/resonant-media/

Besides the—of course basically accurate—impression of entering a huge simulation space that one has when coming to the Deep Space 8K, there is also another way of interpreting what actually takes place there: a symbiosis of humans and machines. In this setting, the ability of extended reality to provide a bridge over the "psychological chasm between machines and humans"[37] becomes apparent. Although he may have envisioned it somewhat differently, this is what J. C. R. Licklider (1915–1990), one of the pioneering computer scientists of the 20th century, had described as early as 1960: "The hope is that, in not too many years, human brains and computing machines will be coupled together very tightly, and that the resulting partnership will think as no human being has ever thought and process data in a way not approached by the information-handling machines we know today."[38] This topic forms one of the golden threads running through the entire history of the Ars Electronica Futurelab. It will later become visible when looking at the Futurelab's work in areas like swarms, robotics, and artificial intelligence, while it probably was those two machines for generating virtual worlds—the CAVE and the Deep Space—where the topic saw some of its initial profound manifestations. But first, technologies and strategies from virtual worlds will meet with "Poetic Systems" and together enter the terrains of cultural and urban spaces.

37 Greengard, Samuel, "Virtual Reality," The MIT Press, Massachusetts, 2019, p. 86.

38 Licklider, J. C. R., "Man-Computer Symbiosis," in: *IRE Transactions on Human Factors in Electronics,* volume HFE-1, 1960, p. 4-11.

Cooperative Aesthetics (2015): *Sinus,* Simon Krenn. With *Cooperative Aesthetics,* students of the Time-Based and Interactive Media Art program at the University for Art and Design, Linz, present projects they have developed for the Ars Electronica Center's Deep Space 8K.

Poetic Systems

Creating Novel Cultural Experience

Hidden Treasures Emerging from the Digital Realm

The treasure of gold rests under the water, hidden deep in the floods of the Rhine. At the sound of the harp, rays from the sun percolate the waters and the gold's shimmering light emanates. The Rhinemaidens guard the gold and mock Alberich, the Nibelung dwarf. Later on a mountaintop, Wotan, the ruler of the Germanic gods, confronts Alberich. The colored shapes of their avatars float high up in the philharmonic hall. Holding their breath, the audience turn their heads from one to the other and back as the scene ensues. The opera *Das Rheingold* opens the cycle of operas *Der Ring des Nibelungen* (The Ring of the Nibelung) by the German composer Richard Wagner (1813—1883), one of the most prominent realizations of his ideas of a Gesamtkunstwerk. In September 2004, such a Gesamtkunstwerk unfolds during the concert performance of *Das Rheingold,* with Dennis Russell Davies conducting the Bruckner Orchester Linz (BOL) at Brucknerhaus in Linz. The Ars Electronica Futurelab complements Wagner's music with closely-linked stereoscopic visuality, thus adding a completely new layer of highly immersive experience for the audience.

Around the same time some 600 kilometers to the north, in the mild evening dusk, hidden entities of a different kind emerge from behind the glass facade of an office building in the fashionable Berlin Mitte district. The digital creatures inside compose their shapes and behaviors reacting in real time to sounds from the street and from passersby, with the avatar's appearances "ranging from the romantic ripples produced by a pebble tossed into a pond to the wild surf of an angry sea."[1] The multinational software company SAP had commissioned the Ars Electronica Futurelab with conceptualizing and realizing a set of interactive media installations—titled *Hidden Worlds*—across their Berlin office building, thus interweaving the inside business environment with the urban space of Berlin Mitte through artistic means.

Das Rheingold Visionized (2004) performed at the International Bruckner Festival by the Bruckner Orchester Linz, conducted by Dennis Russell Davies

1 Leopoldseder, H., Schöpf, C. & Stocker, G. (eds.): *The Network for Art, Technology and Society. The First 30 Years. Ars Electronica 1979–2009,* Hatje Cantz Verlag, Ostfildern, 2009, p. 319.

"[The research area] Poetic Systems tries to regain the lost balance between nature and technology and looks for possibilities with the means of art to make technology positively usable for us as a society and for our environment."

Source: https://ars.electronica.art/futurelab/en/research-poetic-systems

Stefan Mittlböck-Jungwirth-Fohringer (*1977, AT). Artist, producer, and researcher. Trained as an electrician. Studied painting and graphics at the University of Art and Design Linz. Member of the Ars Electronica Futurelab since 2001. Key researcher for Poetic Systems.

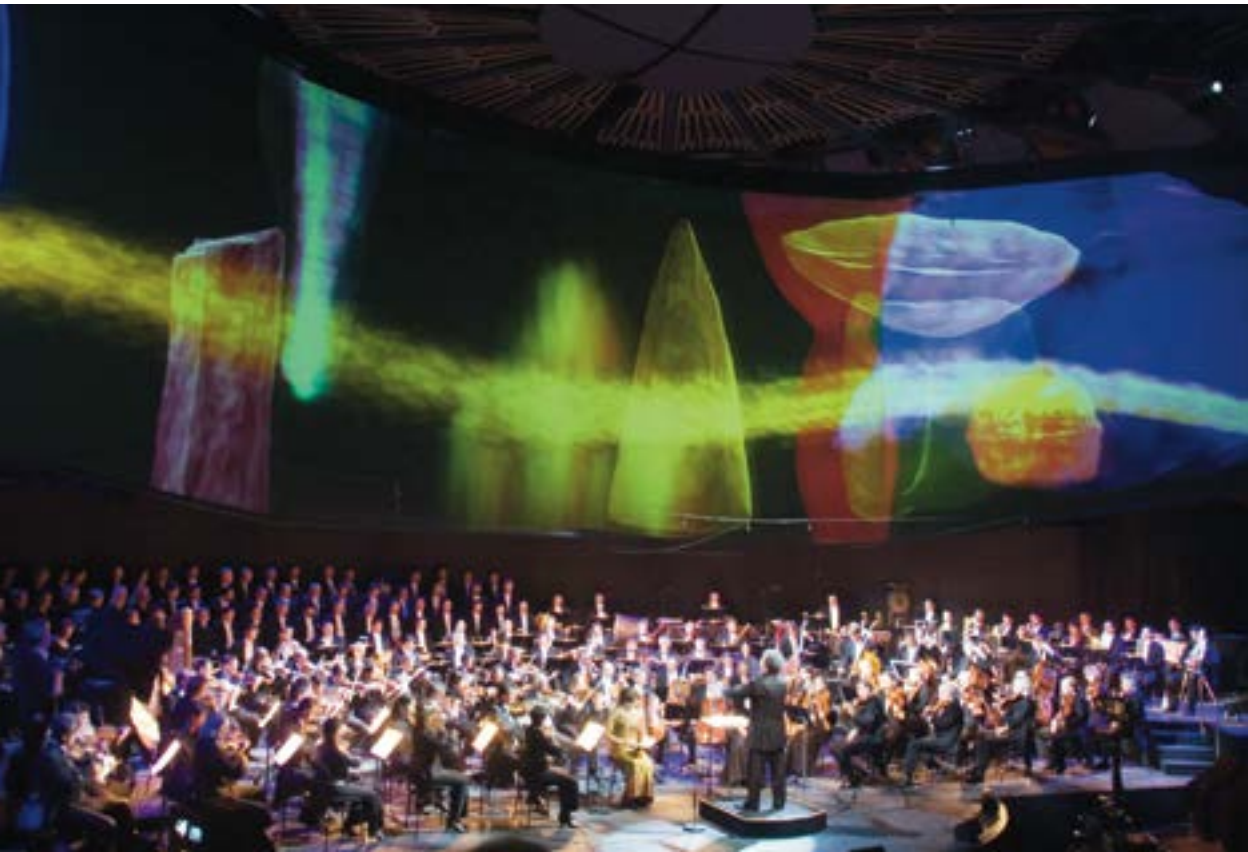
In visualizing *Das Rheingold* in the cultural space of a philharmonic hall and by transforming an office building with the media art interventions of *Hidden Worlds,* the Ars Electronica Futurelab delivered two prominent examples of their work with what they would later call "Poetic Systems." Poetic Systems are about art transforming different kinds of knowledge, cognition, and perception into poetic levels of meaning, in this process striving "to make the invisible visible, the intangible tangible, to encode and decode meanings"[2] or, in other words, to allow treasures, which are hidden inside the many systems humankind creates, to emerge. Stefan Mittlböck-Jungwirth-Fohringer, a member of the Ars Electronica Futurelab since 2001, has developed his work as a key researcher around this concept of Poetic Systems, which he initiated with a broad horizon: "Poetic Systems tries to regain the lost balance between nature and technology and looks for possibilities with the means of art to make technology positively usable for us as a society and for our environment."[3]

2 https://ars.electronica.art/futurelab/en/research-poetic-systems/

3 https://ars.electronica.art/futurelab/en/research-poetic-systems/

Das Rheingold Visionized (2004) performed at the International Bruckner Festival by Bruckner Orchester Linz, conducted by Dennis Russell Davies

Vision Mahler, world premiere in Cologne's Philharmonic Hall on January 1, 2006 at a gala concert held to celebrate WDR's 50th anniversary with the WDR-Sinfonieorchester under Semyon Bychkov.



The Gold from the Depths of the Rhine

Richard Wagner not only composed the music of *Das Rheingold,* he also wrote the libretto himself and developed extensive concepts for staging the opera, all with his vision of the Gesamtkunstwerk in mind. To conceptualize, in virtual space, the events that were to replace the traditional opera staging, the Ars Electronica Futurelab undertook a double analysis of Wagner's creation. First, they dove deep into the aesthetic concepts of Richard Wagner, who around the middle of the 19th century—in his essays "Art and Revolution" and "The Artwork of the Future"—had taken up ideas of a Gesamtkunstwerk, originating from Romanticism. Following thoughts of Brenda Laurel in her book *Computers as Theatre,* concepts like the Gesamtkunstwerk were well in tune with certain properties of virtual realities created with computers: "Computers are theater. Interactive technology, like drama, provides a platform for representing coherent realities in which agents perform actions with cognitive, emotional, and productive qualities. ... creating artificial realities in which potential for action is cognitively, emotionally, and aesthetically enhanced."[4] The Ars Electronica Futurelab invited the Austrian painter and media artist Johannes Deutsch to design the visual language for the virtual spaces and the agents appearing there, based on the characters of the opera and the storyline. Then the music itself was recorded and analyzed in real time by a digital system, with input from separate microphones for all the singers' voices and instrument groups. That system—utilizing technology like the "FL ENGINE," which had originally been developed by the Ars Electronica Futurelab for virtual reality projects in the PC CAVE—would then be able to animate the virtual objects in real-time connection with the actual sounds coming live from the singers and the orchestra. In a way, the setting for *Das Rheingold* was like turning the auditorium of the Brucknerhaus into a huge CAVE for 1,000 visitors. On the other hand, the experiences from mastering those virtual reality simulations on such a grand scale might have planted the seed of inspiration for later concepts, which would ultimately lead to the creation of the Deep Space at the Ars Electronica Center. For *Das Rheingold,* large projection screens were suspended above the orchestra and around the audience, measuring a total of 850 square meters. In order to develop and test the aesthetic concept and the technical solutions, a wooden model of the concert hall was set up at the Futurelab. The audience was equipped with special glasses in order to experience the stereoscopic projections, which gave the virtual stage a seemingly limitless depth and let the avatars of the opera's characters float above the auditorium. Some members of the audience had the impression of now being able to better comprehend how visitors in the basement of the Grand Café in Paris in 1896 might have felt, when seeing the train come right towards them as Auguste and Louis Lumière screened their film *The Arrival of a Train at La Ciotat* for the first time.

4 Quoted from: Rheingold, Howard: *Virtual Reality,* Summit Books, New York, 1991, p. 286.

"I had the strong impression that the music and the visual performance could continue to exist independently of each other, but that together they blended to create a form that effectively communicated sophisticated new sounds and images to a receptive and new audience."

Source: Davies, Dennis Russell, "Music for the Eyes," in: Stocker, G. & Schöpf, C. (eds.): *SIMPLICITY—the art of complexity*, Ars Electronica 2006, Hatje Cantz Verlag, Ostfildern, 2006, p. 251

Dennis Russell Davies (*1944, US/AT). Conductor and pianist. Chief conductor of the Bruckner Orchester Linz and the Musiktheater Linz from 2002–2017. Has worked with numerous institutions and orchestras, including the Bayreuther Festspiele, the Wiener Staatsoper, the Metropolitan Opera, and the ORF Radio-Symphonieorchester Wien. Music director and chief conductor of the Filharmonie Brno since 2018 and chief conductor of the MDR Sinfonieorchester Leipzig since 2020.

The Big Concert Night (2016), Bruckner Orchester Linz under Dennis Russell Davies performing *Le Sacre du Printemps.*

Again, the approach of the Ars Electronica Futurelab was intrinsically rooted in its cultural work between art and science, as Horst Hörtner pointed out: "The music visualizations of the Ars Electronica Futurelab resulted from the genuinely artistic impulse to use new technologies to create new means of expression. Ultimately, our work on Wagner's *Das Rheingold* was an experimental approach to the future of opera."[5] The experiment, however, was well received by a traditionally highly critical audience comprising devotees of Richard Wagner. It had in fact been a quite daring move of the artistic director of the Brucknerhaus, Wolfgang Winkler, to invite the Ars Electronica Futurelab to bring media art and technology into the temple of classical music. Also the conductor Dennis Russell Davies—who, soon after becoming chief conductor of the Bruckner Orchester Linz in 2002, had entered into cooperation with Ars Electronica—was impressed with the results and advocated for further collaborations with the Ars Electronica Futurelab: "I had the strong impression that the music and the visual performance could continue to exist independently of each other, but that together they blended to create a form that effectively communicated sophisticated new sounds and images to a receptive and new audience."[6] Such openness for experiment seems to be a characteristic of Linz, where audiences—since the beginnings of Ars Electronica in 1979—were used to being confronted with the latest media art and technology every year. No wonder that in 2014, a decade after *Das Rheingold* crossed paths with the Ars Electronica Futurelab and 35 years after the inception of the Ars Electronica Festival, Linz became a "UNESCO City of Media Arts."

The Ars Electronica Futurelab flourished not only as part of the ecosystem of Ars Electronica, but also in the specific cultural climate of Linz, and at the same time frequently referred back to its hometown, allowing the city and the region to profit from its work and innovation. Moreover, the topic of urban environments in times of the digital revolution maintained an important position in the work of the Ars Electronica Futurelab and inspired a range of regional as well as international projects. The methods that the Ars Electronica Futurelab applied to questions relating to the encounter of media art and architecture in fact resembled its approach to the challenge of creating a new layer of experience to classical music through the means of media art. Horst Hörtner likes to evoke the metaphor of the hourglass in describing that method: "On one side of the hourglass, we first try to understand a certain system, filter out its essential aspects and properties, and then send them through an artistic transformation—corresponding to the narrow passageway in the middle of an hourglass. On the other side of the hourglass, the artistic interpretation emerges. An entire poetic system unfolds here, which finally makes it possible to experience what initially we had found on the other side of the hourglass."[7]

5 Horst Hörtner, in a conversation with the author, March 2021.

6 Davies, Dennis Russell, "Music for the Eyes," in: Stocker, G. & Schöpf, C. (eds.): *SIMPLICITY— the art of complexity,* Ars Electronica 2006, Hatje Cantz Verlag, Ostfildern, 2006, p. 251

7 Horst Hörtner, in a conversation with the author, March 2021.

Das Rheingold—Visionized

Type: Music visualization
Location: Brucknerhaus, Linz, Austria
Year(s): 2004

Special features / key technologies:
Music visualization, sound interpretation, 3D real-time rendering, poetic system

Das Rheingold—Visionized was the first major project in Ars Electronica's series of music visualizations. Concertgoers wearing 3D glasses were completely immersed in a three-dimensional manifestation of virtual gods and their spheres by means of an interactive, computer-controlled visualization that surrounded the audience seated in the main concert hall of Brucknerhaus Linz with an 850 m² black projection screen. Advanced computer technology was used to interlink the scenes prepared by Austrian artist Johannes Deutsch with the musical score, and the work's performance by orchestra and soloists playing and singing live via microphone directly influenced the visual presentation on stage.
A transdisciplinary team of specialists was given a year to teach a computer system to analyze Wagner's *Das Rheingold* and to interpret it according to design criteria. The raw material in the form of conceptual designs and formalized intentions was modulated in real time based on musical information. One challenge was to develop a visual language that conveyed the artistic intention and interpretation of Wagner's *Ring* with an approach that was neither a classic production nor a systemic interpretation. The musical interpretation that conductor Dennis Russell Davies conveyed to the Bruckner Orchestra Linz and to the soloists provided the actual dramaturgy of the unfolding and modulation of this virtual world.

https://u.aec.at/1F7A49BF

Virtual Creatures Swarm Out After Night Has Fallen

One evening early in the new millennium, a conversation took place in Berlin on the construction site of the new regional office of SAP in the German capital. At that meeting, which marked the beginning of a long-standing cooperation between the software giant SAP and the Ars Electronica Futurelab, this method of thinking and of working with what would—much later—be called "Poetic Systems" could be observed in action in real time. Gerfried Stocker and Horst Hörtner had come to Berlin for that meeting and walked through the new building together with SAP's chief project expert Karsten Koch and other members of the SAP team. Karsten Koch immediately noticed that the two gentlemen from Ars Electronica were listening attentively and taking notes on tablet computers, which they, as the only ones in that encounter, were using. Soon enough, Gerfried Stocker and Horst Hörtner then began to develop, on the spot, first ideas on how media art could be used to open up that office building toward the city space and enable interaction between the company residing there, the public on the sidewalk, and the clients visiting SAP. At that time they were preparing the exhibition *Hidden Worlds* for the Ars Electronica Center, curated by Gerfried Stocker and Futurelab member Dietmar Offenhuber. One of the exhibits there—*The Hidden Worlds of Voice and Noise*—was created in collaboration with the American artists Golan Levin and Zachary Lieberman and became inspirational for *Hidden Worlds Berlin.* It is a valid example of the way in which art, science, and technology interact at the Ars Electronica Futurelab, of how, from an augmented-reality installation that depicted sounds and voices in virtual space, influences for two very different kinds of projects in two highly different settings emerged: for *Gulliver's Box* at the Ars Electronica Center in Linz, and for *Hidden Worlds Berlin* at SAP regional headquarters in the German capital.

Hidden Worlds Berlin (2004/2005), media installation at SAP's Berlin regional headquarters

7 Horst Hörtner, in a conversation with the author, March 2021.

“The Ars Electronica Futurelab is like a marketplace of several different laboratories. The people of the Futurelab do not simply work like an agency would. They first ask themselves, does this topic fit for the Futurelab. It is always an adventurous journey and extensive experience to work with them.”

Source: Karsten Koch, in a conversation with the author, November 2020.

Karsten Koch (*1967, DE). Engineer. Chief project expert, Strategic Finance Projects SAP SE.

Hidden Worlds Berlin (2004/2005), media installation at SAP’s Berlin regional headquarters

Hidden Worlds Berlin populated the office building with virtual creatures, which would appear on rear projection units working also in broad daylight, combined with the opportunity for visitors to engage in direct physical contact with the building immediately upon their arrival in the lobby. After nightfall the virtual creatures would also be projected unto ceilings and walls of the dormant office complex, becoming visible to pedestrians, who were invited to interact with those "hidden worlds" populated with virtual life. From this first encounter of representatives from two organizations, who shared a background in information technology, but were defined by quite different corporate cultures, resulted a Poetic System with virtual creatures displaying an astonishing potential for survival in a business environment. Karsten Koch remembers the immediate impression of the innovative and surprising qualities of that open exchange with Ars Electronica, which he traced back to the special kind of approach characteristic of the Ars Electronica Futurelab: "The Ars Electronica Futurelab is like a marketplace of several different laboratories. The people of the Futurelab do not simply work like an agency would. They first ask themselves, does this topic fit for the Futurelab. It is always an adventurous journey and extensive experience to work with them."[8]

Hidden Worlds Berlin (2004/2005), media installation at SAP's Berlin regional headquarters. Sensor equipped surfaces invited visitors to engage in direct physical contact with the building.

8 Karsten Koch, in a conversation with the author, November 2020.

A Laboratory Comes of Age

The adventurous experience of working with the Ars Electronica Futurelab surely corresponded the adventure of working at the Futurelab through the different stages of its history. In the early days, the team of the Ars Electronica Futurelab could be found scattered among different locations inside and in the vicinity of the Ars Electronica Center. In the Center they worked in a narrow corridor behind a wall shielding them from the exhibition floor populated with museum visitors. There were nondescript office spaces in an adjacent building and of course that legendary "First Floor," the home base of independence and resistance against any tendencies towards beginning commercial activities of the young Ars Electronica Futurelab. Those were the first formative years, where there was no conventional recruiting in place, but people drifted in based on shared views and visions towards the future, and expertise was accumulated to reach potential and not by strategic human resource development. It can be risky to map one myth upon another, in this case the myth of the early Internet upon the founding myth of the Ars Electronica Futurelab, but it may be telling to do so. However, the legendary formula of American computer scientist and Internet pioneer David Clark, which he is credited with first expressing at a 1992 meeting of the Internet Engineering Taskforce, seems to describe quite well the spirit prevailing at the early Ars Electronica Futurelab: "We reject kings, presidents, and voting. We believe in: rough consensus and running code."[9] For the Ars Electronica Futurelab team, the final years of the 21st century were about figuring out how they wanted to work, in which environment, on which topics, and towards which goals. With the first commissions from industry in the region and cooperation with universities, the work style began to change step by step. In that process, the CAVE certainly provided a nucleus of shared attention and projects, thus giving the Ars Electronica Futurelab an element of stability and serving as a key factor in enabling the Futurelab to begin standing on its own feet economically.

Ars Electronica Futurelab (1999)

9 Clark, David, "A Cloudy Crystal Ball: Visions of the Future (Alternate Title: Apocalypse Now)," July 16, 1992, Proceedings of the Twenty-Fourth Internet Engineering Task Force, Cambridge, MA, July 13–17, 1992, available from http://www.ietf.org/proceedings/24.pdf

Ars Electronica Center and Ars Electronica Futurelab

A milestone in the development of the Ars Electronica Futurelab was reached in 2002, when the whole team moved together into their first "own" space, a somewhat run-down, open-plan office on the ground floor next to a supermarket, a stone's throw away from the Ars Electronica Center. This move marked their emancipation from the Ars Electronica Center, as people were now either going to the Center *or* to the Futurelab, two destinations that up to that moment had been seen as one. Once again, Winston Churchill's remark about the interrelation between our buildings and ourselves naturally comes to mind, this time with no need for paraphrasing: "We shape our buildings; thereafter they shape us."[10] The interrelation goes far beyond the merely symbolic in shaping an identity towards the inside and the outside. For the team of the Ars Electronica Futurelab, this new space felt like their "garage," a mythical topos that underlines their roots in computing and engineering by mentally connecting them to a famous kind of founding legend for IT companies. At their "garage" the Ars Electronica Futurelab could install their own hybrid of workshop, atelier, and office, drill holes in the floor, or set up models like the one for *Das Rheingold* at the Brucknerhaus. Feeding themselves from the adjacent supermarket, some of the team might at times even sleep next to their desks for a few hours. When a so-called "Lab meeting" was called for spontaneously, the entire team would form a circle, standing amidst their desks, computers, and installation setups. There was less the feeling of "going to work" and more a feeling of living in the Futurelab. Those were highly productive and successful years, with a strong dynamic allowing the team to work increasingly for international clients and to embark towards new areas of work, such as, for instance, the music visualizations.

And then, in 2009, several things happened more or less at the same time. The Ars Electronica Futurelab had entered another of those high-speed development tunnels in the preparations for the new and much larger building of the Ars Electronica Center, which contained an entirely new set of exhibitions and the brand-new Deep Space to be developed and installed. In the middle of setting up the exhibitions, the Ars Electronica Futurelab moved to its new office space in a wing of the new structure. For the first time in their history, the Futurelab team members had a beautiful view of the Danube flowing past and separate spaces for technical setups and tests. Their desks were no longer on one floor, but split into two levels of the building, which significantly changed the inner communication modalities. It was "the end of the nonchalance of the garage,"[11] which gave way to a new form of organization. This process was intensified by the—legally necessary—structural change from an informal and project-oriented culture of working relations, which felt more like being part of an independent artistic collective, towards a corporate culture with employment contracts, regulated working hours, and paid holidays. Naturally, in times of such massive change, some members of the team left and the new situation was reflected in the new premises as well as, over the years, in several new faces.

10 https://www.parliament.uk/about/living-heritage/building/palace/architecture/palacestructure/churchill/

11 Horst Hörtner, in a conversation with the author, March 2021.

The team grew significantly to more than 70 people in the course of certain projects, so that previous self-organizing processes no longer worked and had to be replaced by tools for project management. However, economic growth had not been the guiding idea when founding the Ars Electronica Futurelab, and a much larger team also raised the pressure for realizing projects to sustain it. This situation sparked new reflections about the right balance between the original intentions of the Ars Electronica Futurelab and ways in which to work best with the team and raise the economic potentials from the innovations coming out of the Futurelab. Ultimately, this process led to the spin-off of Ars Electronica Solutions in 2012, headed by Michael Mondria, a former director of business development at the Ars Electronica Futurelab. Ars Electronica Solutions was created with the aim of bringing the Futurelab's innovations closer to the market and started with a team mainly consisting of former Futurelab members. In the meantime, the Ars Electronica Futurelab focused again on its work at the nexus of art and science, with a smaller team, reduced over a period of years to between 30 and 40 members. Keeping up the artistic core spirit of the Ars Electronica Futurelab in different new frameworks may have presented certain challenges for the triple directorial team of the organization, but they managed the transitions into a significantly more professional environment. It would soon be clear that they not only sustained the spirit of the Futurelab and its defining capabilities for innovation, but were able to go beyond previous achievements towards new and exciting levels of development.

Ars Electronica Futurelab, laboratory and atelier for future systems (2009)

Ars Electronica Futurelab (2009)

Rites of Spring and Beyond

Before reaching that milestone of 2009, still during its "garage" years, the Ars Electronica Futurelab expanded its work with music visualizations, prominent among them Igor Stravinsky's ballet music *Le Sacre du Printemps* (The Rites of Spring) in 2006, with Dennis Russell Davies conducting and Klaus Obermaier creating the artistic design of the visualization and the choreography. The dancer Julia Mach performed on a small elevated platform, with stereo cameras forming a cube of 3 x 3 x 3 meters around her. The cameras picked up her movements, which were then transferred to a three-dimensional virtual space. Futurelab member Pascal Maresch, who directed and advanced this entire strand of projects, noted that *Le Sacre du Printemps* is "a work whose explosive musical power is not just visualized in this production; rather, this artistic treatment complements and enhances it with additional levels of experience."[12] This had, in a way, already been true for *Das Rheingold* in 2004, but in the collaboration with choreographer and director Klaus Obermaier on the music by Igor Stravinsky, the Ars Electronica Futurelab entered new artistic ground. With this iconic work of modernity, premiered in 1913 at the Théâtre des Champs-Élysées in Paris, Stravinsky himself had broken new ground, and in the following years his composition had developed a strong impact on musical language itself. Pushing boundaries by reflecting the implications of virtualization was one of the challenges roughly a century after the premiere of *Le Sacre du Printemps,* as Klaus Obermaier formulated in 2006: "... the issue of the day is the authenticity of experience in the light of the ongoing virtualization of the spaces in which modern life is played out. It's the dissolution of our sensory perception, of the space-time continuum, the blurred dividing line between real and virtual, fact and fake that takes us to the limits of our existence."[13] The collaboration of the Ars Electronica Futurelab with Klaus Obermaier included projects like *Apparition* in 2004 and the long-term research *(St)Age of Participation,* which continued from 2011 until 2015 and also made use of the Deep Space as a laboratory for interaction with virtual environments. The roots of Ars Electronica in early media art, which in turn originated partially from the contexts of "Happening" and "Fluxus", may have added to a certain affinity for exploring terrains like synesthesia—the ability to "hear" colors or to experience other perceptual phenomena as related—and intermediality with the means of cutting-edge digital technology. Pascal Maresch characterized the work of the Futurelab in this context: "The Ars Electronica Futurelab's visualizations are neither directly related to synesthesia, nor do they constitute the attempt to translate from one form of sensory perception into the other. Rather, the media lab brings forth a sphere of audiovisual fusion that enables interplay to occur between the composition, the conductor's interpretation of it, the musicians, and the work of artists in many disciplines."[14]

12 Maresch, Pascal, "The Visualisation of Le Sacre du Printemps," in op. cit., Hatje Cantz Verlag, Ostfildern, 2006, p. 302.

13 Klaus Obermaier, "Music—Dance—Space, The Visualization of Le Sacre du Printemps," in op. cit., Hatje Cantz Verlag, Ostfildern, 2006, p. 303.

14 Maresch, Pascal, "The Further Adventures of Surfaces, Sounds, Pixels and Colors—3-D Music Visualizations from the Ars Electronica Futurelab," in op. cit., Hatje Cantz Verlag, Ostfildern, 2006, p. 291.

The Visualization of Le Sacre du Printemps

The Next Generation of Visualization Technology

Type: Music visualization
Location: Brucknerfest Linz, Linz, Austria
Year(s): 2006

Special features / key technologies:
3D real-time rendering, music visualization, sound interpretation, motion tracking, poetic system

Music visualizations in conjunction with stage performances have become one of the Ars Electronica Futurelab's core competence areas. Once again, a 3D space coupled with musical impulses provided the framework for a narrative structure. For the first time, the body and the movements of a dancer were integrated live into the stereoscopic visualization so that real actions on stage could be duplicated and artistically processed in real time in virtual space.
Such crossmedial projects represent an amalgamation not only of technologies and artistic genres, but also of personalities and ways of approaching a work, which gives rise to new methods of cooperation. In *Le Sacre du Printemps* (The Rite of Spring), it was dancer Julia Mach and media artist, director, and composer Klaus Obermaier who collaborated with the Ars Electronica Futurelab to design and develop a multifaceted performative creation, performed and interpreted by the Bruckner Orchester Linz under Dennis Russell Davies.

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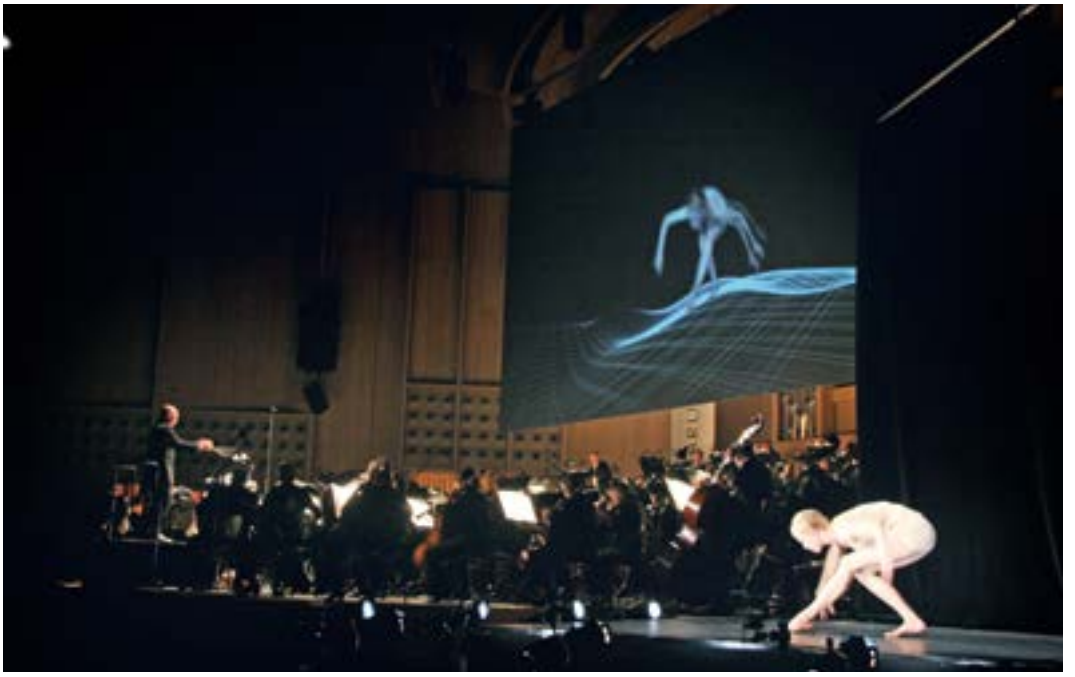
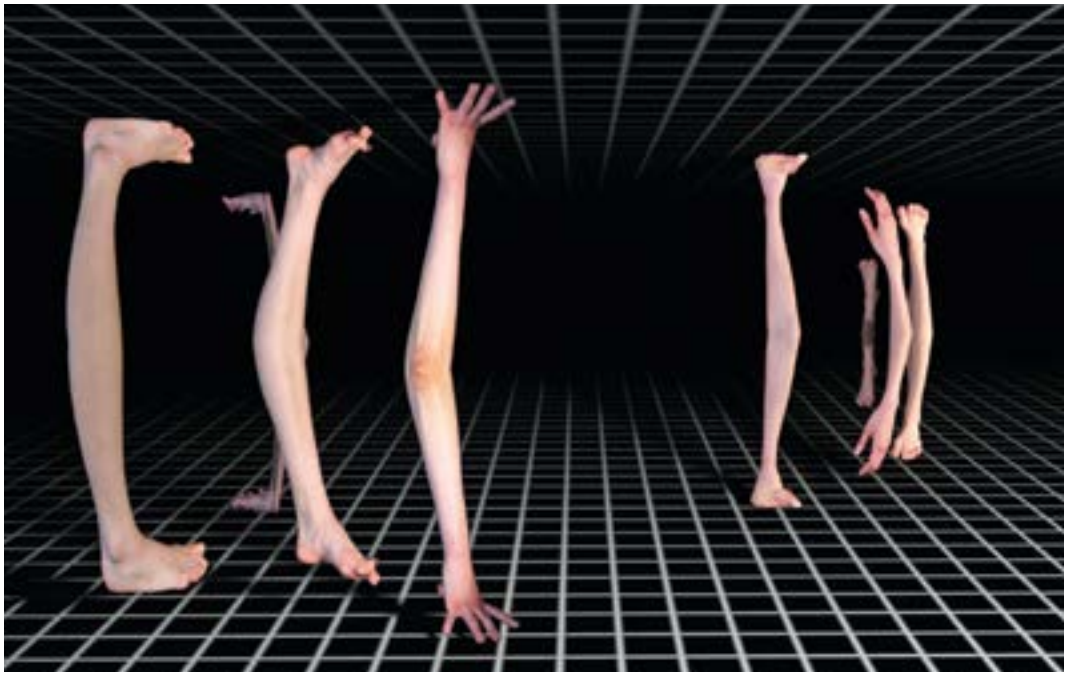


The visualization of Igor Strawinsy's *Le Sacre du Printemps* (2006) in collaboration with Klaus Obermaier, dancer Julia Mach, Bruckner Orchester Linz under Dennis Russell Davies, and Brucknerhaus Linz.

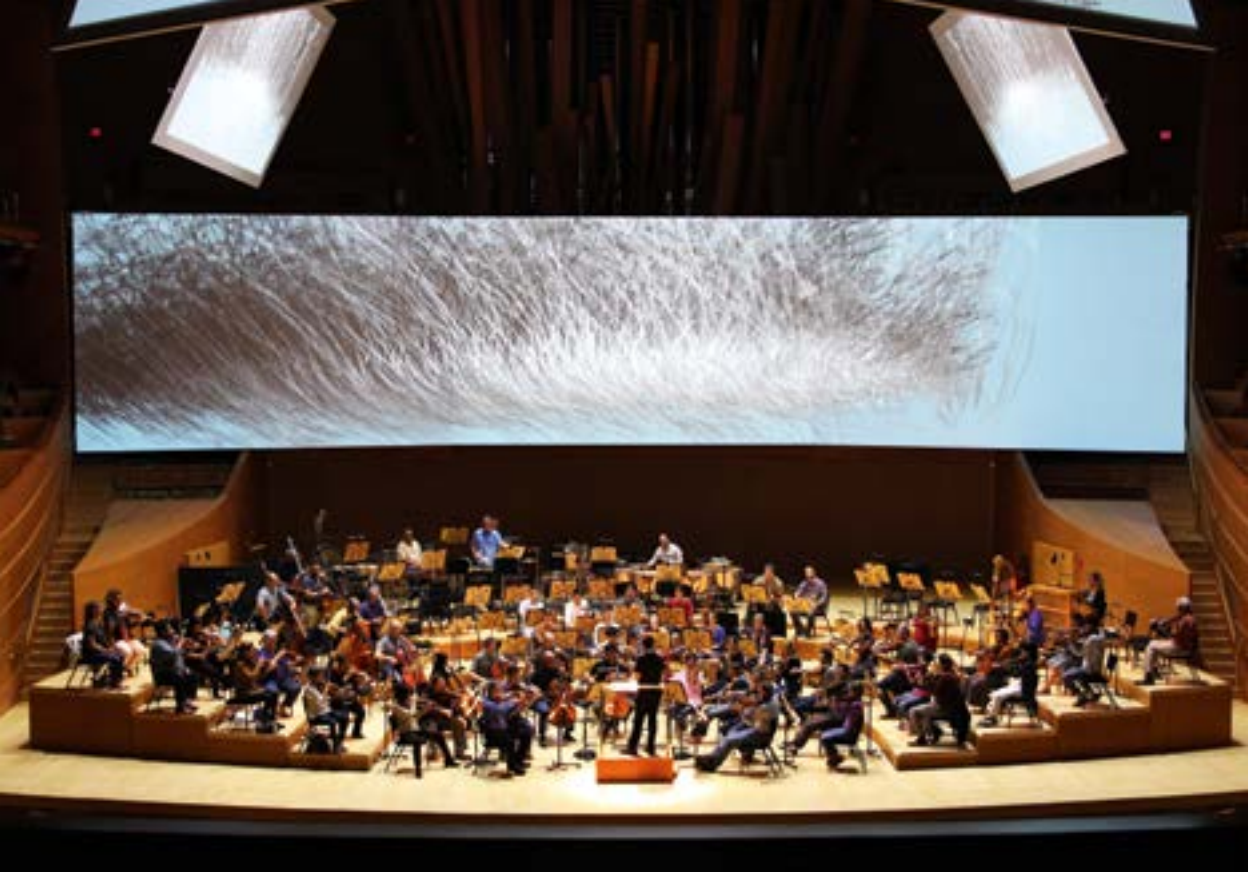


The visualization of Igor Strawinsy's *Le Sacre du Printemps* (2006) was transmitted live to the Donaupark.

Vision Mahler, world premiere in Cologne's Philharmonic Hall on January 1, 2006 at a gala concert held to celebrate WDR's 50th anniversary with the WDR-Sinfonieorchester under Semyon Bychkov.

Ars Electronica 2019, Big Concert Night, *Mahler Unfinished,* Bruckner Orchester Linz under Markus Poschner, visuals by Akiko Nakayama. Gustav Mahler never finished his Symphony No. 10, but by using an artificially intelligent algorithm, Ali Nikrang, Key Researcher at Ars Electronica Futurelab, completed the piece.

Several projects of the Ars Electronica Futurelab with music and visualization followed over the years, while the cultural landscape of visualizations of music became much broader, also due to a growing number of tools, which no longer required programming skills of visual artists, and, on the other hand, the fact that art education was beginning to incorporate literacy in media technology. Meanwhile, the Ars Electronica Futurelab proceeded towards increasingly sophisticated methods of working with real-time connections of music, visuality, and virtual space—developing new algorithms using different kinds of signals from the music, and new ways of generating patterns and behaviors of visuals. The original intention of exploring the potentials of new technologies for artistic expression kept guiding the team's approach to various projects also in changing contexts. Classical music, namely compositions conceived for the stage, like opera and ballet, proved especially apt for the creation of such an additional layer of real-time visualizations and for exploring future ways of presenting musical works, but the projects of the Ars Electronica Futurelab were not limited to opera and ballet music. On the occasion of the 50th anniversary of the public broadcaster WDR, the Ars Electronica Futurelab had also collaborated with Johannes Deutsch for a 3D visualization of Gustav Mahler's *Symphony No. 2 in C minor,* the *Resurrection Symphony* of 1895, at the Cologne Philharmonic Hall. The WDR broadcast the concert live on January 1, 2006, and television audiences across Europe could experience the virtual spaces in stereoscopic form after they had been sent special glasses through television print magazines. 13 years later, the Futurelab would work again with a composition by Gustav Mahler (1860–1911), this time Mahler's *Symphony No. 10,* which exists only in sketches. Ars Electronica Futurelab key researcher Ali Nikrang, himself both a composer and a computer scientist, used an artificial intelligence system to complete the unfinished movements and then orchestrated them by hand. Projects like this one illustrate how the use of artificial intelligence in the creative process and the future collaborations of artists and AI systems open up new and additional perspectives in the work of the Ars Electronica Futurelab with music. The Bruckner Orchester Linz, conducted by Markus Poschner, performed *Mahler-Unfinished* at the Ars Electronica Festival in 2019. In contrast to the composition, which in part originated from an AI, the visuals this time did not come from a computer system, but were created live in a very "analog" way by the artist Akiko Nakayama.



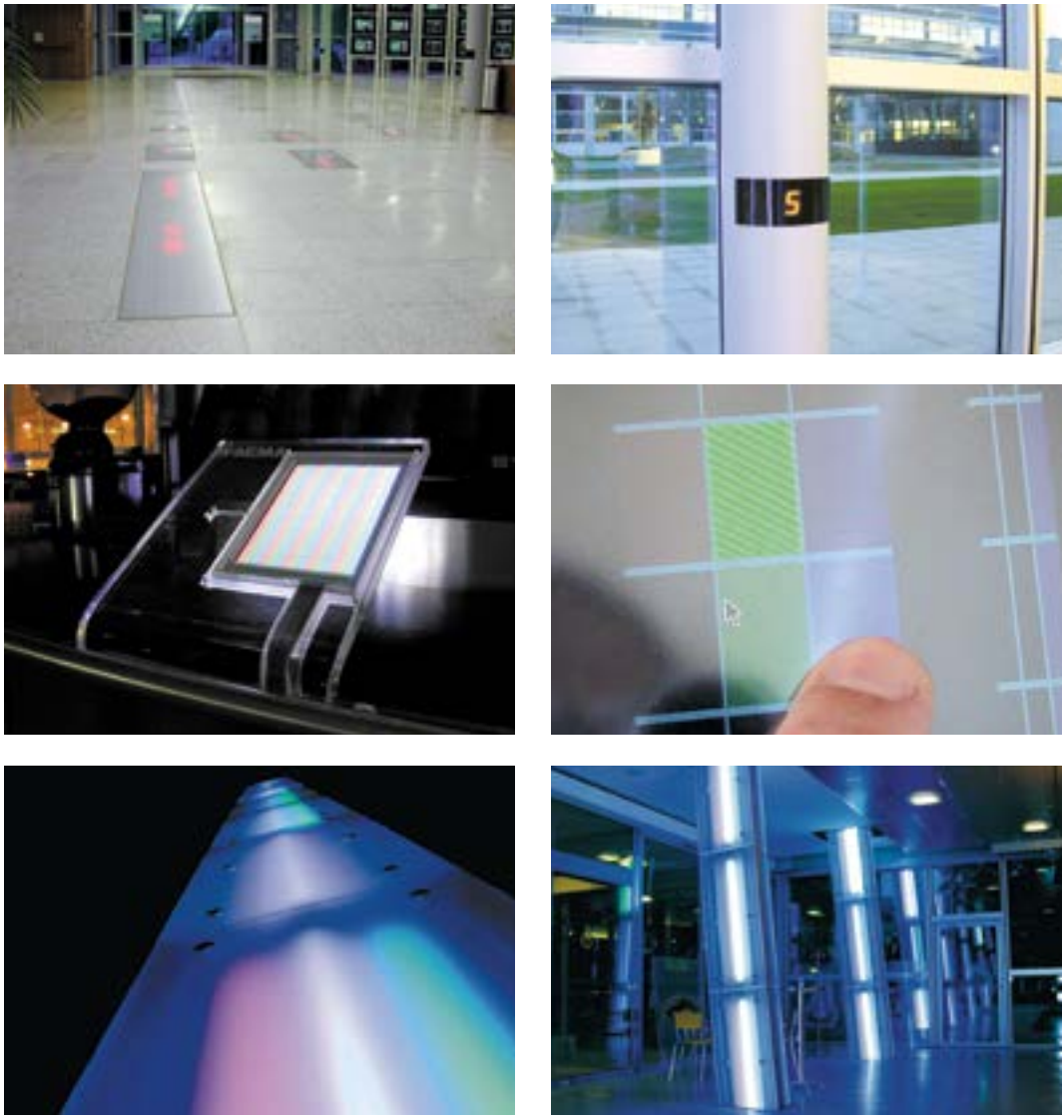
Visualization of Maurice Ravel's *Mother Goose* (2016). As part of the Walt Disney Concert Hall's IN/SIGHT series, Esa Pekka Salonen conducted the L.A. Philharmonic Orchestra in a performance of Ravel's *Mother Goose* that featured impressive visualizations designed by Cori O'lan and Ars Electronica Futurelab. A joint commission by Los Angeles Philharmonic and Abu Dhabi Festival.

Music visualization projects by the Ars Electronica Futurelab travelled to places like Shanghai or the Walt Disney Concert Hall in Los Angeles, where visuals from Cori O'Lan and the Futurelab interacted with *Ma Mere l'Oye* (Mother Goose) by Maurice Ravel (1875–1937) in 2016. Moreover, they were not confined to the inside of philharmonic halls, but, in 2006, with *Le Sacre du Printemps,* were also transferred live to the outside: in the Donaupark in front of the Brucknerhaus in Linz, a huge audience, this time equipped with 25,000 pairs of glasses allowing them to see the stereoscopic projections, experienced it live as the Linzer Klangwolke (Linz Cloud of Sound). In this way, the music visualizations also reached the urban space of Linz, a process for which the Ars Electronica Futurelab has been providing the tools since its beginnings, thus connecting the work of the Ars Electronica Futurelab with the initial moments of Ars Electronica in 1979, when Anton Bruckner's *Symphony No. 8 in C minor* had flowed along the banks of the Danube and through the streets of the city.

The Quest for the Intelligent Environment

Over the last decades, media art has entered the modern city in various forms. It has also radically transformed the traditional ways in which art used to be integrated in architecture or, oftentimes, happened to be merely attached to buildings. Interactive media have the potential to actually complement architecture. The role of media art goes well beyond the purely aesthetic or semantic; it can also affect and even enhance the functional aspects of a building. Around the turn of the millennium, however, it was still fairly unusual to involve media artists in "Kunst am Bau" (art in architecture) and there were also widespread doubts as to whether a technology-driven installation would be art at all. The annual activities of the Ars Electronica Festival since 1979 and of the Ars Electronica Center since 1996 had of course significantly raised awareness and openness in Linz for different aspects of the "digital city."

Thus, it may have seemed like a logical step, but still came as a nice surprise, when in 2000 the Ars Electronica Futurelab was invited by the Austrian Institute for Economic Promotion (WIFI) in Linz to create a media art installation for its new educational facility. Led and conceptually directed by Dietmar Offenhuber, *unit M* became an interactive, networked media art project, which turned the WIFI building into an "intelligent environment" that would already contain several of the defining elements of coming projects of the Ars Electronica Futurelab in that respect. *Hidden Worlds Berlin* at the regional office of SAP in Berlin soon followed, and paved the way for a much larger installation for the same client. The software company SAP was the biggest corporate player to commission the Futurelab up to that point. Being the largest non-American software company by revenue, SAP at that time had a staff of around 40,000, which grew to 100,000 in 2019, and 180 regional offices worldwide. In the meantime, SAP had also acted as a sponsor for exhibitions in New York City, celebrating Ars Electronica's 25th anniversary in 2004. "Digital Avantgarde" took place at Eyebeam in Brooklyn and presented the development of interactive art, based on award-winning works of the respective category of Prix Ars Electronica, which included reconstructions of legendary works by artists such as Myron W. Krueger, Paul Sermon, Lynn Hershman Leeson, and Christa Sommerer with Laurent Mignonneau. "Interactions / Art and Technology," realized mainly by the Ars Electronica Futurelab, was presented at the American Museum of the Moving Image in Queens. On the same day on which the New York Times published a laudatory article about the Ars Electronica exhibitions in New York, the Moscow Times reported on an architecture visualization of a historic chapel, realized by the Ars Electronica Futurelab. Again, it was the world of interactive art, this time as exemplified in the cities of New York and Moscow, that would become an inspirational source for a new project in Europe, which the Ars Electronica Futurelab was entrusted with fully realizing on its own and which turned out to be the Futurelab's most extensive project for an international client so far.



UnitM–User Sensitive Information Architecture (2001), a prototype for an interactive building. The interaction proceeds indirectly via sensors and values that are provided by the building's central control system, or directly via the activities and actions of visitors. A commission for the computer training center at the Institute for Economic Development (WIFI) of the Austrian Chamber of Commerce, Linz.

Going to the Source of the Code

At first glance, the mission for *Source.Code* may have seemed to be about creating an innovative system for welcoming and guiding visitors from all around the world through the headquarters of SAP in Walldorf, so that they would be accompanied on their way to the Visitors Center, located somewhere deep inside the complex. For the Ars Electronica Futurelab, however, the project, from the very beginning, was also about creating a "portrait" of this huge software company, where processes stood at the core of their business. Consequently, the Futurelab conceptualized the project *Source.Code* around the processes of the company itself and mapped them upon the campus in Walldorf. Walldorf, a small town in the German province of Baden-Württemberg, is situated near the Rhine just south of the historic university town of Heidelberg. At Walldorf, the premises of SAP headquarters have, in their vicinity, the main plant of the company Heidelberger Druckmaschinen, the largest global manufacturer of offset printing presses. Consequently, at Walldorf, two epoch-making technologies and two essential "languages" of human culture—the printing press and the programmable digital computer, in other words, moveable type and computer code—can be found at work here, side by side. In order to enable visitors to SAP's five-story, star-shaped headquarters building to intuitively find their way to the Visitors Center, the Futurelab came up with the idea of using the flow of water, in fact one of humankind's oldest navigational aids. A watercourse with a length of 182 meters guides visitors from its source at the parking lot to the main entrance, where it is transformed into a flow of data, populated by virtual creatures, who accompany the visitors through the building. These virtual creatures are generated from a real-time interpretation of the global business activities of the company's workforce. Five main elements of this interactive media art installation relate to the main evolutionary steps in the biotope of the company's business operations. Horst Hörtner, who led the conception of the project, and Daniela Kuka, who worked as a member of the project management team, pointed out one of the key ideas of realizing such an unconventional visitor guidance system with media art: *"Source. Code* creates a venue for encounter and transfer that is in keeping with the times, one that mediates between the encoding systems of art and business, between a company's conception of itself and the perceptions of its visitors."[15] SAP, as facility manager Karsten Koch recalls, embraced the adventure of completing an intensive development and implementation process together with the Ars Electronica Futurelab, which led to this "virtual portrait" of the company. The fact that the Poetic System of *Source.Code* is—quite unusual for many media art installations—still kept up and running after almost 15 years of operation is remarkable in itself and indicates that the portrait is still valid.

15 Hörtner, Horst; Kuka, Daniela, "Code of Creativity," in: Stocker, G. & Schöpf, C. (eds.): *GOODBYE PRIVACY,* Ars Electronica 2007, Hatje Cantz Verlag, Ostfildern, 2007, p. 318.

Source Code (2007), media art as interactive visitor guidance system for SAP Deutschland's headquarters campus in Walldorf.

Source.Code

Type: Media art architecture
Location: SAP corporate campus, Walldorf, Germany
Year(s): Since 2007

Special features / key technologies:
Display walls, computer vision, media art architecture, site-specific art, peripheral displays, poetic system

Source.Code is an interactive visitor guidance system designed especially for SAP Deutschland's corporate campus in Walldorf. The project's works of media art combine aesthetic and functional systems to set up a dialog between human beings and architecture—and simultaneously offer a dynamic, unique way of looking at SAP's business and information processes. Conceptualizing a visitor navigation system not as a conventional signage but rather as an architectural implant led to the emergence of a concept that combines state-of-the-art technology and one of humankind's oldest navigational aids: Follow the water.
Business processes that take place within the company's corporate structure are transformed into visualizations that fill the headquarters complex. Every bit of system input and each line of recorded information is visualized as a "process creature" swimming in a flow of data and interacting with visitors—sometimes timidly, sometimes politely and encouragingly, and sometimes even somewhat annoyed.

https://u.aec.at/11F58B1A

Source Code (2007), media art as interactive visitor guidance system for SAP Deutschland's headquarters campus in Walldorf.

A Global Space of In-Between

Airports are among the iconic places of modernity. They have a special inner structure that separates them from other kinds of buildings, even other traffic hubs like train stations. Due to numerous legal regulations, from border control to the prevention of terrorism, they contain at least three zones with different degrees of public access and levels of security. After crossing the public check-in areas, you pass security control to an "inner" waiting area, where the mood is different. Everybody here has passed a security check and has a valid ticket for flying. Beyond that are the restricted areas reserved for airport staff and aviation crews. And beyond that are the aircraft, special territory again, already belonging to a different realm.
As hubs of international air traffic, airports are permanently connected with the remotest locations and time zones on earth. With thousands of passengers passing through them and between their different zones loaded with sensors, checkpoints, and cameras, airports generate huge amounts of data and could be seen as a laboratory for the future of cities with comprehensive surveillance.

ZeitRaum (2012), interactive art installation for the new terminal at Vienna International Airport. It creates real-time interpretations of arriving and departing flights.

When in 2012 a new wing of the Vienna International Airport (VIE) was nearing completion, the Ars Electronica Futurelab created the interactive art installation *ZeitRaum* (Time-Space) specifically for this setting. It was to become the Futurelab's largest project so far, including three weeks of living at the airport for the team installing it. They used the data from various technical systems of the airport and created an infrastructure to continuously transform this data into a very special Poetic System. The complex multi-part installation produced real-time interpretations of arriving and departing flights and accompanied departing passengers on their way to the gates. The Futurelab team analyzed the (anonymized) data produced by the airport and—on a poetic level—made visible that special, temporary community of people who populate the waiting lounges at the gates. In 2012, globally more than five billion air travelers per year could be counted, and around twice as many were projected for 2020. Air traffic grew massively during that decade and at the same time awareness of its ecological footprint was rising. Of course, the figures for 2020, as the first year of the Covid-19 pandemic, would turn out differently. However, reflecting on the phenomenon of this global group of air travelers in a strange continuum called *ZeitRaum* formed the core of the Futurelab's concept for Vienna International Airport. Various texts from science and literature—by authors including sociologist Saskia Sassen, biologist Humberto Maturana, and robot researcher Hans Moravec—about this phenomenon flowed into the various parts of the installation, forming entire "textscapes," including dynamic mountains determined by parameters of incoming or departing aircraft. Also, the movements of the passengers across the airport influenced the output of the installation and allowed everyone to leave their trace in the overall art installation. The texts, while forming the landscapes, shifted between languages according to the immediate departure of a flight to a certain country and the size of the plane en route to that destination. At the barrier separating the publicly accessible check-in area from security control, a huge gate made of display panels was erected, in fact a kind of liquid, shimmering wall of digital surfaces in the size of a stately family mansion. This element of *ZeitRaum* was the overture to the entire media installation expanding along most of the new wing of the airport. Although this digital membrane was located indoors in the vast departure hall of the airport, it felt, in a way, like the media facade of a building, some mysterious kind of temple-like structure you queued up to, finally entering through a small opening in the wall. Somehow corresponding to the merely transient presence of travelers in this "time-space," the entire Poetic System itself, which the Ars Electronica Futurelab had created for the Vienna International Airport, turned out to have only an ephemeral character. After only a few years, the airport decided to repurpose the displays of the media art installation as a profitable infrastructure for corporate advertising, thus illustrating once more an age-old conflict zone of public spaces. For the Ars Electronica Futurelab, this experience sharpened the understanding of how dominating economic paradigms and power are shaping our entire environment, from public space to digital media space. Through this, the mindsets and actions of people are influenced, until they are reduced to an existence as consumers of goods and services, subject to an omnipresence of advertising.

ZeitRaum

Type: Media art architecture
Location: Vienna International Airport, Vienna, Austria
Year(s): 2012

Special features / key technologies: Display walls, computer vision, media art architecture, site-specific art, spatial audio, poetic system

ZeitRaum (TimeSpace), an interactive art installation designed for the new terminal at Vienna International Airport, creates real-time interpretations of arriving and departing flights. *ZeitRaum* consists of a series of stations that accompany departing passengers on their way to their gates. They take travel, time, and air traffic as their subjects, and offer encounters with art to those passing through this hub. Travelers' initial encounter with *ZeitRaum* is in the Check-In area, where an imposing wall of monitor screens straddles the corridors leading to and through the security checkpoint. A person's approach triggers a cloud of letters cascading down this wall. Once they come to rest at the bottom, these letters coalesce into texts that, in turn, form the topography of a landscape. Hills and valleys take shape in this way, all of them incessantly in motion because their growth is linked to the constant flow of arrivals and departures. Every takeoff engenders a hill, every landing a valley.

At the core of this work is an imaginary space, one at the interface of all the world's airports. Passengers enter it when they pass through a security checkpoint prior to takeoff and leave it after touching down at their final destination. This space's boundaries are constantly shifting in accordance with current air traffic. Within its confines, cultures, languages, and nations segue into one another like adjacent time zones. This space hosts more than five billion people a year, men and women who are total strangers and yet feel that they're temporarily interconnected as fellow members of a transient community. This space has had no name until now. Ars Electronica Futurelab calls it *ZeitRaum.*

https://u.aec.at/7F60053B

Sonic Encounters on the Bridge

Sometimes, two areas of activity flow into one, as occurred in 2016 with a project of the Ars Electronica Futurelab in which media technology let music and architectural space enter a dynamic continuum of remarkable poetic consistency. Between two buildings at SAP headquarters in Walldorf, with programmers housed on one side and administrators and the cafeteria of the campus on the other, there is a bridge, in fact a pedestrian passageway 60 meters in length. In collaboration with the Austrian composer Rupert Huber, the Ars Electronica Futurelab created the interactive media installation *Building Bridges* specifically for this location. Peter Freudling, a senior researcher at the Ars Electronica Futurelab, describes one of the main conceptual ideas of the project: "Translating the movements of the pedestrians through a compositional algorithm, the bridge serves as stage and instrument at the same time." The people crossing the bridge trigger sounds that were recorded by members of an—unofficial—SAP orchestra. Rupert Huber had a clear vision of the intended experience: "When I cross the bridge, the sounds walk with me. And when we meet on the bridge, our encounter would resonate with the installation, and the sounds following us would be complemented by overtones."[16] The company's employees contribute to the resulting, always-unique composition with their music and their movements, and are at the same time accompanied on their walks along the bridge with musical sound. For Rupert Huber, a project like *Building Bridges* not only turns an attitude—important for peaceful coexistence—into a sensual experience, but also is perfectly compatible with his artistic intentions: "In my spatial and installation work, I like to use direct interactivity to turn social encounters into music, to explore the possibilities of communication in a given space, and to work with music originating from the people living or working there. Collaborations with the Ars Electronica Futurelab exactly match this approach."[17]

Rupert Huber during recording works with the employees of SAP campus Walldorf

16 Rupert Huber, in a conversation with the author, May 2021.

17 Rupert Huber, in a conversation with the author, May 2021.

“In my spatial and installation work, I like to use direct interactivity to turn social encounters into music, to explore the possibilities of communication in a given space, and to work with music originating from the people living or working there. Collaborations with Ars Electronica Futurelab exactly match this approach. I consider *Building Bridges* as one of the most felicitous projects in my installation work.”

Source: Rupert Huber, in a conversation with the author, May 2021.

Rupert Huber (*1967, AT). Composer, music artist, and musician. Since 1994, electronic-music project *Tosca* together with Richard Dorfmeister. Music installations since 1995, including *Building Bridges* together with the Ars Electronica Futurelab in 2015.

Building Bridges

Type: Media art architecture
Location: SAP Business Campus, Walldorf, Germany
Year(s): 2015

Special features / key technologies:
Display walls, computer vision, media art architecture, site-specific art, peripheral displays, poetic system

"The Bridge" is one of the main passageways connecting two building complexes on the SAP Walldorf campus and is host to the interactive music piece *Building Bridges,* jointly composed with Vienna-based musician, music artist and composer Rupert Huber. Translating the movements of the pedestrians through a compositional algorithm, "The Bridge" serves as stage and instrument at the same time.
A laser tracking system reads people's movements and consecutively triggers the playback of tones. Each of the 48 individual tones is assigned to one of the speakers that are evenly distributed in the ceiling of the 60-meter-long passageway, summing up to 96 tones for both walking directions. This linear arrangement of evenly distributed sound sources in the space renders an always-unique composition created by the people walking by.

https://u.aec.at/5AA67EFB

Linz von oben (2012), in the *Linz Changes* exhibition tent, a high-resolution floor print, measuring around 150 m², showed a bird's-eye view of the entire city of Linz.

Ars Electronica Futurelab and the City

The different Poetic Systems that the Ars Electronica Futurelab has created in the broader format of "art in architecture" projects were naturally often also "art in the public space," and thus embedded in urban environments, albeit in varying degrees. For instance, in the case of *Hidden Worlds Berlin* and the way in which the system there reacted to the surrounding city, this became immediately apparent. Stefan Mittlböck-Jungwith-Fohringer understands such Poetic Systems as enablers of transformation: "Transformation is always an interplay between deconstruction and construction. Deconstruction in the searching, researching and analyzing sense; construction in the sense of the creative act, creation in all its conceivable and feasible forms."[18] Drawing from experience with numerous projects of designing Poetic Systems, Horst Hörtner emphasizes the importance of system design in contemporary cities in particular: "As the design skills of architects are important for creating quality in buildings, system designers are essential if we also want our information infrastructures to enable meaningful consistency in our cities and our societies. Otherwise the technosphere would spread to all areas of our urban environments in an uncontrolled and undesigned way, not regarding their social and cultural implications."[19] Over the last decades, cities have undergone significant transformations, which were closely connected with the advances and rising ubiquity of digital technology. Ever since the birth of

18 https://ars.electronica.art/futurelab/en/research-poetic-systems/

19 Horst Hörtner, in a conversation with the author, May 2021.

the Ars Electronica Futurelab, the city—both as a general topic and also as the specific city of Linz as the hometown of Ars Electronica—has been the subject of many projects in which the potential of the Futurelab to make urban systems visible and understandable and to reflect on their design was put to use for the community.

At its inauguration in 1996, the Ars Electronica Center already contained an interactive installation called *Cybercity,* which marked the beginning of a continuous series of installations that brought the population of Linz in immediate touch with the datascape of their city and gave them hands-on experience with issues of urban planning. Around the middle of the 1990s, enthusiasm regarding the potentials of digital technology for future life in cities had been as big as expectations of "new frontiers" in cyberspace and life online. Discussions circled around technology-driven concepts of a *City of Bits*[20] and also hopes for democratizing effects of citizen participation in "digital cities."[21] A decade later, visions of a "Smart City" had become a key topic, which was debated at the Ars Electronica Futurelab's annual conference "Pixelspaces," as Pascal Maresch described in 2006: "The urban realm is being equipped to function as a multimedia environment. Digitization is making a physical impact on the cityscape itself. Architecture is being endowed with the qualities of media and infrastructure ranging from built-in telematic furnishings to location-based services forms interfaces to linking up virtual and material spheres of communication."[22] With *Digital Pheromones* in 2007, the Ars Electronica Futurelab, together with Siemens and the Johannes Kepler University Linz, had provided a prototype for the self-organization of traffic flows in the city, a bionics-based solution inspired by the collective intelligence of ant colonies. In the following years, a massive commercialization regarding technologies and tools for "smart cities" set in, comparable to the gold rush of the "dot-com bubble," which had profoundly changed the face and the fate of the Internet around the turn of the millennium.

GeoCity (2009), exhibition area at the Ars Electronica Center that focused on the global trend towards urbanization. It provided a playful way of encountering global processes and, at the same time, opened up a totally new way of looking at the City of Linz as a localized setting for everyday life.

20 Mitchell, William J.: *City of Bits—Space, Place and the Infobahn,* The MIT Press, Cambridge, Massachusetts, 1995.

21 Pioneering in this field was "De Digitale Stad" Amsterdam; see also https://waag.org/en/project/digital-city-dds

22 Pascal Maresch, "Pixelspaces 2006: Goblin City—Media, Art and Public Spaces", in op. cit., Hatje Cantz Verlag, Ostfildern, 2006, p. 308

Connecting Cities (2013), a network of urban media facades. *United Colors of Dissent* by Orkan Telhan & Mahir M. Yavuz, displayed on the Ars Electronica Center facade.

Connecting Cities (2014), a network of urban media facades. *Entangled Sparks (LinzerSchnitte)* by Ars Electronica Futurelab displayed on the Ars Electronica Center facade.

Roughly another decade later, Dietmar Offenhuber, former member of the Ars Electronica Futurelab and meanwhile professor at Northeastern University in Boston, Massachusetts, would speak the sobering remarks at the conference "Connecting Cities" at the Ars Electronica Festival in 2015: "The 'Smart City' is dead. … even its evangelists have given up on the idea. The Smart City is a comprehensive concept in which all urban systems talk to each other, governed by a control system that, invisible to the public, keeps everything in an optimal equilibrium."[23] This technocentric approach did not involve the citizens themselves, something which more recent concepts using "civic technologies" are aiming for. True to their own working principles and thus somehow autonomous from the general trends, the work of the Ars Electronica Futurelab has always been oriented towards enabling and involving the population. With *Geo City,* which opened at the Ars Electronica Center in 2009, the Ars Electronica Futurelab provided a set of prototypical digital media applications forming a hybrid of exhibition and laboratory, this time not merely offering insights into the dynamic organism of a city, but also with the aim of raising awareness of the simultaneity of local and global phenomena. In the following years, the Ars Electronica Futurelab also contributed to the so-called "Linz Changes" tent at the traditional Urfahr Spring and Fall Fairs, a popular market for regional food and drinks and amusement park attractions. One of the many easy-to-access installations offered by the Futurelab took a set of postcards with historic photographs of the city as a point of departure. Instead of the usual augmentation of the camera image of today's urban spaces with historical information, this time a table with augmentation features showed the visitors the present state of the historic photograph's location and thereby gave an immediate impression of the urban development process. The installation did not turn the visitors into passive recipients listening to a story; on the contrary, the installation listened to the visitors and encouraged them to gather around the table with the photographic postcards and tell their own stories about certain places in the city and their past.

Connecting Cities (2015), a network of urban media facades. *Urban Entropy* by Dietmar Offenhuber displayed on the Ars Electronica Center facade.

23 Offenhuber, Dietmar, "Civic Technologies: Tools or Therapy?," in: Stocker, G., Schöpf, C. & Leopoldseder, H. (eds.): *POST CITY—Habitats for the 21st Century,* Hatje Cantz Verlag, Ostfildern, 2015, p. 150.

“How does a project need to be configured so that it bears actual relevance in the world? This characterizes the kind of transdisciplinary collaboration that seems most important to me.”

Source: Dietmar Offenhuber, in a conversation with the author, November 2020.

Dietmar Offenhuber (*1973, AT). Artist and researcher. Member of the Ars Electronica Futurelab from 1995–2004. PhD in urban planning from the Massachusetts Institute of Technology, studies at MIT Media Lab and the Vienna University of Technology. Associate professor at Northeastern University, departments of Art + Design and Public Policy, and visiting associate professor at Princeton University.

Opening the Membrane towards the City

The Ars Electronica Center, itself an urban landmark of Linz, relates to the surrounding city from the inside out and from the outside in, working with data and topics of the city in its exhibitions as well as radiating, with media art, towards the urban space. Situated at the northern bridgehead of the Nibelungenbrücke, which connects it to the historic inner city and the Main Square, the Ars Electronica Center is located very close to the Danube in an area that has repeatedly been heavily affected by floods. Therefore, deep inside, in a long corridor adjacent to the Main Gallery exhibition space, the art project *blue* by the artist group h.o[24] had been installed in 2009. It processed real-time environmental parameters of the Danube River flowing past the building and transformed them into a long stretch of projections visualizing the water level and biological condition of the river. The installation connected the technology-packed inside of the Ars Electronica Center with its natural environment and with the city of Linz, unique among the communities along the Danube, where the river flows right through the city center, with a sandy beach just a stone's throw away.

Blue (2009) by h.o. The interactive installation at the Ars Electronica Center visualized in real-time water depth, flow, weather, and news related to the adjacent river Danube.

24 https://www.howeb.org/portfolio-item/blue/

On the outside, the Ars Electronica Center is coated with a second skin, a 5,100 m² glass shell with 38,500 LED built-in elements that can emit light in the colors red, green, blue, and white. They turn each of the 1,100 glass panels of the facade into a "pixel" that can be controlled individually, commanding a wide color spectrum. These elements allow the facade to become a huge programmable display, visible even from afar. Artists Zachary Lieberman from New York and Daito Manabe from Tokyo were invited to create the opening performance of the new media facade of the Ars Electronica Center on January 1, 2009. They based their piece *Lights On* upon the idea of a planetary clock, where the planets control the shifting colors of the facade. To allow artists as well as the general public control over the facade, the Ars Electronica Futurelab created a standard interface for developers—the so-called *Fassadensimulator*[25]—and installed a public terminal at the walkway along the Danube. The terminal offered various interactive features, which included having your pulse read and then seeing it visualized on the facade. Thus, the facade of the Ars Electronica Center became part of the strategy of the Ars Electronica Futurelab to enable the public to be co-creators, or even to hand over the creation process to them. In the following year, the Ars Electronica Futurelab co-initiated and organized the "Media Facades Festival Europe 2010," which connected cultural institutions from Helsinki to Madrid and from Liverpool to Budapest in joint broadcast events interlinking their media facades. The festival—which in 2015 was followed by the *Connecting Cities* project and conference—had been created with the intention of initiating a "counter-movement against the primary commercial use of urban screens and media facades,"[26] thus reacting to a deficit still found in many municipalities. This critical stance was in line with the Futurelab's understanding of media facades as a kind of cultural urban commons, which should be under the disposition of the citizens as co-creators and remain free of otherwise omnipresent advertising.

Ars Electronica Center by night

25 The tool is freely available to educational institutions.

26 https://ars.electronica.art/futurelab/de/connecting-cities/

Ars Electronica Center Media Facade & Facade Terminal

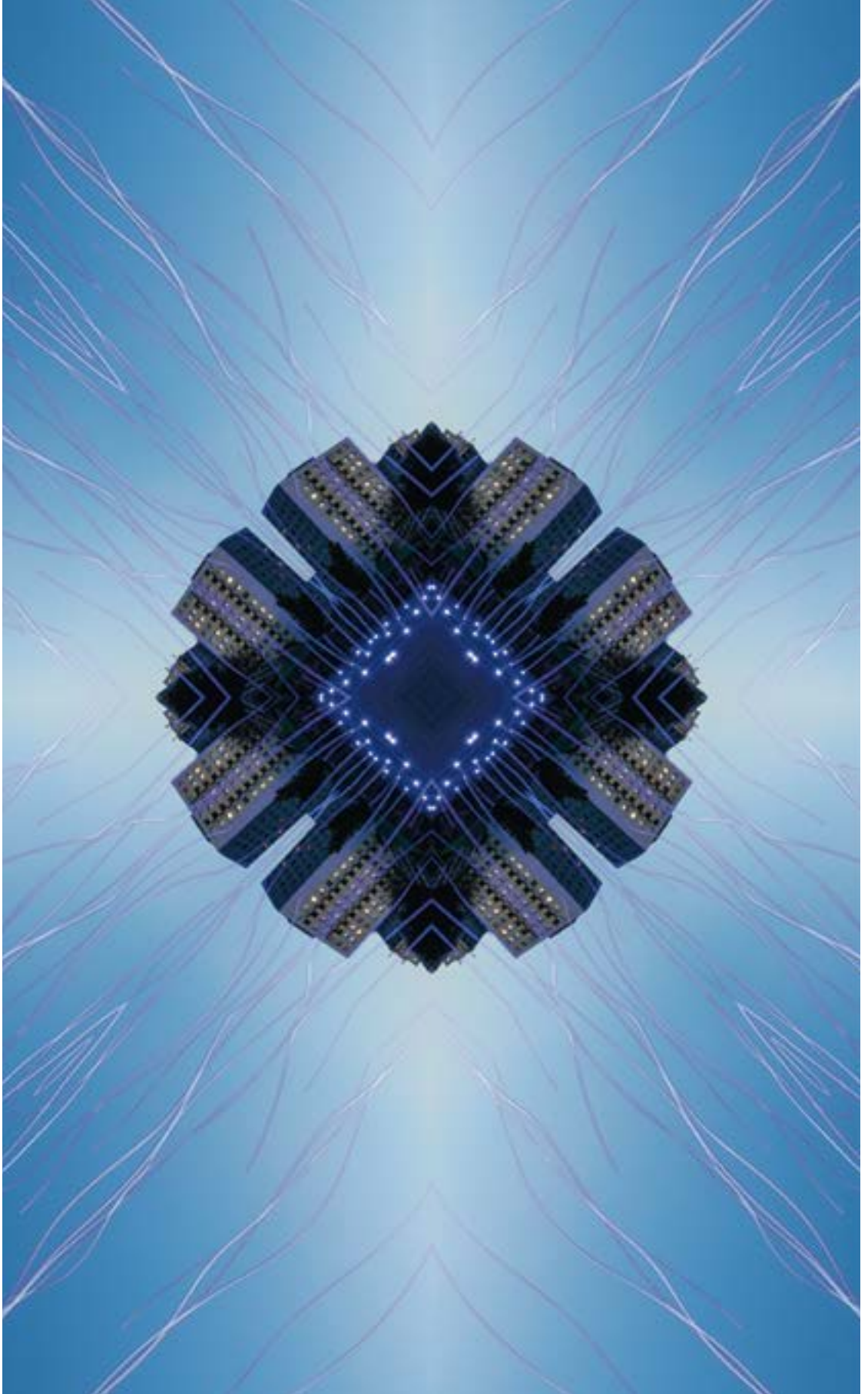
Type: Media art architecture
Location: Ars Electronica Center, Linz, Austria
Year(s): 2009

Special features / key technologies:
Site-specific art, media facade, audience participation, public screening, music visualization, poetic system

The facade of the Ars Electronica Center is equipped with LED panels. This interactive, 5.100 m² LED surface is used regularly to create outstanding art projects, either by invited artists or by media art classes of universities from all over the world.
In the evening, via the “facade terminal” on the banks of the river Danube, passersby can take control over the Ars Electronica Center’s facade and change its glowing appearance. By connecting a Bluetooth-enabled device such as a smartphone or a notebook, an individual can make the building resound and the 38,500 LED lamps pulse to match the rhythm of his or her favorite music.

https://u.aec.at/666F7CDC

The *Fassadenterminal,* developed by Ars Electronica Futurelab, to control and play the LED facade lighting of the Ars Electronica Center.



The Art of Swarms

Artificial Collectives on the Rise

One Swarm in the Sky, One on the Ground

On a slightly chilly, partially cloudy evening in early September 2012, along the banks of the Danube in Linz, two equally unlikely and astonishing swarms emerged for the first time in two epoch-making appearances. One swarm was robotic and airborne; the other was human, seen strolling across the bridge and through the Danube park after nightfall. 49 dots of light configured and reconfigured themselves to form a series of spatial images against the clouds in the night sky, while some 5,000 people carrying tall, colorfully illuminated letters, an alphabetic ocean of characters joining others to form words and phrases, proceeded on their way until they merged with the much larger crowd of 85,000 visitors who had come to experience the 2012 Klangwolke (Cloud of Sound) by Ars Electronica.

The swarm in the clouds was an "artificial collective" formed by autonomous, unmanned aerial vehicles called "Spaxels." The name of those machines, developed by the Ars Electronica Futurelab, combined the terms "space" and "pixel" to describe their unprecedented ability to be deployed as a swarm of illuminated points in midair, thus "painting" three-dimensional images in the skies. The Spaxels were operating autonomously to remain airborne, while a controlled choreography allowed them to configure themselves in the formations, which appeared as pictures in space. The swarm on the ground was formed by people who, for several weeks, had prepared themselves to participate in a large-scale project called *Klangwolke ABC,* for which each of them had selected and designed their personal letter. These letters were equipped with LEDs and radio transmitters, their lights controlled in a coordinated way, illuminating the multi-colored swarm of letters they formed. Their individual positions across the cityscape as well as their collaboration with others to form texts out of the letters of the *Klangwolke ABC* rested entirely with the social self-organization of the crowd.

Rehearsal voestalpine Klangwolke 2012 by Ars Electronica

Spaxels over the river Danube (2013)

Spaxels—
A Paradigm Shift Takes Off

On that Saturday, September 1, 2012, it seemed as though the two swarms were somehow reflecting the idea of swarm behavior, which can be observed in nature in flocks of birds or schools of fish, and at the same time were mirroring each other in a visionary—albeit still somewhat distant—entanglement of humans and autonomous machines. Certainly, the 2012 Klangwolke by Ars Electronica, of which those two swarms were in fact two key elements, was itself an aesthetic and participatory endeavor mirroring the founding moment of Ars Electronica 33 years before, the very first Linzer Klangwolke, in 1979. On that legendary evening of Tuesday, September 18, 1979, the *Symphony No. 8* by Anton Bruckner (1824–1896) had flowed from large speaker systems and—in a remarkable participatory effort—from numerous radios, which the population of Linz had placed in their open windows. For the Ars Electronica Futurelab, two milestones in its development merged on the evening of September 1, 2012: the first-ever public performance of the Spaxels, and the unprecedented participation and emerging collective action in the *Klangwolke ABC.* This moment also allowed Ars Electronica as a whole to perceive its own mirror image in a festive act of critical self-reflection, brought about through an encounter of two swarms of what could also be interpreted as rapidly firing mirror neurons, comprising a large area on land and reaching high up into the skies.

Preparing for the *DRONE 100—Spaxels over Linz* (2016) show

The story of the Ars Electronica Futurelab inventing the Spaxels is the story of a paradigm shift that was in fact quite typical for the specific way of thinking at the Futurelab, and that—again quite typical—occurred "en charette," as there was a truly challenging deadline. 33 years after its inception, Ars Electronica itself was charged with creating the 2012 Klangwolke at rather short notice and the deadline was the traditional night of the Klangwolke in early September, only some nine months away. The overall concept was titled *Die Wolke im Netz* (The Cloud in the Net) and aimed at telling the story of telecommunication from the first telegraphs up to present-day Internet with cloud computing and social networks. For the culminating point in the staging, the team of Ars Electronica clearly wanted to break with the traditions of the Klangwolke, and replace the usual huge fireworks—harmful for numerous animals and polluting the air with fine dust—as well as the traditional laser shows, with a new "digital" element of the performance. This was the entry point for Horst Hörtner's dream of sending out a swarm of drones with lights to create a new aesthetic in the night sky. Consultations with leading experts and manufacturers in the field of aerial robotics quickly made clear that basically all of them considered Horst Hörtner's plan—to put it mildly—unrealistic, especially given the narrow time frame. In face of the seemingly "impossible," the specific way of thinking at the Ars Electronica Futurelab brought the turnaround. Looking at the challenge from an artistic point of view led to the decisive paradigm shift of understanding the problem not as one of controlling a swarm of flying robots, but as one of designing patterns in three-dimensional space with light-bearing drones. This hybrid approach of art and engineering formed the basis for the solution, as Horst Hörtner recalls: "The actual solution had less to do with aerial robotics or with autonomous swarms than had initially been assumed. There were semantic interrelationships embedded in the problem, which had not immediately occurred to other experts. Due to the artistic know-how of the Ars Electronica Futurelab, we were able to detect and use them to achieve an evolutionary step in the field of aerial robotics. The revolutionary potential had in fact been waiting in the area of computer graphics."[1]

1 Horst Hörtner, in a conversation with the author, April 2021.

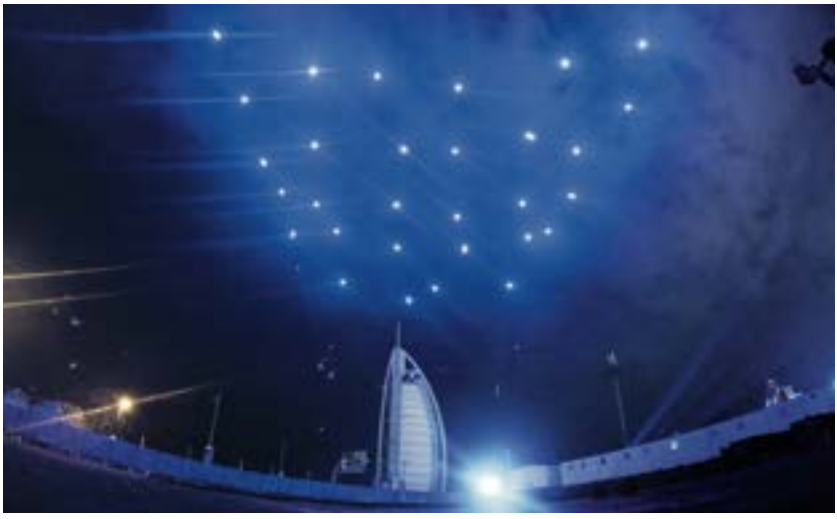
“The Spaxels were intended as an art project and this is the way we implemented them.”

Horst Hörtner, in a conversation with the author, Linz, 2019.

Horst Hörtner (*1965, AT). Media artist, musician, and researcher. Expert in Human Computer Interaction. Co-founder of artists’ group x-space (together with Gerfried Stocker) 1991–1995. 1996, technical director of Ars Electronica Center. Co-founder and Managing Director of Ars Electronica Futurelab since 1996. Since 2020 he is also CTO of Ars Electronica.

DRONE 100—Spaxels over Linz (2016)

Drone 100 at Vivid Sydney Festival (2016). Sydney Harbor provided the spectacular backdrop for a breathtaking choreographed drone performance.



The Spaxels by Ars Electronica Futurelab were part of the UAE National Day, December 1st, 2014, in Dubai.

Rock in Rio (2017). Every evening of the event's run, the Ars Electronica Spaxels took to the sky above Rio de Janeiro's Barra Olympic Park to get the audience fired up for the headliner.

DRONE 100—Intel (2015). A spectacle produced by the Ars Electronica Futurelab for Intel (2015) has made it into the Guiness book of records.

Spaxels in Sharjah (2014). Ars Electronica Futurelab's drone swarm made appearance in the night sky of Sharjah, the Islamic Capital of Culture in 2014

WE ARE HERE (2013). A multimedia-performance by Salvatore Vanasco for the opening of the Ars Electronica Festival 2013

DRONE 100—Spaxels over Linz (2016), ascending Spaxels

A process of rapid prototyping set in. In January 2012, Gerfried Stocker had called for a meeting of all the teams from the different parts of Ars Electronica to inform everybody of the exceptional challenge that awaited them in working on the new Klangwolke by Ars Electronica over the coming months. The seminar room at the Ars Electronica Center was crammed full, some people even sitting on the floor, when the Futurelab presented first visualizations created by Florian Berger. The manufacturers of the drones needed for this were still more than skeptical and expected a "proof of concept," for which they gave the Ars Electronica Futurelab only three drones. The Ars Electronica Futurelab delivered, and then came the day in early summer when the decisive test flights with twelve aerial vehicles were performed above an empty meadow close to the Danube. The twelve Spaxels turned on their lights and rose into the evening sky to form a simple plane above the heads of the entire Ars Electronica team present. Slowly that plane then tilted and appeared to be coming down upon the spectators. Horst Hörtner still remembers this moving breakthrough moment, when every one of them felt the power of that pattern in the sky, a power already strongly impressive with only twelve of the planned total of 50 Spaxels for the Klangwolke. That very night, Horst Hörtner also felt reminded of the fact that no other client—either from industry, or academia, or culture—would have commissioned them with such a daring and presumably impossible undertaking than their own mother organization, Ars Electronica. The race until the show on September 1 remained exciting, as the majority of the drones were delivered only in August and the dress rehearsal on the night before the Klangwolke was a disaster, in which one unmanned aerial vehicle was lost. The first public show of the Spaxels as part of the Klangwolke by Ars Electronica on the following day, however, turned out to be a great success. The audience of some 85,000 spectators on site was mesmerized and the video of the Spaxels' flight over Linz quickly went viral. The entrance of the Spaxels would create previously unheard-of momentum for the Ars Electronica Futurelab over the years to follow.

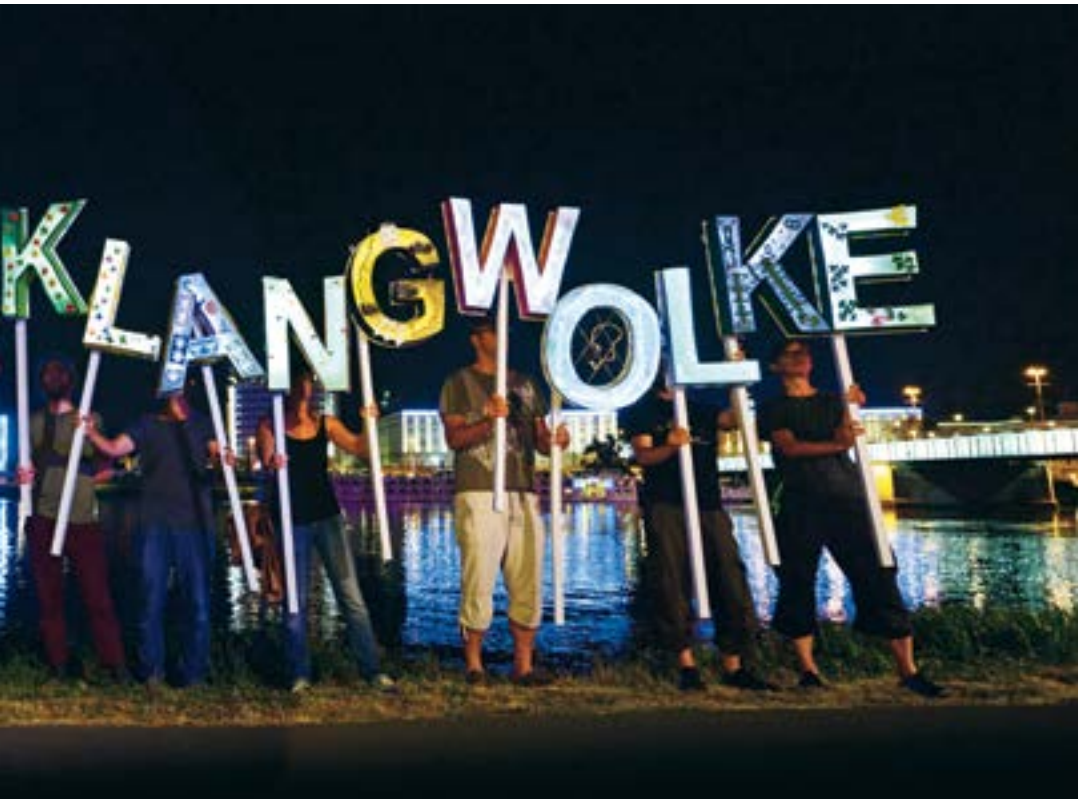
Crowd at the Donaupark. On September 1, 2012, more than 90,000 people gathered at the Donaupark in Linz to see the voestalpine Klangwolke by Ars Electronica.

Characters Looking for Other Characters

The 2012 Klangwolke by Ars Electronica was created with the intention of reinterpreting—with state-of-the-art technology—certain defining elements of its "ancestor" of 33 years previously for a meanwhile profoundly changed world. Gerfried Stocker described the ideas behind the concept of the "Open Cloud Project": "The aim was to shift essential design parameters into the collective sphere—that is, to put a part of the Klangwolke into the hands of the public, but also to derive the materials for a Klangwolke from the swarms of the cloud and thereby arrive at forms that symbolically express the realities of global networking."[2] This approach then met with the idea of using the alphabet, a key carrier of culture and knowledge throughout the history of human civilizations up to the use of text in social media and messaging systems and—notably—in computer code at the core of information technology. Thus, the alphabet was chosen to serve as the core of a major participatory project called

2 Stocker, Gerfried, "The Cloud in the Web," Leopoldseder, H., Schöpf, C. & Stocker, G. (eds.): *The Big Picture—New Concepts for a New World,* Ars Electronica Festival 2012, Hajte Cantz Verlag, Ostfildern, 2012, p. 203.

Klangwolke ABC. Hideaki Ogawa and Emiko Ogawa led that project in what was probably the longest and most intense collaboration between three departments of Ars Electronica: Ars Electronica Futurelab, Ars Electronica Festival, and Ars Electronica Center. When developing the concept with the aim of stimulating audience participation in a process looking for collective meaning and new forms of artistic expression, they activated the potentials of the alphabet: "The alphabet seems to have an innate intention for democracy. In an alphabet, the individual letter hardly makes sense. A character is always looking for other characters."[3] Hideaki and Emiko Ogawa also recognized their responsibility as artists when working with a swarm formed by a large number of human participants in real space. Consequently, they designed an entire tool kit and a complex system of preparatory activities to allow the actual participation to turn into a playful collaborative experience for the people involved.



With the Ars Electronica Center serving as a main hub, several locations across the province of Upper Austria offered workshops and equipment for participants to each creatively design their own letter from environmentally sound cardboard elements and equip it with a radio receiver and LEDs, then make it part of the *Klangwolke Font* by recording it in an image database and joining *CharacterBook,* a social media platform enabling people to communicate and collaborate with others in forming words or entire phrases from their characters and make appointments to meet up on the day of the Klangwolke in Linz. In the late afternoon of September 1, 2012, *Klangwolken ABC Parades* took place in the city until they all converged near the banks of the Danube for their participation in the actual Klangwolke. Entire phrases could be seen wandering around the city, including the message "Free Pussy Riot," referring to the prison sentence for two members of the Russian feminist performance art group just a few weeks before. In his 2003 book *Smart Mobs: The Next Social Revolution,* the American writer Howard Rheingold—several years before the ubiquity of smartphones, the Arab Spring, and social media platforms—had described the convergence of those phenomena: "Smart mobs consist of people who are able to act in concert even if they don't know each other. The people who make up smart mobs cooperate in ways never before possible because they carry devices that possess both communication and computing capabilities."[4] During the Klangwolke, this "smart mob" of people, with their individually designed letters, tuned into the same radio frequency—as the population of Linz had done in 1979 with their radios set to the broadcast of Bruckner's symphony—this time letting their letters shine with light in various formations, in sync with the action and music of the Klangwolke.

For the Ars Electronica Futurelab, the *Klangwolke ABC* was a special kind of experiment in creating new kinds of social rituals and ways of collaboration, thus once more providing a new form of infrastructure for creative expression—not for the self-realization of an individual artist, but by handing authorship over to the public. This puts *Klangwolke ABC* in line with other projects of the Ars Electronica Futurelab focusing on participation and co-creation, from *Gulliver's World* to numerous installations at the Deep Space 8K. Further developments in that vein would follow. For the success of both "swarms" of that evening—the Spaxels and the *Klangwolke ABC*—this particular kind of thinking, cultivated in the transdisciplinary setting of the Ars Electronica Futurelab, was decisive, a way of thinking that would later be cast in the term "Art Thinking."

3 Ogawa, Hideaki and Ogawa, Emiko, "Klangwolke ABC," in: op. cit., Hajte Cantz Verlag, Ostfildern, 2012, p. 242.

4 Rheingold, Howard: *Smart Mobs: The Next Social Revolution,* Perseus Publishing, 2003, p. xii.

Klangwolken ABC Parade (2012). Before the start of the voestalpine Klangwolke, the people of Linz paraded through the streets. Later on, their letters became an integral part of the Klangwolke.

"Both the *Klangwolke ABC* and the Spaxels each had their special mission as part of the overall concept of the 2012 Klangwolke by Ars Electronica. While the Spaxels replaced fireworks and laser shows with something entirely new that the people would enjoy, the *Klangwolke ABC* always related to society with the aim of letting the people become the protagonists."

Source: Emiko Ogawa, in a conversation with the author, December 2020.

Emiko Ogawa (*1979, JP). Artist and curator. BA in psychology from the University of the Sacred Heart, Tokyo. Member of the artist group h.o, member of the Ars Electronica Futurelab 2008–2009, head of Prix Ars Electronica since 2013.

ABC Werkstatt (2012). Thousands of gleaming letters of the alphabet were constructed, imaginatively designed, and equipped with LEDs and receivers.

Klangwolke ABC

Type: Social participation project
Location: Linz, Austria
Year(s): 2012

Special features / key technologies:
LED, Radio transmission, RDS, public participation, DIY, LinzerSchnitte

Audience participation in the context of social media: the *Klangwolke ABC* was initiated as a social participation project, focusing on "character" in the age of networks and constituting one of the core programs at Klangwolke 2012 by Ars Electronica. People created their own characters to interact with radio frequencies at the event—a huge galaxy of characters meeting on the banks of the Danube. In *Klangwolke ABC* workshops, weeks before the event, people designed and constructed their own alphabet characters and added a receiver and LED kit to link to the Klangwolken event itself. Each single letter would light up based on the signal it received.
To control this large number of devices the *LinzerSchnitte* was created, a low power RDS FM transmitter and programmable FM receiver that was used to control the five thousand LED-equipped letters to the network. The open source hardware and software system was developed in collaboration with Ray and Josh Gardiner from Australia, who worked in Linz on the technical implementation with Ars Electronica Futurelab for several months.

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The Sky is the Limit

Word about the Ars Electronica Futurelab's achievements with the Spaxels in Linz swiftly spread internationally. The fruits of that daring endeavor enabled the Futurelab team to enter a phase of several years in which their capabilities were in great demand across the globe and further development and research on that subject could be financed from their commissions of Spaxel shows, something that would have been highly unusual for the common startup in that field. A growing group at the Ars Electronica Futurelab worked exclusively on projects with the Spaxels, spending more and more time abroad. Soon after the 2012 Klangwolke in September, the Spaxels received an invitation from Paramount Pictures to fly over London in March 2013 for the opening presentation of a new movie from the Star Trek franchise: *Star Trek Into Darkness,* directed by J. J. Abrams. On the evening of March 23, 2013, a swarm of 30 Hummingbird quadcopters from Ascending Technologies turned into Spaxels choreographed by the Ars Electronica Futurelab. The Spaxels were launched in utter darkness from Potters Fields Park by the Thames during the unusual lights-off minutes of Earth Hour, a global event organized by the World Wide Fund for Nature (WWF) with the aim of expressing commitment to the planet. Consequently, the Spaxels were to fly into darkness and turn on their lights at the end of Earth Hour to form the Star Fleet Logo in the skies above Tower Bridge. The tools that the Ars Electronica Futurelab had developed allowed the team to choreograph the aerial maneuvers of the Spaxels in a three-dimensional grid, where any number of points could be defined and animated. Peter Holzkorn, key researcher at the Ars Electronica Futurelab in the area of "artificial collectives," soon began to think beyond the initial challenges: "It may be a philosophical question at what point a decision deserves to be called truly autonomous in a technical apparatus, but we humans certainly perceive autonomy, form, and purpose in the coordinated behavior of a multitude. From this perspective, the expressive potential of a distributed autonomous system is vast … ."[5] With every new show—from Australia to Latin America—the Ars Electronica Futurelab got the opportunity to refine the tools behind the Spaxels as well as its aesthetic command of the expressive potential of this swarm of autonomous airborne vehicles.

5 Holzkorn, Peter, "Artificial Collectives – How do we teach groups of machines autonomy, cooperation and expression?," in: Stocker, G., Schöpf, C. & Leopoldseder, H. (eds.): *In Kepler's Gardens. A global journey mapping the 'new' world*, Hatje Cantz Verlag, Berlin, 2020, p. 382.

Quadcopter in the London night sky (2013). A squadron of 30 LED-studded AscTec Hummingbird quadcopters hovered above Potters Fields Park near London's Tower Bridge and, in conjunction with Earth Hour, formed a three-dimensional Star Trek logo in the night sky—as high-tech heralds of Paramount's *Star Trek— Into Darkness.*

When in the fall of 2014 Intel got in touch and expressed interest in performances related to their new project, *Drone 100,* Horst Hörtner recalls being impressed that such a leading player of information technology would contact them. At the same time, he felt rising concerns that—now with such a big player behind it—the project of the Spaxels would ultimately shift from an art project into an advertising tool, with huge swarms of drones globally conveying commercial messages across the skies of the cities and along the beaches of the world. With this dystopian vision in mind, Horst Hörtner made a note in his diary, reading: "What have we done?" Ranking high among the Fortune 500 companies, the leading manufacturer of semiconductors was indeed an unusual partner for the Ars Electronica Futurelab. The main aim of the collaboration was achieved when approximately a year later, in the early evening of November 4, 2015, a total of 100 Spaxels rose in coordinated formation to an altitude of 120 meters above Ahrenlohe Airport in Tornesch, Germany. With an orchestra on the airfield playing music from Ludwig van Beethoven's *Symphony No. 5 in C minor,* frequently referred to as the *Fate Symphony,* this flight of 100 Spaxels, developed by the Ars Electronica Futurelab in conjunction with Intel, made it into the Guinness Book of World Records for "The Most Unmanned Aerial Vehicles (UAVs) airborne simultaneously." There can be no doubt that the series of highly visible international appearances of the Spaxels, the collaboration with a company like Intel, and also this World Record lifted the Ars Electronica Futurelab to a different league of attention.

However, Intel itself operated in a league of its own, where for instance a manufacturer of drones could be taken over within less than an hour to avoid a shortage of supply that might have endangered the *Drone 100* project.

In retrospect it may therefore not seem too astonishing that Intel would soon decide to build its own fleet of drones and lure members from the Spaxels' group at the Ars Electronica Futurelab to its own facilities. For the Ars Electronica Futurelab, which had only recently created an international spin-off for the work with the Spaxels, Intel's one-sided withdrawal from the collaboration in late 2016 came as an unpleasant surprise. The breakup of their cooperation took place not long after the project *DRONE 100—Spaxels over Linz* had been presented by Ars Electronica and Intel at the Ars Electronica Festival 2016. This sudden end of the Spaxels adventure forced the Ars Electronica Futurelab once more to re-focus on its original mission and its inherent strengths. The Spaxels had of course been a technological achievement, but for the Ars Electronica Futurelab they were first and foremost an art project. The Futurelab team clearly enjoyed solving technical and design problems, but their main concern and research interest were the implications of any technology on society. This grounding in their own, very special way of thinking and working enabled them to soon recover and further pursue new kinds of research questions, as Peter Holzkorn summarized: "What if we could find a way to control swarms of not only special, limited sets of drone models, but virtually anything that supports one of the open communication standards for autonomous vehicles? What if this control could range from strict choreographies to highly responsive interactive scenarios?"[6]

6 Holzkorn, Peter, "SwarmOS," in: Stocker, G., Schöpf, C. & Leopoldseder, H. (eds.): *ERROR—the Art of Imperfection,* Hatje Cantz Verlag, Berlin, 2018, p. 358.

Drone 100, Intel (2015). 100 drones took to the air over Tornesch (DE), earning a place in the Guinness Book of Records for the "most unmanned aerial vehicles airborne simultaneously."

“It may be a philosophical question at what point a decision deserves to be called truly autonomous in a technical apparatus, but we humans certainly perceive autonomy, form, and purpose in the coordinated behavior of a multitude. From this perspective, the expressive potential of a distributed autonomous system is vast … .”

Source: Holzkorn, Peter, “Artificial Collectives—How do we teach groups of machines autonomy, cooperation and expression?,” in: Stocker, G., Schöpf, C. & Leopoldseder, H. (eds.): *In Kepler's Gardens. A global journey mapping the ‘new’ world,* Hatje Cantz Verlag, Berlin, 2020, p. 382

Peter Holzkorn (*1985, AT). Studied computer science at the Vienna University of Technology and Interactive Telecommunications at New York University. Member of the Ars Electronica Futurelab since 2011. Key researcher for Artificial Collectives, leading activities in the area of swarm robotics, such as *Swarm Arena* and *Space Ink*.

Spaxels

Type: Drone show
Location: Worldwide
Year(s): Since 2012

Special features / key technologies:
Swarm technologies, quadcopters, choreographed UAVs, Guiness Book of Records entry, space pixels

September 2012, world premiere of a spectacular airborne choreography developed by Ars Electronica Futurelab: The world's first-ever LED-lit drone swarm was presented in the night sky above Linz. A swarm of simultaneously performing quadcopters, equipped with LED modules performed a real 3D computer graphics display in the sky. Spaxels—short for space pixels—are points of light that can be freely positioned in space and create three-dimensional shapes and symbols in the sky.
Ars Electronica Futurelab set new standards with this new form of artistic expression. What started as an art piece in 2012 became a worldwide success and created a global market for *drone shows,* which have been copied and elaborated on by numerous international companies, among them global players such as Intel and Ehang, as well as several startups, from Japan to Mexico.

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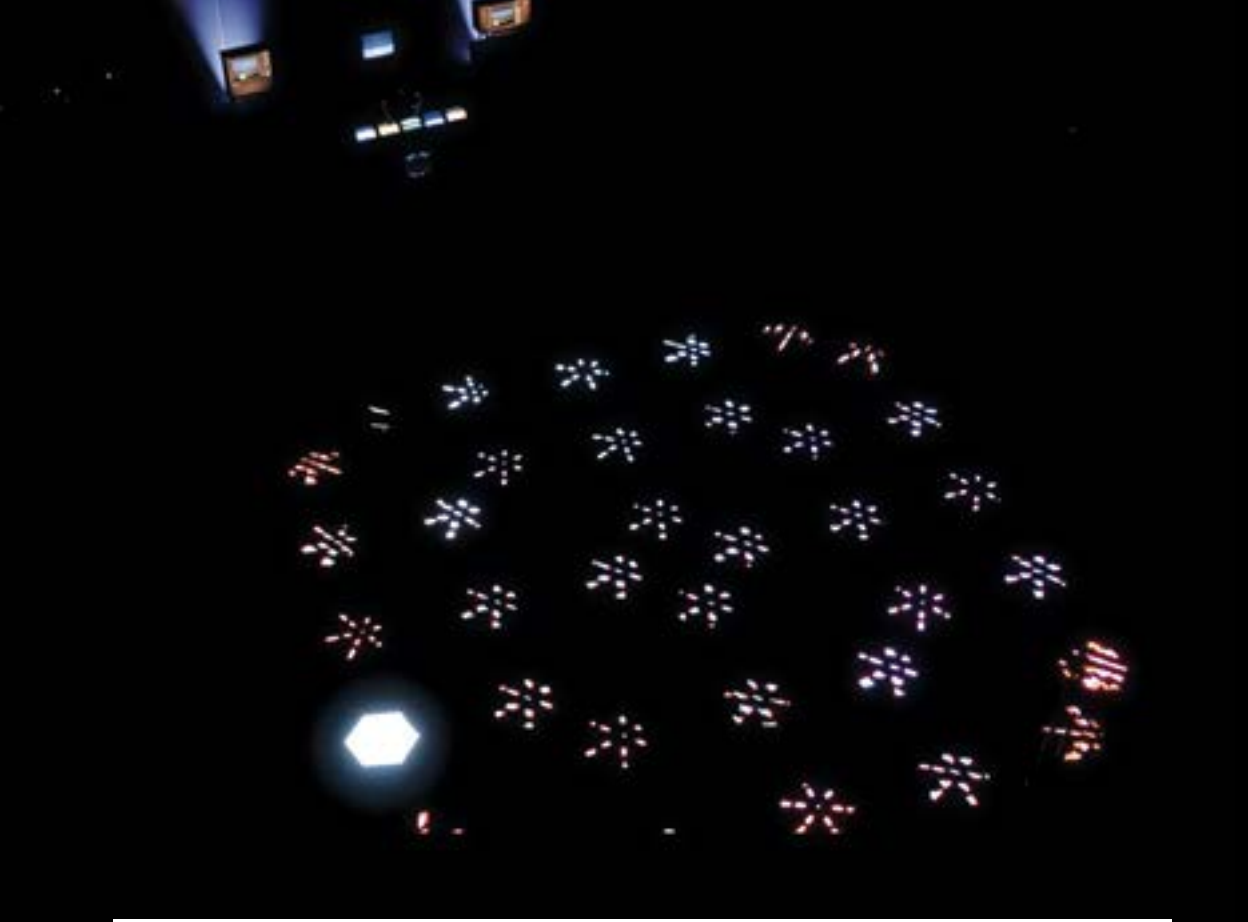
Already, parallel to the international shows of the Spaxels, the Ars Electronica Futurelab had developed *Swarm OS* as a tool that would make it possible to quickly come up with new prototypes for any kind of autonomous vehicle from any manufacturer. This opening up of the perspective also brought into view questions that went far beyond choreographing a swarm of Spaxels in the sky, questions looking not only at the interactions within a swarm of autonomous machines, but also between humans and such machines—in fact, a research horizon that would carry the team far into the future of their work.

The Fluxels of the *Swarm Arena* (2020) by NTT—Nippon Telegraph and Telephone Corporation R&D Service Evolution Labs and Ars Electronica Futurelab, are put to the test. The Fluxels demonstrate how SwarmOS can be used as a research platform for the future of expressive swarms and human-robot interaction.



SwarmOS

Type: Software
Location: —
Year(s): Since 2019

Special features / key technologies:
Swarm control, choreographies, interactive swarms, fail-safe backup systems

SwarmOS is an operating system for swarms of drones, ground bots, or other autonomous vehicles. Key components of *SwarmOS* are the “Ground Control,” a desktop application that acts as a command central, and the “Implant,” a small hardware device installed on every vehicle, responsible for abstracting logic and communication.
SwarmOS can be used for a predefined choreography or in a scenario with live interaction. Its core idea is to provide abstraction from hardware-specific details: it can support all sorts of vehicles as long as they implement certain protocols. *SwarmOS* is set up to be easily integrated into third-party systems for research partners and vehicle manufacturers.

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The Gift of Prometheus and a Stream of Hope

The appearance of the Spaxels at the 2012 Klangwolke by Ars Electronica had also made a deep impression on executives of another Fortune Global 500 company, the Nippon Telegraph and Telephone Corporation (NTT), the fourth-largest telecommunications company in the world. NTT had a long track record of work with cutting-edge telecommunications technologies, namely for very large events, and entered into cooperation with the Ars Electronica Futurelab in 2017 in the course of its preparations for TOKYO 2020, the Olympic Summer Games to be hosted in Japan. Ultimately, NTT was attracted by the special qualities of the Ars Electronica Futurelab, which NTT's executive research engineer and project director Shingo Kinoshita quickly detected from his very first encounters with the Futurelab: "Developing new Information and Communication Technologies (ICTs) is important, but even more important are two additional things: artistic expression obtaining people's empathy, and *Art Thinking* as the ability to define the future. The Ars Electronica Futurelab is the only institution that has these two excellent abilities and at the same time a deep knowledge of technologies. We are a technology-first organization, but the Ars Electronica Futurelab is well balanced among society, art, science, and technology."[7] Thus, NTT and the Ars Electronica Futurelab entered into a collaborative development process, which would at first consider the use of drones for *Sky Compass,* a visionary and highly intuitive urban signage system offering orientation and guidance to visitors of the Olympic Games. When Intel became an Olympic sponsor in the category of drones and contacted NTT in this regard, NTT decided to nonetheless continue the fruitful collaboration with the Ars Electronica Futurelab. Together, NTT and the Ars Electronica Futurelab gave their project a new direction, this time using ground bots with digital displays on their surfaces. The ground bots of what was now titled *Swarm Arena* would offer spectators in a stadium additional information about the ongoing tournaments in the form of a "liquid video," making use of the ability of the human mind to recognize patterns and—ultimately—also characters from a set of moving parts. With *Swarm Arena,* not only was the content on the screens liquid, but the dynamically reconfigured formations of the moving screens themselves also formed a "liquid" display.

7 Shingo Kinoshita, in a conversation with the author, February 2021.

“Developing new Information and Communication Technologies (ICTs) is important, but even more important are two additional things: artistic expression obtaining people’s empathy and *Art Thinking* as the ability to define the future. The Ars Electronica Futurelab is the only institution that has these two excellent abilities and at the same time a deep knowledge of technologies. We are a technology-first organization, but the Ars Electronica Futurelab is well balanced among society, art, science, and technology.”

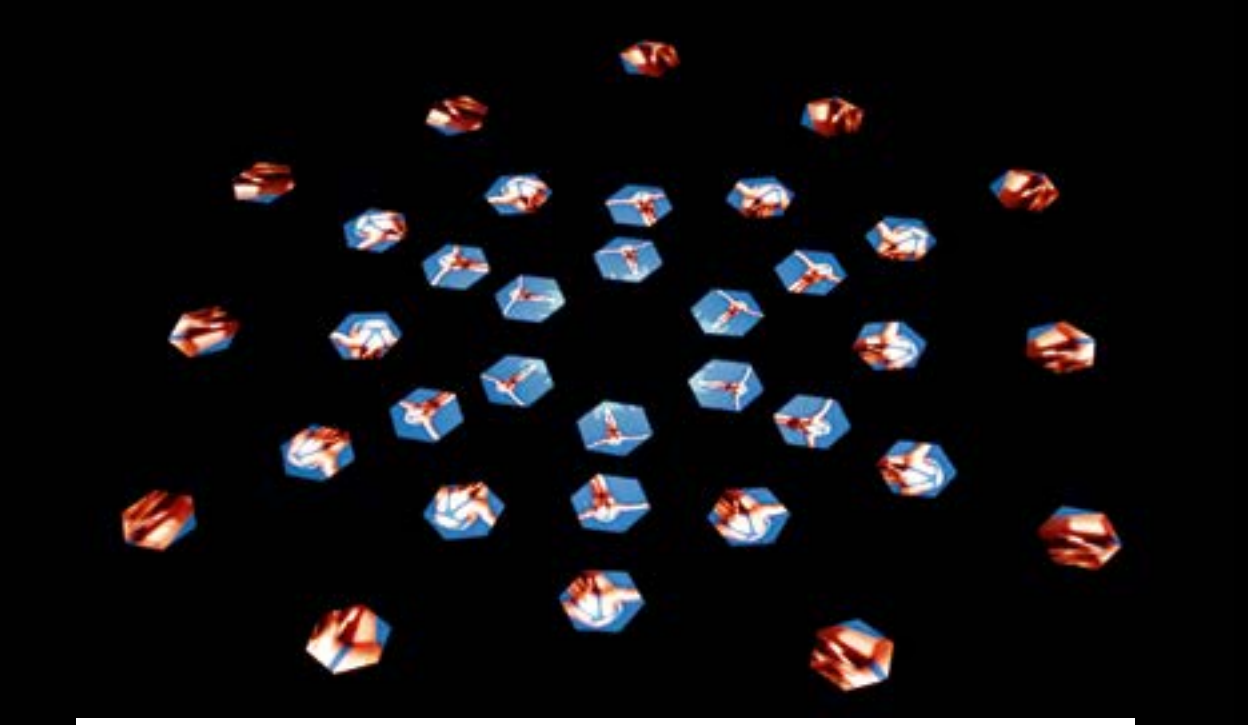
Shingo Kinoshita, in a conversation with the author, February 2021.

Shingo Kinoshita (*1968, JP). B.E. from Osaka University, Japan, in 1991. M.Sc. with distinction from University College London, UK, in 2007. Executive research engineer and project director at NTT Service Evolution Labs since 1991. Visiting professor at Osaka University of Art since 2018. Visiting executive research engineer at Dentsu Lab Tokyo since 2018.

Under the title *Stream of Hope,* results from the development work on this entirely new kind of information system were presented in 2019 during a performance at Mirai-kan, the Japanese Museum of Emerging Science and Innovation, together with the visual artist Akiko Nakayama and the musician Ei Wada: A young woman with the torch of the Olympic Fire entered the *Swarm Arena.* She stood in the center, surrounded by a swarm of 39 ground bots, and, with the torch lowered towards them, passed the virtual fire on to their waiting displays, where it was distributed to the entire swarm, which was rotating around her in a kaleidoscopic pattern. This performance not only presented the aesthetic and technological achievements involved, but also carried symbolic meaning far beyond the occasion. The Olympic Fire is, of course, an integral part of the Olympic Games in modern times, representing the Olympic Truce that has ensured the peaceful conduct of the Games since their origins in ancient Greece more than 2,700 years ago. When the Fire was passed on by the young woman to that swarm of autonomous machines surrounding her, it was also reminiscent of the fire in Greek mythology that the Titan Prometheus stole from the gods and passed on to humankind as the fire of civilization. Horst Hörtner summarized the further development of *Stream of Hope* in the context of the Olympic celebrations: "With the Japanese telecom company NTT we are exploring Swarm Art, combining NTT's cutting-edge communication technology with the Futurelab's Swarm technology. The result of this research, *Stream of Hope*, was also presented at the performance event of the 'NTT presents Tokyo 2020 Olympic Torch Relay Celebration,' where countless robots equipped with displays greeted the torchbearers." The American historian of science James Gleick, in his seminal book *The Information,* had given his interpretation of the fire from Prometheus by quoting from Aeschylus: "The greatest gift of Prometheus to humanity was not fire after all: 'Numbers, too, chiefest of sciences, I invented for them, and the combining of letters, creative mother of the Muses' arts, with which to hold all things in memory.'"[8] With this kind of fire at Mirai-kan, fire which, ultimately, consisted of purely digital information, a circle closed from the swarm of Spaxels in the skies above several cities across the world and the radio-connected swarm of letters of the *Klangwolke ABC* in Linz to the *Swarm Arena* for the Olympic Games in Tokyo, opening up new ground in liquid communication on a massive scale.

8 Gleick, James: *The Information: A History, a Theory, a Flood,* Fourth Estate / Harper Collins Publishers, London, 2011, p. 11. Gleick is quoting from Aeschylus, *Prometheus Bound,* trans. by H. Smyth, p. 460–461.

Stream of Hope (2021), Yokohama
NTT presents Tokyo 2020 Olympic Games Torch Relay Celebration in Yokohama



Swarm Arena

Type: Research project / autonomous swarm
Location: NTT R&D Forum in Musashino, Tokyo, Japan
Sports Viewing Re-Imagined—Special Exhibition, Miraikan Museum, Tokyo, Japan
Ars Electronica Festival, Linz, Austria
Year(s): Since 2017

Special features / key technologies:
SwarmOS, ground bots, displays

Swarm Arena embodies several concepts to enhance conventional sport events by using ground bots to display measurements, metrics, or outcomes, thus visualizing otherwise invisible sports data right at the arena. Using swarm bots, athletes and events can be visually represented on moving displays to create a digital, real-time duplication of the game or competition. Alternatively, the fluid visuals in this new medium can be used in expressive and illustrative ways to complement the live viewing experience.
Swarm Arena is one outcome of joint research efforts by Ars Electronica Futurelab and Japanese telecommunications giant NTT that started in 2017 with the aim to work on using unmanned aerial or ground vehicles (UAVs and UGVs) as a means of communication. The first project, *Sky Compass,* as well as its follow-up, *Swarm Compass,* focused mainly on navigation, public signage, facilitation of traffic, and swarm intelligence, but *Swarm Arena* shifts the research focus to create an entirely new audience experience at sport events.

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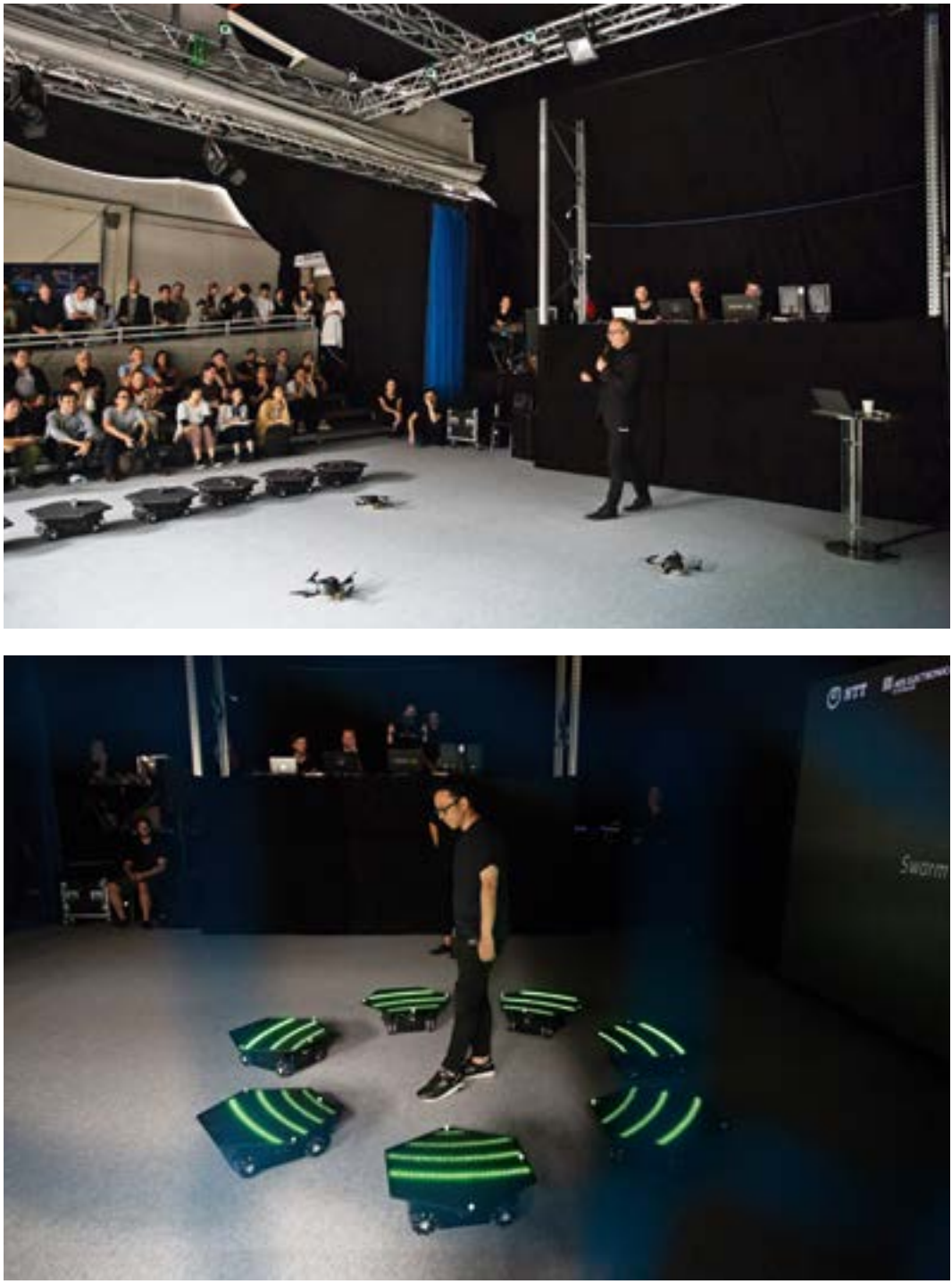
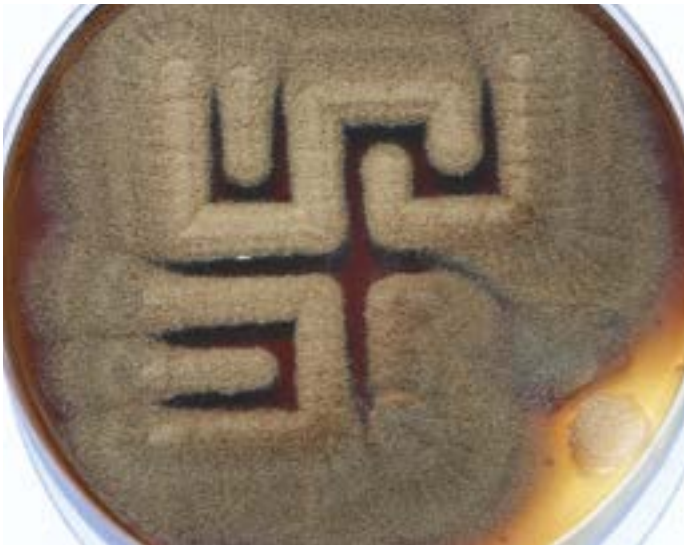


Swarm Arena at POSTCITY Linz (2018)—a new kind of audience experience based on swarm intelligence, interactivity, and robotic organisms.

The Ink of the Future Redraws the Vitruvian Man

There is one "fire" behind the work of the Ars Electronica Futurelab that presumably surmounts all the other driving forces fueling its explorations towards new perspectives: the profoundly civilizing impulse to humanize technology. In this effort, the artistic side of the Futurelab's approach plays a crucial role. Therefore, it seems almost logical that it was a company creating tools for creative work that became a dedicated partner of the Ars Electronica Futurelab in a remarkably open collaborative research process looking deeper into the secrets of the artist's mind.
Long before he became CEO and president of Wacom in 2018, the world's leading Japanese producer of digital interactive pen and ink technologies, Nobutaka Ide had hoped to one day work together with the Ars Electronica Futurelab. When the opportunity finally arose, he initiated the *Future Ink Project* together with the Ars Electronica Futurelab, taking one—at first glance perhaps unexpected—question about creativity as the starting point: Where is my soul? Behind this question lies the experience of being deeply moved and inspired by the performance of artists. The special power coming from such creative moments compares to the Japanese concept of "Kotodama," which attributes soul and mystical powers to our expressions. Horst Hörtner resonates to this approach: "We want to create human-centered architectures and systems for the future of digitization. And the

Future Ink Project (2020/2021) by Wacom and Ars Electronica Futurelab, designed around 5 concepts, is looking at creativity from different angles. Photo showing *Bio Ink, AI Ink,* and *Space Ink*



9 Hörtner, Horst, in: Cakir, Birgit, "Future Ink: Where is my Soul?", Ars Electronica Blog, 2020, https://ars.electronica.art/aeblog/en/2020/10/13/future-ink-wo-ist-meine-seele/

central question 'Where is my soul?,' this idea of Kotodama, is based on the fundamental desire to identify the unique moment of creation."[9] This research into the secrets and the future of creativity, which takes place in the framework of the *Future Ink Project,* is highly experimental and designed around five core concepts looking at creativity from different angles: *Space Ink, Bio Ink, AI Ink, Body Ink,* and *Mind Ink.*

For research in the phase of *Space Ink,* a combination of pen and tablet technology by Wacom with drones controlled through the *SwarmOS* of the Ars Electronica Futurelab and a high-precision optical tracking system was chosen with the aim of first exploring future ways of drawing in three-dimensional space. Basically, human brushstrokes of the digital pen on the tablet are translated into spatial movements of the drones, which carry lights whose traces are filmed and projected in real time. However, this system is not simply used to control the paths of the drones with the pen, but the result is in fact an interpretation of the human drawing by the autonomous airborne machines. Thus the research looks into the Kotodama of the human artist as well as striving to capture something from the drone's soul. Nobutaka Ide looks far beyond the technical achievements: "… this is exactly where [the] unexpected moment in the collaboration comes from. Of course, it is the technology that makes everything possible. But the key question is still: Where is my soul? Where is Kotodama? Can a drone have Kotodama? And can the drone's Kotodama convey [something] to the artist? Of course, there are no real answers to these questions, and we are not

10 Ide, Nobutaka, in: Cakir, Birgit, "Future Ink: Where is my Soul?", Ars Electronica Blog, 2020, https://ars.electronica.art/aeblog/en/2020/10/13/future-ink-wo-ist-meine-seele/

11 Hörtner,Horst, in: Cakir, Birgit, "Future Ink: Where is my Soul?", Ars Electronica Blog, 2020, https://ars.electronica.art/aeblog/en/2020/10/13/future-ink-wo-ist-meine-seele/

“Creative expression does not come from technology or from an instrument. It really comes from inside of human nature. … Of course, it is the technology that [often] makes everything possible. But the key question is still: Where is my soul? Where is Kotodama? Can a drone have Kotodama? And can the drone’s Kotodama convey [something] to the artist? … it is these creative questions that move us ahead.”

Source: Cakir, Birgit, “Future Ink: Where is my Soul?”, Ars Electronica Blog, 2020, https://ars.electronica.art/aeblog/en/2020/10/13/future-ink-wo-ist-meine-seele/

Nobutaka Ide (*1970, JP). Master of Public Administration (Major in International Law) at the Graduate School of International Christian University. Since 2018, CEO and President of Wacom Co., Ltd.

looking for technological solutions. And yet it is these creative questions that move us ahead."[10] Horst Hörtner and the Ars Electronica Futurelab team share this openness in the collaboration: "The entire frame of *Future Ink* is motivated by our mutual approach of challenging each other. In our collaboration we try to create an input tool for getting new, creative outputs, rather than solving challenges and giving answers. Experimentally driven and transdisciplinary research in collaborating teams is our approach, inspired by the mission of creating the future."[11] It is exactly such encounters with clients—which are in fact partners in a collaboration and in a dialogue on an equal footing—that are best in line with the working method of the Ars Electronica Futurelab and also lead to the most surprising and innovative results. The inspiring quality of the conversations, the shared ideas and interests regarding the future, together with a mutual respect for each other's expertise: these are, after all, among the aspects most cherished by many of the long-standing partners of the Ars Electronica Futurelab. At the Futurelab, such collaborations—free from any pressures of competition between the partners—are not only enjoyed, but also seen as immensely fruitful impulses towards new directions in their work.

During one of the research sessions of the *Future Ink Project* held at the premises of the Ars Electronica Futurelab in Linz, the artist and concept designer Mike Jelinek, a senior product manager on the Wacom team, picked up the digital pen to redraw one of the most famous works in the history of art, created more than half a millennium ago: Leonardo da Vinci's *Vitruvian Man* of 1490. The Roman architect Marcus Vitruvius Pollo, born around 80 BC, had written about the analogy between the microcosm of human beings and the macrocosm of the earth and the application of that analogy to the design and proportions of buildings. Those thoughts resonated strongly with Leonardo da Vinci, who let his studies of human anatomy instruct his artistic depictions of the human figure. His drawing of the *Vitruvian Man* merges the aspects of micro- and macrocosmic proportions in a single clear and iconic image. But the work can also be seen as "a kind of metaphysical self-portrait in which Leonardo—as an artist, a natural philosopher, and a stand-in for all of humanity—peers at himself with furrowed brow and tries to grasp the secrets of his own nature."[12] The lines of the *Vitruvian Man,* taking up ideas of more than 2,000 years ago, drawn at the time of the Renaissance by Leonardo da Vinci with ink on paper and redrawn 500 years later in the digital age with pen and tablet, transferred into spatial movements of flying apparatuses and reinterpreted by these autonomous machines, point to the broader context of research by the Ars Electronica Futurelab into the nature of humankind in the face of a future symbiosis of humans and machines, the encounters of humanity and "Robotinity."

12 Toby Lester Interview, Talk of the Nation, NPR, March 8, 2012; quoted from: Isaacson, Walter: *Leonardo da Vinci—The Biography,* Simon & Schuster, London-New York, 2017, p. 157.

Future Ink

Type: Research project
Location: Ars Electronica Futurelab, Linz, Austria
Year(s): 2020/2021

Special features / key technologies:
UAVs, light painting, pen-tablet interaction, autonomous drones

A collaborative research project between Wacom, the world's leader in pen tablets, interactive pen displays, and digital interface technologies, and Ars Electronica Futurelab to explore the creative potential of ink from diverse angles: *Space Ink, Bio Ink, AI Ink, Body Ink,* and *Mind Ink.* The aim of the project was not to find a specific answer but to continuously ask questions and conduct innovative and experimental research that inspires further creativity.
What if we can draw in any space with a pen? As part of the *Future Ink Project, Space Ink* research captures the multidimensionality of the artistic moment of creation, to interact, to control, and to project it onto the wall as a sign of a successful cooperation between humans and machines.

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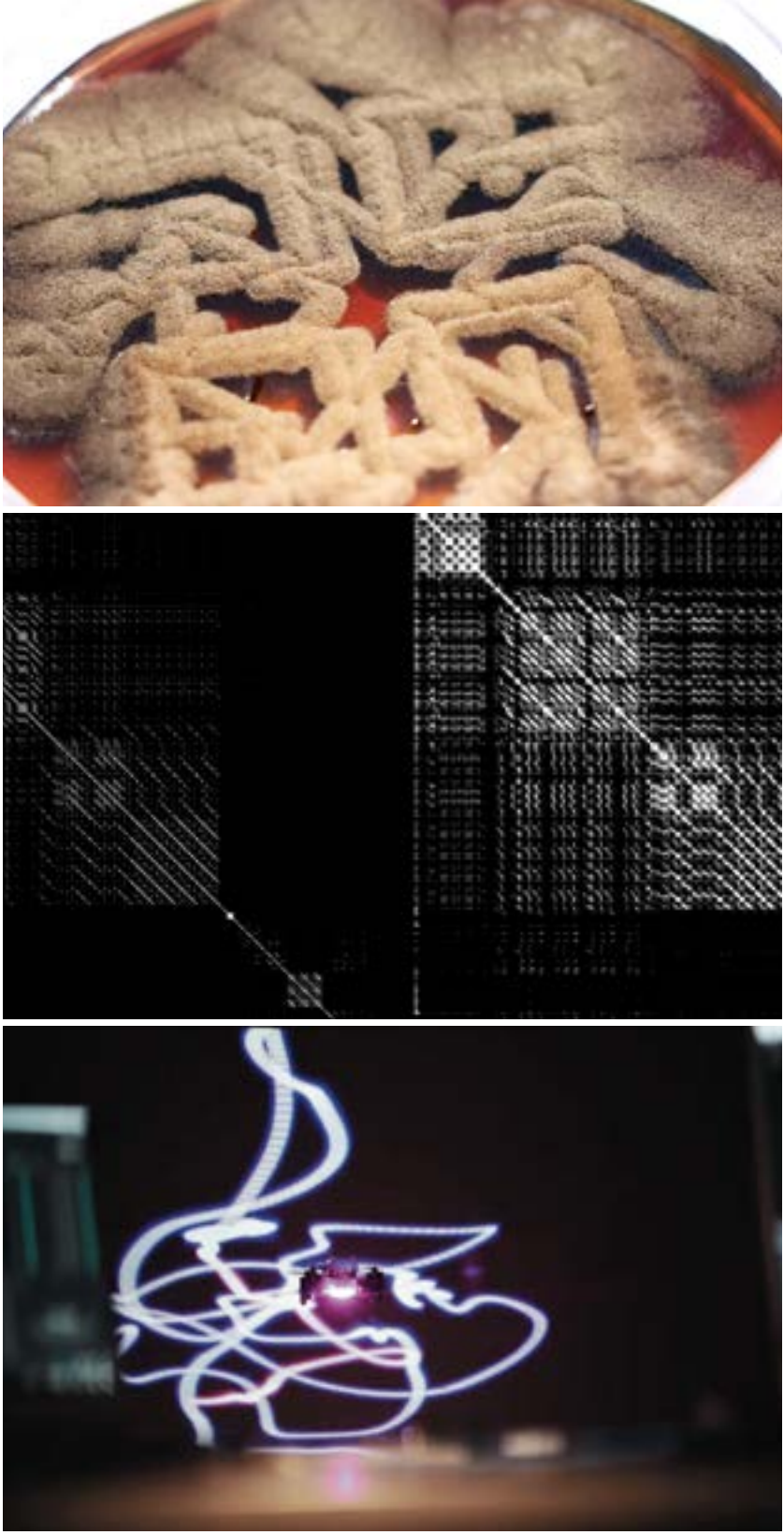


Future Ink Project (2020/2021): *Bio Ink, AI Ink,* and *Space Ink*

Humanity and Robotinity

Toward a New Paradigm of Co-Existence

The Android at the Café

The man was sitting all by himself. He did not seem to enjoy the splendid view from the rooftop café at the Ars Electronica Center, nor was he eating anything. It took some time until other guests took notice of him. Some of them found his appearance strange, his presence creating an eerie feeling. When they decided to take a closer look, their puzzlement increased until they found out that this was a teleoperated android, which the Japanese robotics researcher Hiroshi Ishiguro had created as a duplicate of himself. The presence of the android, called "Geminoid HI-1," at the café was of course not devoted to leisure, but part of a series of experimental exposures of the humanoid robot to audiences outside of the robotics laboratory, experiments conducted by the Ars Electronica Futurelab in collaboration with Professor Ishiguro and his institute at Osaka University in Japan. The research field is called android science and uses "androids that behave similarly to humans for studying what it essentially means to 'be human,' i.e. the mystery of human nature. Androids and geminoids are artificial humans that allow us to investigate human nature by means of psychological and cognitive tests, which we conduct during interaction with people."[1]

Geminoid, Hiroshi Ishiguro (2013) and his Geminoid HI-4 at the Ars Electronica Center

During the preparations for this collaboration, Horst Hörtner had paid a visit to Hiroshi Ishiguro at his laboratory in Osaka, where he experienced firsthand what the effects involved in such encounters between humans and androids can be about. When Horst Hörtner arrived for the meeting, Hiroshi Ishiguro was nowhere to be seen, and so Hörtner was shown to another room, where he sat together with "Geminoid HI-1," which had been built to look like his host. Finally they had their conversation, with the professor speaking through the remote-operated android. At a certain point, Horst Hörtner wanted to know from which material the skin of "Geminoid HI-1" had been made. He raised his hand, but felt a strong reluctance to touch the android's face, just as you would not touch another person's face in a business meeting. At this moment, Hörtner strongly felt how the process of humanizing robots can take place and how important it was to conduct further research, also outside the laboratory situation. Hiroshi Ishiguro later recalled a corresponding experience when teleoperating his android, which was again visiting the rooftop café at the Ars Electronica Center. When a group of children approached the android, which responded to their questions, one of them must have felt the same curiosity as Horst Hörtner had, and suddenly touched the android's face. "Geminoid HI-1"—that is, Professor Ishiguro, teleoperating—shouted at the child not to touch his face, because when the child had actually put a hand to the android's skin, he himself had felt the touch on his own face.[2] Some theories indicate that such effects are due to the firing of mirror neurons, which create "mirroring" sensations when we watch a scene. Such research conducted by Hiroshi Ishiguro together with the Ars Electronica Futurelab goes far beyond engineering aspects of improving robotic technology and refining the human likeness in androids, but rather looks at cognitive aspects and, ultimately, further at the human condition. As Hiroshi Ishiguro puts it: "My research question is to know what is a human … I use very humanlike robots as test beds for my hypotheses."[3]

1 ATR Intelligent Robotics and Communication Laboratories, "Geminoid HI-1," in: Stocker, G. & Schöpf, C. (eds.): *HUMAN NATURE,* Ars Electronica 2009, Hatje Cantz Verlag, Ostfildern, 2009, p. 221.

2 Paré, Zaven, "The Art of Being Together with Robots: A Conversation with Professor Hiroshi Ishiguro," in *International Journal of Social Robotics,* 2014.

3 Ishiguro, Hiroshi, quoted from: Guizzo, Enrico, "Hiroshi Ishiguro: The Man Who Made a Copy of Himself: A Japanese roboticist is building androids to understand humans—starting with himself," IEEE SPECTRUM, April 23, 2010 - https://spectrum.ieee.org/robotics/humanoids/hiroshi-ishiguro-the-man-who-made-a-copy-of-himself

Geminoid Research Collaboration

Type: Research
Location: Ars Electronica Center, Linz, Austria
Year(s): 2009

Special features / key technologies:
Human-machine interaction, android, tactile sensors, pneumatic actuators, external control system, uncanny valley

A Geminoid is an android that resembles a specific living person. Its name comes from the Latin word ‘geminus,’ meaning ‘twin,’ and literally means “like a twin.” The human-machine duo is linked together by network and sensor technology, so that the Geminoid not only resembles its human model, but also moves like it. In 2009, Geminoid HI-1 and its creator, Professor Hiroshi Ishiguro, were special guests at the Ars Electronica Festival. The festival theme that year was “Human Nature.” In a collaborative experiment during the festival, Geminoid HI-1 was secretly installed in CUBUS café at the Ars Electronica Center, and it also put in an appearance at the exhibition space of the museum. HI-1 was tele-operated from a distance to observe the reactions of the visitors.
Geminoid Hl-1 is one of the most complex androids ever built. Ars Electronica Futurelab and Professor Ishiguro have collaborated on unique projects such as the Geminoid experiment in CUBUS café, new forms of interactive installations, and research on the social robot in contextual interactions since 2009.

https://u.aec.at/A170E50D

“My research question is to know what is a human ... I use very humanlike robots as test beds for my hypotheses.”

Source: Ishiguro, Hiroshi, quoted from: Guizzo, Enrico, “Hiroshi Ishiguro: The Man Who Made a Copy of Himself: A Japanese roboticist is building androids to understand humans—starting with himself,” IEEE SPECTRUM, April 23, 2010—https://spectrum.ieee.org/robotics/humanoids/hiroshi-ishiguro-the-man-who-made-a-copy-of-himself

Hiroshi Ishiguro (*1963, JP). Ph.D. in systems engineering from Osaka University in 1991. Distinguished professor in the Department of Systems Innovation at Osaka University since 2009. Visiting director of Hiroshi Ishiguro Laboratories at the Advanced Telecommunications Research Institute (ATR) since 2011.

Telenoid (2011), a human-like remote controlled android created by roboticist Hiroshi Ishiguro.

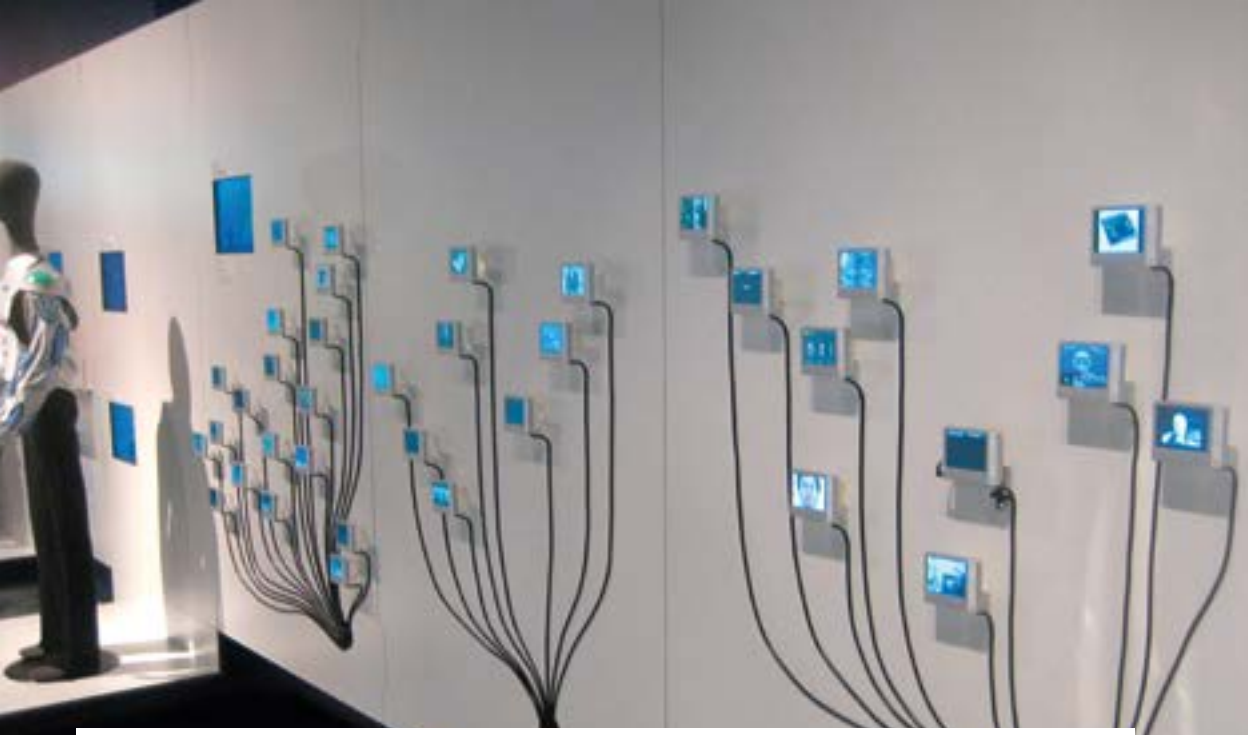
Robots were certainly no strangers to Ars Electronica, since it had been the robot SPA 12 that had held the opening speech of the first-ever Ars Electronica Festival in 1979. SPA 12 did not look human, but rather like the robots in science-fiction films of the 1950s. What it had in common with "Geminoid HI-1" was that both of them were teleoperated. Hiroshi Ishiguro explained in 2009 that this was necessary due to the deficits of artificial intelligence in pursuing lengthy and plausible conversations, deficits which would in turn hamper the acceptance of the android in the experiments. The concept of the "uncanny valley," first formulated by robotics scientist Masahiro Mori in 1970, describes the effect of humans' more easily accepting robots as human the more realistic they look, but only up to a certain point; when the robots become "too human," the empathy reverses into its opposite again. In 2011, another android from Ishiguro's laboratory appeared at the Ars Electronica Festival, taking part in a theater performance titled *Sayonara,* in which a human actress played together with "Geminoid F". Questions that the theater performance raised corresponded with the Ars Electronica Futurelab's research in the area: "What does it mean to be a human/robot?" In Linz, the play was staged in the Catholic cathedral of Linz, the Mariendom, which somehow added a special background of philosophical or—one might say—theological dimensions to the topic.

Impressions of *RoboLab* (2009) at Ars Electronica Center

Robots Inside and Outside of their Lab

In the wide field of robotics, as with any dynamically evolving technology, many design decisions are currently being made; these will deeply influence the future applications of robots in numerous areas from healthcare to warfare. However, the history of technology shows that such design decisions should not be left to the specialists of the respective technology and the decision makers in the industries alone. In order to enable an informed, democratic discussion in wider parts of societies about the desired ways of using robotics and the criteria and rules for doing so, broader, fact-oriented knowledge about this field is necessary. It has always been part of the mission of the Ars Electronica Futurelab to look into the social implications of new technologies and to allow wider audiences insight into and personal experience with them. In line with this aim, in 2009 the Ars Electronica Center—making use of a significantly larger building with more exhibition floors—received a number of new labs, workshop-like settings for hands-on experience, which were developed by the Ars Electronica Futurelab. One of those labs was the *RoboLab,* which offered instructive, surprising, and also entertaining encounters with many different kinds of robots, thus making the manifold applications of robotic technology visible. The ultimate idea behind the *RoboLab*—conceptualized by Hideaki and Emiko Ogawa—was to inspire an awareness for the way in which robots reflect our own humanity by creating an experimental platform for socializing robots.

This strategy also implied transferring the robots from the laboratories, where they usually reside under controlled conditions, to the social situation of the Ars Electronica Center exhibition and—beyond that—also to the public space of the city of Linz outside the museum walls. Two bicycle-riding "guest robots" at the *RoboLab,* called "Murata Boy" and "Murata Girl," won the hearts of the public by making little daytrips in the surroundings of the Ars Electronica Center. In contrast to such two-legged humanoid robots, the so-called "Hexapods" showed that six legs allow robots to be far more stable, faster, and capable of carrying greater loads. The visitors themselves could experiment with the Hexapods and thus gain insights into the challenges of robotic motion. Various aspects of human-robot interaction could also be explored, for instance with the face robot "Mertz," which has big eyes and bushy eyebrows and enters into contact with any person who approaches, recognizing and remembering their faces.



RoboLab

Type: Exhibition
Location: Ars Electronica Center, Linz, Austria
Year(s): 2009–2017

Special features / key technologies:
Robotics, prosthetics, wearable technology, human-machine interaction

Ars Electronica Center's RoboLab was designed as an open lab situation conducive to a direct, interactive encounter with the exhibits and installations on display. It offered a close-up look at the multifarious technical and cultural developments that paved the way to a future that humans now share with their machines. Exemplary contributions from the fields of art, design, and research reveal how robots and humans live together and interact in today's world. They also drew attention to the potential opportunities and challenges arising from human-robot interaction.
From conventional prostheses to brain implants and futuristic nanorobots that travel through our blood vessels, from wind-up toy robots to high-tech robotics employed in medical therapy and telecommunications, this experimental hands-on array served as a lab for examining questions about social interrelationships among humans and machines. After the complete thematic redesign of the Ars Electronica Center in 2019, these questions have been discussed in a new generation of labs and studios, namely the SecondBodyLab, and the Machine Learning Studio.

https://u.aec.at/AE6D9E49

Coming out of the Honda Research Institute, an updated version of the humanoid robot "ASIMO" participated in the Gala of the Ars Electronica Festival 2010, impressing the audience by expertly handing over the certificates to the winners of the Prix Ars Electronica. For "ASIMO" and the group of representatives from Honda, who had accompanied the robot to Linz, this appearance at the Ars Electronica Festival was a new experience outside the robot's usual habitats of the laboratory and diligently planned demo showcases. Honda was decidedly looking for this new kind of feedback and in fact also came to Linz for research experiments in cooperation with the Ars Electronica Futurelab, using the simulation environment of the Deep Space. Satoshi Shigemi, president of the Honda Research Institute Japan, explains their mission in this collaboration with the Futurelab: "Honda had aimed to create the humanoid robot 'ASIMO' that was exploring coexistence between humans and robots. To find the factors that would enhance the human-robot interaction, we conducted citizen participatory experiments at Deep Space, and we obtained broad insights and opinions from the international perspective. Before the collaboration, we introduced 'Asimo' as a technology demo to the public. Through the inclusive experiment conducted with the Futurelab, I realized once again that human-coexistence robots need to be able to connect with people, like a collaborator. They shouldn't be just for replacing human work."[4] "ASIMO"—the first robot that could run on two legs and reach a speed of up to 6 km/h—was designed to cooperate with humans and to perform movements in harmony with human motion. In the experiments at the Deep Space it became possible to study the collaborative abilities of "ASIMO" as a team player among a group of humans. For the Ars Electronica Futurelab, this cooperation project with Honda, one of the world's leading developers of humanoid robots, meant an important further step in its series of collaborations with the industry. The clients and partners of the Ars Electronica Futurelab range among those players in the corporate world that actively approach the Futurelab with the aim of bringing precisely its kind of expertise between art and science into their development activities and of confronting themselves with an open discourse about the implications of their technologies.

4 Satoshi Shigemi, in a conversation with Hideaki Ogawa, May 2021.

Human Robot Harmony
Humanoid Robot “Honda ASIMO”

Type: Research
Location: Linz, Deep Space
Year(s): 2010

Special features / key technologies:
ASIMO, Deep Space, human-machine interaction, robotics

Ars Electronica Futurelab and Honda R&D worked on collaborative applied research into the next-generation relationship between humans and robots. The applied research addressed important questions, such as how to integrate technologies like the humanoid robot ASIMO into our daily lives and how to influence human acceptance of and co-existence with humanoid robots.
In 2010, Honda’s leading-edge humanoid robot ASIMO (Advanced Step in Innovative Mobility) made its public debut in Austria at the Ars Electronica Festival. To enable ASIMO to walk, Honda engineers studied the complexly coordinated movements of human beings. ASIMO’s size and design were calculated to enable it to optimally interact in a human environment. A program developed especially for the Ars Electronica Center by Honda engineers and Ars Electronica Futurelab staff provided ASIMO with plenty of opportunities to show off its wide range of robotic skills.

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“Honda had aimed to create the humanoid robot ‘ASIMO’ that was exploring coexistence between humans and robots. To find the factors that would enhance the human-robot interaction, we conducted citizen participatory experiments at the Deep Space, and we obtained broad insights and opinions from the international perspective. Before the collaboration, we introduced ‘ASIMO’ as a technology demo to the public. Through the inclusive experiment conducted with the Futurelab, I realized once again that human coexistence robots need to be able to connect with people, like a collaborator. They shouldn’t be just for replacing human work.”

Source: Satoshi Shigemi, in a conversation with Hideaki Ogawa, May 2021.

Satoshi Shigemi (*1964, JP). Robotic researcher. Graduate of Tokyo Denki University (TDU). Involved in humanoid robot research and development at Honda R&D since its inception in 1986. President of Honda Research Institute Japan Co. since 2021.

"The nature of being human, i.e. humanity, has been the subject of endless discussions and research, and at this juncture in time we need to address 'robotinity,' to ensure the harmonious coexistence of humans and robots in society."

Source: Ogawa, Hideaki, "Robotinity," in: Stocker, G. & Schöpf, C. (eds.): *origin,* Ars Electronica 2011, Hatje Cantz Verlag, Ostfildern, 2011, p. 286

Hideaki Ogawa (*1977, JP). Creative catalyst, artist, educator, curator, and researcher in the field of art, technology, and society. Artistic director of the media artist group h.o. Member of Ars Electronica Futurelab since 2007. Founding director of Ars Electronica Japan since 2016. Co-director of Ars Electronica Futurelab since 2019.

Impressions of the *Robotinity* exhibition (2011) at Ars Electronica Center

Understanding Robotinity

Drawing from the extensive experiences of those years with robotic projects, in 2011 Hideaki Ogawa came up with a concept—incubated also in the Futurelab's "Innovation Research Group," which he had formed together with Christopher Lindinger and Roland Haring—that had the ability to integrate and shape the approach of the Ars Electronica Futurelab towards robotics research. This also considered the fact that the Ars Electronica Futurelab does not develop robots itself, but works with partners from that industry to explore the issues of a growing robotization of societies. For this new concept, Hideaki Ogawa coined the term "robotinity" as a mirror term for "humanity" and described it as a journey to understand what a robot actually is. "The nature of being human, i.e. humanity, has been the subject of endless discussions and research, and at this juncture in time we need to address 'robotinity,' to ensure the harmonious coexistence of humans and robots in society."[5] There is a remarkable paradigm shift taking place that leads to an approach that no longer simply focuses on the recurring and certainly also limiting questions for the "conditio humana," but instead forces us to ask for something as seemingly alien as a "conditio robotica." The "juncture in time" that Hideaki Ogawa mentions may also be read as a pointer towards those future path dependencies resulting from the design decisions made in the present. The overarching goal behind the concept of "robotinity," however, is to transcend issues of human-robot interaction by inserting the wider horizon of looking into future ways of arriving at a "harmonious coexistence of humans and robots."

To illustrate and further explore this concept of "robotinity," Hideaki Ogawa curated an exhibition of the same name that allowed visitors to gain personal experiences with issues of emotional design and to understand the balance between design and functionality, always looking at the relationships between humans and robots. Workshops in a *Social Robot Studio* also offered visitors the opportunity to design their own prototype robots. The exhibition was also intended to contribute to efforts toward finding a new language for "robotinity." A new language is frequently required in order to understand and cooperate with a new technology. Horst Hörtner reflected on the work of the Ars Electronica Futurelab with robots, now framed in this new concept: "Robotinity would not exist without humans. Robots become something else by interacting with humans, and our projections turn robots into more than a machine."[6]

5 Ogawa, Hideaki, "Robotinity," in: Stocker, G. & Schöpf, C. (eds.): *origin,* Ars Electronica 2011, Hatje Cantz Verlag, Ostfildern, 2011, p. 286.

6 Horst Hörtner, in a conversation with the author, April 2021.

Impressions of the *Robotinity* exhibition (2011) at Ars Electronica Center

Robotinity Exhibition

Type: Exhibition
Location: Ars Electronica Center, Linz, Austria
Year(s): 2011 – 2017

Special features / key technologies:
Human-machine interaction, robotics, Telenoid, Paro

The exhibition “Robotinity” explored what it means to be a robot and how humans and robots can harmoniously coexist. This unique perspective on machines developed out of long-term research by the Ars Electronica Futurelab Research & Innovation Group. The exhibition was divided into five zones: *Human Beings, Robotics and Medicine, Robotic Design, The Coexistence of Humans and Robots,* and *Social Robot Studio.*
In 2015 an international spin-off of the exhibition was realized by “Ars Electronica in the Knowledge Capital” in Osaka, Japan. Business and creative people were invited to be inspired by creative perspectives with a mix of exhibition, lectures, and workshops, and to discuss the question “What does it mean to be a robot?” in the light of cutting-edge robot technology.

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Face to Face with the Automobile

In 2013, the Ars Electronica Futurelab crossed paths with another robot, which at first glance might not be recognized as belonging to that species of machine: the research car by Mercedes Benz called "F 015 Luxury in Motion." This autonomous vehicle was part of Daimler's research on self-driving cars with the aim of exploring modes of communication to ensure a safe and trustful co-existence in road traffic. The futurist Alexander Mankowsky, working in Future Studies & Ideation at Mercedes-Benz, opened a conversation with Christopher Lindinger, co-director of the Ars Electronica Futurelab and head of innovation and research, and Martina Mara, at the time a key researcher at the Futurelab. In the ensuing collaboration, the Spaxels—which not only could operate high up in the skies, but were also able to fly at up to 60 km/h at human shoulder height—were used for experiments. The aim was to develop a syntax for human-machine communication, including gestures and intention signals creating confidence and a feeling of trust and safety. As an outcome of this collaboration, in which the Ars Electronica Futurelab contributed to fundamental research aspects and Daimler took care of the design, the "F 015 Luxury in Motion" concept car had its European premiere presentation during the Ars Electronica Festival in 2015. The expansive space at the Festival's main venue in that year, the POST CITY (former Austrian Postal Service logistics facility) made indoor presentations of the communicative abilities of this autonomous vehicle possible. Signage with the aim of starting a reliable negotiation process between car and pedestrians included, for instance, a crosswalk projected onto the tarmac by the car itself. With regard to pedestrians and autonomous cars sharing public space, Alexander Mankowsky pointed out: "Concepts of [sharing] will need an interaction model between mobile robots and humans as [a] foundation. Mobility can be seen as an interaction process, driven by continuous, non-verbal communication."[7] Although it was a prototype and therefore not admitted to road traffic, the "F 015 Luxury in Motion" was able to make a short trip from the Ars Electronica Center across the bridge to the Main Square, thus exposing not only the many visitors at the POST CITY but also the population of Linz to this glimpse into the future of self-driving cars.

7 Source: Mankowsky, Alexander, "Futures Studies & Ideation – Autonomous Cars: The Introduction of Automation into Society," in: Stocker, G., Schöpf, C. & Leopoldseder, H. (eds.): *POST CITY—Habitats for the 21st Century,* Ars Electronica 2015, Hatje Cantz Verlag, Ostfildern, 2015, p. 84.

“Art can function as a beacon into the future, picking up culturally sensitive topics that may be difficult to address otherwise. We need this orientation to determine the direction of future developments in society and industry.”

Source: Alexander Mankowsky in a conversation with the author, January 2021.

Alexander Mankowsky (*1957, DE). Futurologist. Studies in social science, philosophy, and psychology at the Freie Universität Berlin. Has worked at Daimler’s research institute in Berlin since 1989. Future studies with a focus on the culture of mobility and the interdependency of social and technological innovation.

Mercedes-Benz F 015 Luxury in Motion at the main square of Linz

Communication with Robot Cars

Type: Research
Location: Ars Electronica Center, Linz, Austria
Year(s): 2013–2015

Special features / key technologies:
Autonomous driving, Spaxels, robopsychology, human-machine interaction, public discourse, F 015

In 2013, Ars Electronica Futurelab started working together with Mercedes-Benz on how to facilitate communication between human beings and the smart self-driving cars of tomorrow. The primary focus is on the futuristic vision of shared space—a street design approach that replaces separate zones for vehicles and pedestrians by one zone for pedestrians and vehicles in interaction with each other.
In 2014, Mercedes-Benz staged the conference “Future Talk Robotics,” conceived in collaboration with Ars Electronica Futurelab. The Ars Electronica Futurelab, for its part, also developed “Shared Space Spaxels” and “Shared Space Bots”—interactive proving grounds to focus on aspects of communication with autonomous machines. The simulation of robotic mobility scenarios focused on the research question of “How can we humans understand the intentions of autonomous machines, and what language do we need for that?” In 2015 the research vehicle “Mercedes-Benz F 015 Luxury in Motion” drove to the main square of Linz, the first time ever this autonomous car has made contact with the public on the European continent.

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“Replicating humans and animals will not be the solution for robotics. Robots should rather become their own social category. Instead of competing with robots, we should strive for cooperation with them, which needs to be based on understanding and trust.”

Source: Martina Mara in a conversation with the author, January 2021.

Martina Mara (*1981, AT). Tech psychologist, PhD in psychology from the University of Koblenz-Landau. Member of the Ars Electronica Futurelab from 2010 until 2018. Professor of robopsychology and director of the Robopsychology Lab at the Linz Institute of Technology (LIT) at Johannes Kepler University Linz since 2018.

Mercedes-Benz, Future Talk 2014. Experimental research of human-machine interaction.

Inside Futurelab: 25th Anniversary Series (2021), *Humanity and Robotinity* in Deep Space 8K

The way humans still view robots is usually heavily charged with (frequently dystopian) myths from science fiction. As Martina Mara sees it, we have reached a new phase in the relationship of humans and robots: "For the first time in history, we are now approaching an era in which intelligent machines might no longer just be fictional characters, but also start to appear in real-life situations."[8] Ars Electronica Futurelab key researcher Martina Mara had become a professor of robopsychology at the Linz Institute of Technology (LIT) at Johannes Kepler University Linz in 2018. This opened up the opportunity to enter into a cooperation project involving the Ars Electronica Futurelab, the LIT, and several other organizations in order to explore collaborative robots in the setting of the Deep Space 8K, based on this insight: "Replicating humans and animals will not be the solution for robotics. Robots should rather become their own social category. Instead of competing with robots, we should strive for cooperation with them, which needs to be based on understanding and trust."[9] The project *CoBot Studio* was started in 2019 as a several-stage research process under the heading: "Crossing Realities for Mutual Understanding in Human-Robot Teams." Roland Haring described the advantages of using the Deep Space 8K as a research facility: "Here we can create a mixed reality environment where future ways of co-existence with collaborative robots—CoBots—can be simulated. This research involves several disciplines and institutions with expertise from robotics to psychology and from virtual reality to non-verbal communication."[10]

8 Martina Mara, in a conversation with the author, January 2021.

9 Martina Mara, in a conversation with the author, January 2021.

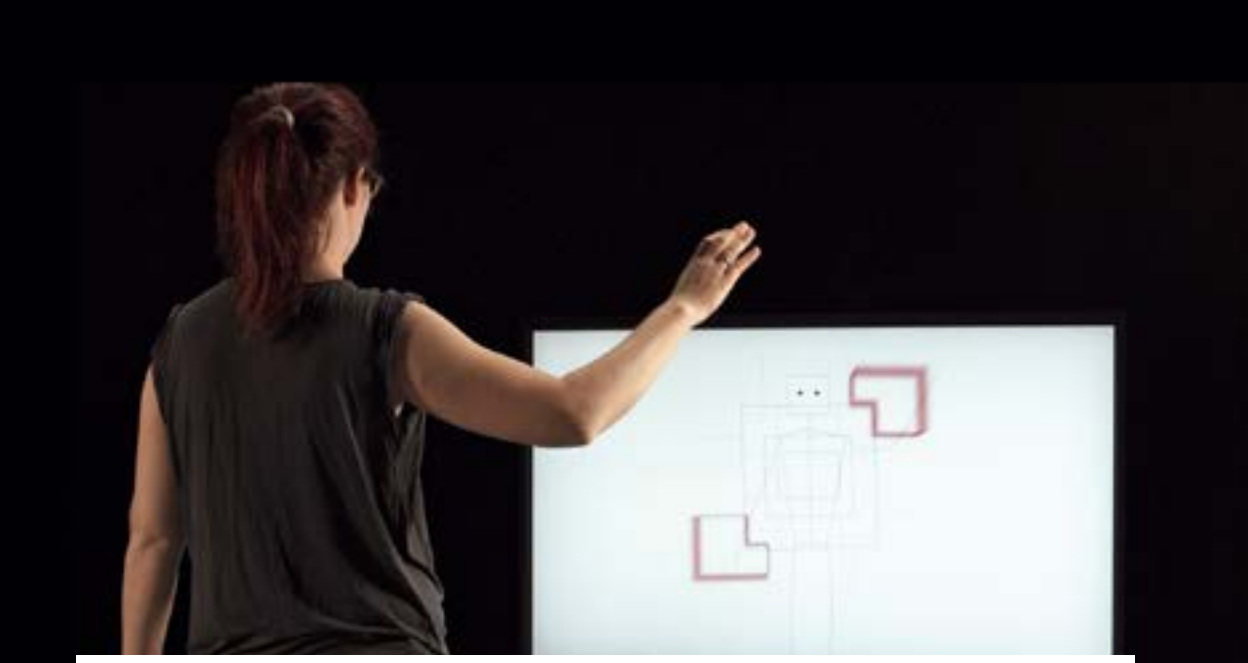
10 Roland Haring, in a conversation with the author, December 2020.

“In order to explore human-robot interaction, we use the Deep Space 8K as a research facility. Here we can create a mixed reality environment where future ways of co-existence with collaborative robots—CoBots—can be simulated. This research involves several disciplines and institutions with expertise from robotics to psychology and from virtual reality to non-verbal communication.”

Source: Roland Haring in a conversation with the author, December 2020.

Roland Haring (*1975, AT). Media technologist, designer. Studied media technology and design at Hagenberg University of Applied Sciences. Member of the Ars Electronica Futurelab since 2003, technical director since 2014.

CoBot Studio (2019), prototyping for the first experiment series of *CoBot*



MANUACT

Type: Research, Exhibition
Location:
Saxon Museum of Industry, Chemnitz, Germany
Chemnitz University of Technology, Chemnitz, Germany
Ars Electronica Futurelab, Linz, Austria
Year(s): 2017

Special features / key technologies:
Artistic research, human-machine communication, gesture control, interactive interfaces, motion tracking, tactile feedback, digital representations

"How can gesture research be presented so that it is comprehensible by everyone?" was a key research question of the interdisciplinary project, *Hands and Objects in Language, Culture and Technology: Manual Actions at Workplaces between Robotics, Gesture, and Product Design (MANUACT),* which Chemnitz University of Technology commissioned in conjunction with an R&D assignment. Ars Electronica Futurelab was brought on board as a scientific associate to support the university research group by developing specially designed installations and exhibits about gesture research.
An interactive exhibition at the Saxon Museum of Industry entitled "Gestures – Yesterday, Today and the Day after Tomorrow" was the product of the joint research project. It was an opportunity to find out more about the subject of gestures, the research now being done in this field, and the various applications in which gestures will be employed in the future. From operating old looms all the way to Industry 4.0 and communication with self-driving cars: gestures play a major role in our interaction with technology. They are complex, and their significance has, in some cases, undergone radical changes and in others remained unchanged for generations.

https://u.aec.at/1FE26057

In a joint research project between the Ars Electronica Futurelab and the Chemnitz University of Technology in Germany, the future use of gestures in interaction between humans and machines was explored in 2017. The full title of the research program MANUACT indicated the scope of the collaboration: "Hands and Objects in Language, Culture and Technology: Manual Actions at Workplaces between Robotics, Gesture and Product Design." The resulting exhibition at the Saxon Museum of Industry combined the scientific and technological perspective with artistic installations in order to allow visitors to explore the growing importance of gestures, namely where machines are assigned tasks that were previously performed by humans. The relevant gestures might be derived from the physical act of performing the task manually, but could also belong to an entirely new gestural language. Marianne Eisl, key researcher at the Ars Electronica Futurelab, sees gestures in a process of changing significance: "The question of the spectrum of significance comes into play with every gesture. The meaning of gestures changes repeatedly over the centuries, and one of the reasons for this is that technologies change—and that will continue to be the case."[11]

Gesture Space Visualizer (left) developed by Ars Electronica Futurelab for the Gesture exhibition at the Chemnitz Museum of Industry in cooperation with the MANUACT project.

With the *Virtual Pottery Wheel* (2017), developed by the Ars Electronica Futurelab for the Gestures exhibition at the Chemnitz Museum of Industry, visitors can experiment with gesture control in the context of pottery.

11 Eisl, Marianne, "Gestures: When Humans Reach out to Machines," Ars Electronica Blog, 2017–https://ars.electronica.art/aeblog/en/2017/12/05/gestures/

“On the Marionette Theater”

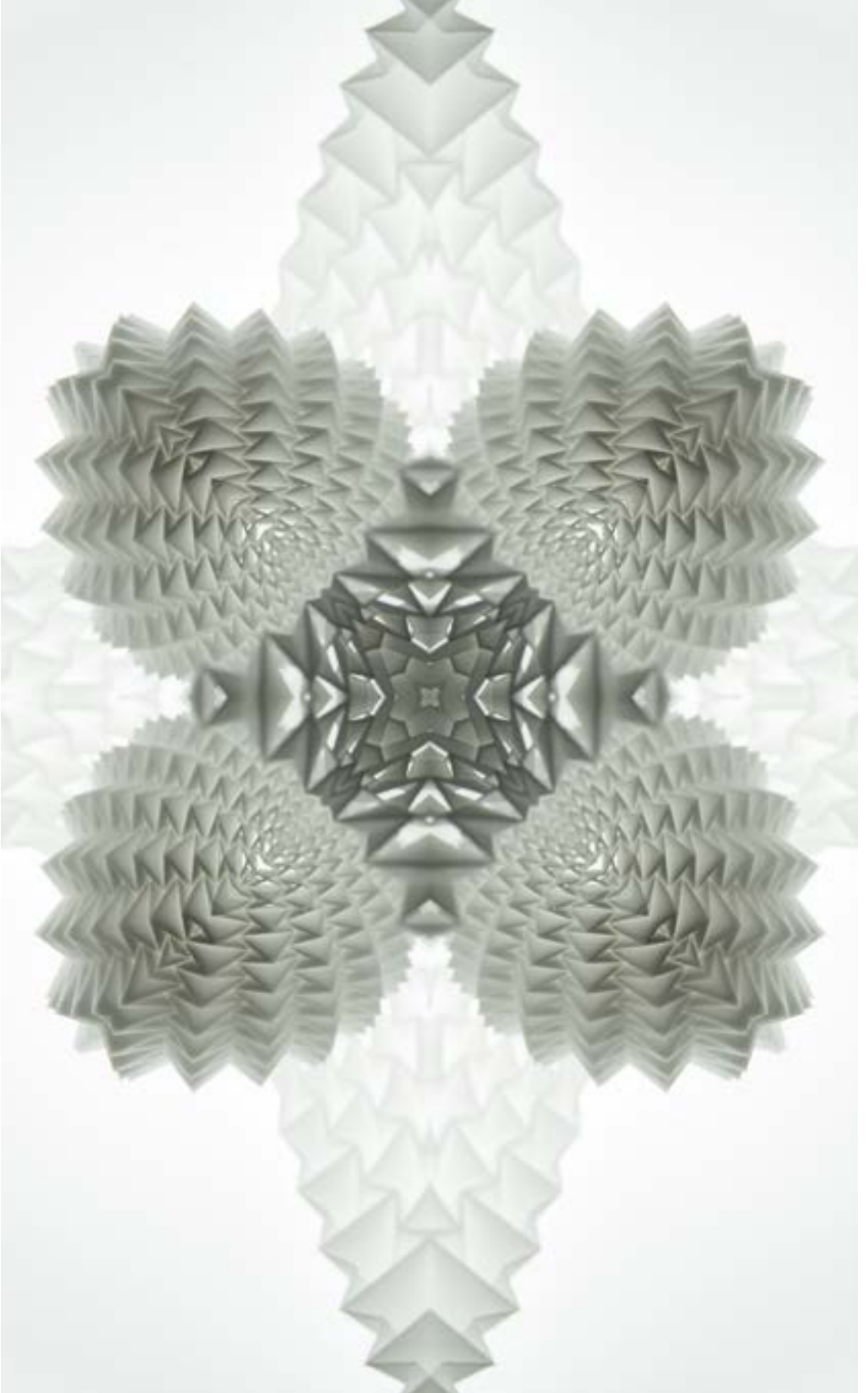
A different kind of non-verbal communication occurs in an installation involving two marionettes that perform a little scene in which they attempt to escape from the exhibition at the Main Gallery of the Ars Electronica Center. At the very last moment they abandon their escape mission and back away from the abyss opening before them. The two puppets seem fragile compared to the strong arms of two industrial robots, which are gently guiding their movements. One of the puppets has been carved from wood in a traditional way by the artist Michael Lauss, the other has been shaped as a wireframe by Benjamin Krux with a 3D printer. For this installation, titled *pinocchio,* the puppeteer Katharina Halus had originally played the scene inspired by the children’s novel, written by the Italian author Carlo Collodi (1826–1890), about the wooden puppet who dreams of becoming a real boy. The robots were trained with a recording of the puppeteer’s motions, which they then replicated with utmost precision. In a collaboration between the Ars Electronica Futurelab and the Creative Robotics department of the Institute of Space and Design at the University of Art and Design Linz, this unsettling mis-en-scène was created in 2019 for the exhibition “Understanding AI” at the Ars Electronica Center.

In traditional marionette theater, a human player guides humanoid puppets, which—for the eyes of the audience—assume human attributes like individual character traits, with which they are endowed by the story. Like robots, such as SPA 12 of 1979 and “Geminoid HI-1” of 2009, the marionettes are remote controlled, but in the case of the *pinocchio* installation, the remote controlling is done by robots, too. It almost seems as though the German poet Heinrich von Kleist (1777–1811) had foreseen such a scenario when he wrote in his 1810 text “On the Marionette Theatre” (“Über das Marionettentheater”): “He had since come to believe that even this last fraction of spirit could be removed from the marionettes, that their dance could pass completely into the realm of mechanical forces, and could, by means of a handle, just as I had imagined, be reproduced.”[12]

The installation *pinocchio* is part of a larger context of Ars Electronica projects with robots co-performing with human artists. For the *Berlioz Project* in 2018 and for *Mahler Unfinished,* which was created by Futurelab key researcher Ali Nikrang in 2019, dancers entered into a creative encounter with robots in a shared choreography. Fueled also by projects of this kind, the Ars Electronica Futurelab’s enquiry into both the “human condition” and “robotinity” continued to unfold and also to expand far into areas like “wetware” and “artificial intelligence.”

12 “On the Marionette Theatre” (“Über das Marionettentheater”) by Heinrich von Kleist, translated by Kevin J M Keane, 2012.

pinocchio (2019). Two industrial robots play the role of two marionettes. The motions of a human puppeteer were recorded and are copied by the two robot arms.



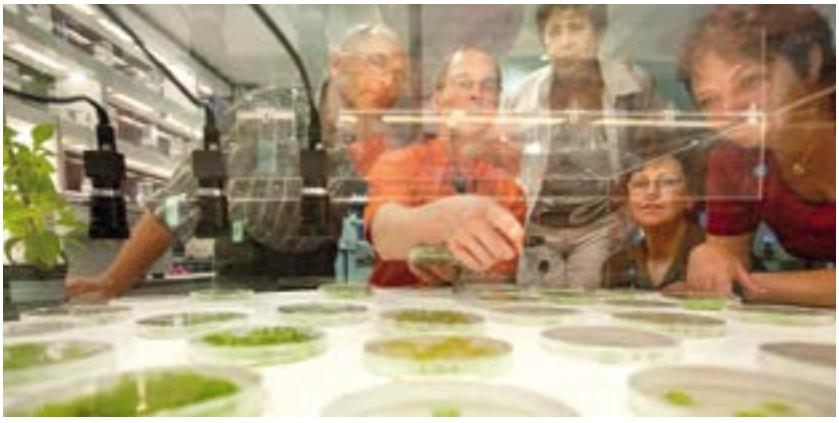
Code for Matter

Computing Goes Biological

BioLab and FabLab: Messengers of a Paradigm Shift

It is often the seemingly small things that can indicate a major paradigm shift. That evening in 2009, the water pipe was just a tiny detail among the complex installations in the spacious new Main Gallery of the Ars Electronica Center. They had known it would be there, but when, during the final stages of the construction phase, they actually came across that freshly installed water outlet, Horst Hörtner and his colleagues suddenly felt very strongly that they were looking at something groundbreaking. The Ars Electronica Futurelab's domain of work up to that point had been defined by digital computers and the various technologies that sprang from the so-called "digital revolution." Water is clearly one of the most dangerous enemies of any information technology equipment, since all kinds of electric circuitry could be affected by contact with that element. But water was going to be there, and the "weak signal" of the single water pipe amidst all the other electronic devices indicated the arrival of "wetware"—basically the elements equivalent to computer hardware and software in living creatures—also in the work of the Ars Electronica Futurelab.

In the overall ecosystem of Ars Electronica, questions related to biotechnology had been prevalent for several years, for example in the Ars Electronica Festival theme "Life Science" in 1999, or the Prix Ars Electronica category "Hybrid Art". Referring to the Festival theme of 2009, "Human Nature," Gerfried Stocker and Christine Schöpf remarked: "The achievements of genetic engineering and biotechnology are the truly indicative markers of this transition to a new epoch. … we're revising the fundamentals of life itself—even our own human life."[1]



BioLab (2009) at the Ars Electronica Center

1 Stocker, Gerfried, Schöpf, Christine, "Human Nature," in: Stocker, G., Schöpf, C. (eds.): *HUMAN NATURE,* Ars Electronica 2009, Hatje Cantz, Ostfildern, 2009, p. 10.


“We are entering a new age here on earth: the Anthropocene. An age definitively characterized by humankind’s massive and irreversible influences on our home planet. Population explosion, climate change, the poisoning of the environment and our venturing into outer space have been the most striking symbols of this development so far. But to a much more enormous extent, the achievements of genetic engineering and biotechnology are the truly indicative markers of this transition to a new epoch. … we’re revising the fundamentals of life itself—even our own human life.”

Source: Stocker, Gerfried; Schöpf, Christine, “Human Nature,” in; Stocker, G.; Schöpf, C. (eds.): *HUMAN NATURE,* Ars Electronica 2009, Hatje Cantz, Ostfildern, 2009, p. 10

Gerfried Stocker and Christine Schöpf

Among those advances of biotechnology, certainly the sequencing of the human genome in 2003 and the discovery of the "genetic scissors" CRISPR-Cas9 in 2012 were the most prominent and widely discussed milestones in a landslide development that only compares to a similar dynamic in the area of artificial intelligence research, the advent of machine learning. In fact, those two parallel processes were interconnected in several ways. One connection consisted in the simple fact that those recent achievements in biotechnology could not have happened without state-of-the-art information technology.

For the exhibition "New Views of Humankind" in the Main Gallery of the Ars Electronica Center in 2009, the Futurelab team had developed two new "Labs," which stood next to each other like two semi-transparent pavilions, shimmering towards the outside and usually brimming with activity inside. The American-Austrian architect and designer Scott Ritter (1962–2018) had conceived—as a special kind of design highlight among the many exhibition designs he had created for Ars Electronica between 1996 and 2018—those indoor housings for the BioLab and the FabLab. The idea of a "Fab Lab"—which became part of the broader movement of a "maker culture" and an international network of "maker spaces"—had originated at the Massachusetts Institute of Technology (MIT). Neil Gershenfeld, the director of the MIT's "Center for Bits and Atoms," had early on recognized the need for lab environments that enable hands-on experimentation with digital manufacture, also building upon an analogy between the personalization of fabrication and that of computation.[2] In 2009, Irene Posch, an artist and researcher at the Ars Electronica Futurelab at that time, served as the project lead for the creation of both the FabLab and the BioLab at the Ars Electronica Center in 2009: "New and complex technologies often exert a big influence on everyday life and present challenges to understand their potentials. New tools allow for new interactions with previously unknown potentials of materials. In the growing demand for new skills and technological literacy, Fab Labs can support people by providing access to the tools as well as an environment where complex topics can be grasped through personal experience."[3] The FabLab combined areas for design and for fabrication with a gallery—in the transparent walls of the Lab—to exhibit the results to the surrounding exhibition hall. Tablet computers and other kinds of interfaces with easy-to-use applications were available to generate three-dimensional models, which then could be "printed" with a laser cutter for cutting and engraving, a fabber for experimenting with materials, and of course a 3D printer. The BioLab offered professional-grade laboratory equipment, including a raster electron microscope, and allowed for performing forensic DNA analyses as well as cell analyses.

2 Gershenfeld, Neil, *Fab: The Coming Revolution on Your Desktop—from Personal Computers to Personal Fabrication,* Basic Books, New York, 2005, p. 15.

3 Irene Posch, in a conversation with the author, April 2021.

BioLab (2009) at the Ars Electronica Center

FabLab (2009) at the Ars Electronica Center

“New and complex technologies often exert a big influence on everyday life and present challenges to understand their potentials. New tools allow for new interactions with previously unknown potentials of materials. In the growing demand for new skills and technological literacy, Fab Labs can support people by providing access to the tools as well as an environment, where complex topics can be grasped through personal experience.”

Source: Irene Posch, in a conversation with the author, April 2021.

Irene Posch (*1983, AT). Researcher and artist. Member of the Ars Electronica Futurelab from 2007 until 2011. Concept design and project lead for the FabLab and the BioLab at the Ars Electronica Center in 2009. Professor of Design & Technology at the University of Art and Design Linz since 2018.

BioLab, BrainLab, FabLab, RoboLab

Type: Exhibition
Location: Ars Electronica Center, Linz, Austria
Year(s): 2009 – 2019

Special features / key technologies:
3D printing, Security 1 wet lab, PCR machine, brain scan, robotics, cloning

Center stage of the new, expanded Ars Electronica Center (2009) was the main exhibition *New Views of Humankind,* which investigated the continuous changes of our picture of the world. It showed where these images come from, how they materialize, and how we interpret them. The BrainLab, BioLab, RoboLab and FabLab played a key role in the exhibition. These four labs were accessible to the public. Via interaction and hands-on experiences, visitors gained insight into the cognitive and visual worlds of modern-day life sciences. BrainLab shed light on how humans perceive their environment and how their brain leads them to believe the way they do. BioLab was a wet lab for hands-on experience with state-of-the-art lab equipment amidst cloned plants. FabLab focused on making computer-aided design and fabrication accessible for users—from interactive installations for intuitive first experiences to custom-designed software for easy access to fabrication tools, and in RoboLab input from the fields of art, design, and research demonstrated how robots and humans already interact and live together.
A key idea behind this 2009 exhibition was to show that laboratories are hubs of creativity, technology, society, and science and not mysterious places behind closed doors, where scientific experiments take place that have little relevance in everyday life. This approach continues with the next generation of Ars Electronica Labs installed in 2019: BioLab, MaterialLab, CitizenLab, SecondBodyLab, and CCI Lab.

https://u.aec.at/1461DFD7

Life from the Lab

The proximity of the BioLab and the FabLab in the exhibition space of the Ars Electronica Center—and in the work of the Ars Electronica Futurelab—somehow seemed to anticipate a certain convergence between an international maker culture and the science and practices behind biotechnology. At the Ars Electronica Futurelab, those two developments met with artists exploring and utilizing insights and tools from both fields in order to look at the critical points and ethical issues involved. Futurelab key researcher Matthew Gardiner observed: "The deeper philosophical concerns of the science of synthetic biology became the paramount concerns of a future society."[4] When he curated the exhibition "Project Genesis" at the Ars Electronica Center in 2013, Matthew Gardiner had the opportunity to bring together key positions from artists working in that field: "It's a natural attraction for artists to be drawn to the frontiers of technological and social change … Their speculations have long since departed from … communication via simple media of forms, kinetics and text; they design and construct their storylines with the functional aesthetics of natural processes as symbolic metaphors."[5]

"Project Genesis" exhibition (2013), Ars Electronica Center

4 Gardiner, Matthew, "The Futurelab as Catalyst: From Artist to Alchemist," in: Stocker, G., Schöpf, C. & Leopoldseder, H. (eds.): *RADICAL ATOMS and the alchemists of our time,* Ars Electronica 2016. Hatje Cantz, Berlin, 2016, p. 356.

5 Gardiner, Matthew, "Yours Synthetically," in: Stocker, G., Schöpf, C. & Leopoldseder, H. (eds.): *TOTAL RECALL—the Evolution of Memory,* Ars Electronica 2013, Hatje Cantz, Ostfildern, 2013, p. 239.

Project Genesis

Type: Research project, exhibition
Location: Ars Electronica Center, Linz, Austria
Year(s): 2011–2014

Special features / key technologies:
Bioart, life-art synthetic biology, genetics, DNA, tissue culture, PCR, CRISPR, bacteria, ethics

A project that facilitated and promoted creative interaction between art and science. The three-year project focused on synthetic biology and art. Artists were mentored in a masterclass on synthetic biology and were able to improve their immediate networks and then create new art works that were shown in the exhibition "Project Genesis. Synthetic Biology Life from the Lab." These works, together with pieces submitted following an open call and works by and with Ars Electronica staff, were exhibited over two full floors of the Ars Electronica Center.
Project Genesis started from Futurelab's partnership within the Studiolab initiative, funded by the European Commission Seventh Framework Programme (FP7). Studiolab, inspired by the merging of the artist's studio with the research lab to create a hybrid creative space, was one of the first specific art science calls funded by FP7.

https://u.aec.at/EE7CE559

The ways in which the Ars Electronica Futurelab adopted this new area of biotechnology was characterized by two strategies, which were basically part of the DNA of the Futurelab, but now appeared in a modified form. The work on aspects of biotechnology also put additional emphasis on the importance of the entire ecosystem of Ars Electronica for the work of the Futurelab and vice versa. With the creation of the BioLab and the FabLab, the Ars Electronica Futurelab played a key role in the process of introducing the new format of "lab" infrastructures to Ars Electronica. Their enabling potential represented a further step in the Ars Electronica Futurelab's efforts to make new technologies tangible and to provide the basis for an informed discussion of the implications of those technologies to the public. On the other hand, the curation of an exhibition like "Project Genesis" by a key researcher of the Ars Electronica Futurelab indicated a further widening of the Futurelab's dialogue between art and science, which usually took place inside the Futurelab with partners from academia and industry as well as with artists coming in through various artist-in-residence programs. Work relating to such exhibitions, and also the labs installed there, also meant that the Ars Electronica Futurelab was pushing the envelope in reflecting upon the medium of the exhibition itself and its future, namely by enhancing the shift from interaction towards participation.[6] This step in exhibition design needed to be taken with the overall aim of enabling and empowering the public in the encounter with new technologies, as Futurelab key researcher Marianne Eisl pointed out: "Although science is all around us and unconsciously influences our daily lives, research priorities are often built on the input and feedback of a selected scientific group of people and not really on the empirical values of the people that are affected by it. The challenge is to design a balanced minds-on experience, which leaves enough room to integrate knowledge in our own individual construct of reality. If knowledge suddenly fills up with meaning, we can encourage the public to get active, take part and with this mix of different perspectives jointly shape our future."[7]

"Project Genesis" exhibition (2013), Ars Electronica Center

6 Eisl, Marianne, "Beyond interaction—participation as key element for exhibition—design," in: Stocker, G., Schöpf, C. & Leopoldseder, H. (eds.): *Out of the Box: The Midlife Crisis of the Digital Revolution,* Ars Electronica 2019, Hatje Cantz Verlag, Berlin, 2019, p. 398.

7 Eisl, Marianne, Tangible Link, https://ars.electronica.art/futurelab/de/research-tangible-link/

“Although science is all around us and unconsciously influences our daily lives, research priorities are often built on the input and feedback of a selected scientific group of people and not really on the empirical values of the people that are affected by it. The challenge is to design a balanced minds-on experience, which leaves enough room to integrate knowledge in our own individual construct of reality. If knowledge suddenly fills up with meaning, we can encourage the public to get active, take part and with this mix of different perspectives jointly shape our future.”

Source: Marianne Eisl, Tangible Link, https://ars.electronica.art/futurelab/de/research-tangible-link/

Marianne Eisl (*1986, AT). Key researcher and artist at the Ars Electronica Futurelab since 2015. Master’s degree in media informatics from Vienna University of Technology. Her focus is currently on developing interactive and participative artifacts as well as concepts for exhibitions and tangible installations.

Matters of Materials and Symbioses

When in 2019 the entire Main Gallery of the Ars Electronica Center was redesigned to house the new exhibition "Understanding AI," the Ars Electronica Futurelab contributed several key installations. The time had also come to update the BioLab and the FabLab, since in the area of biotechnology as well as in the sphere of Fab Labs further advances had been made, and the Ars Electronica Labs had morphed even further into spaces of interchange between different knowledge cultures. This led to the installation of a completely new Bio Lab in 2019, which also covered aspects of genetic engineering that had meanwhile been enabled by methods of CRISPR gene editing. Also, the rise of "Grow It Yourself" or "DIY biology" resulted from the convergence of the fields that had been represented by the original BioLab and FabLab in 2009. Fab Labs had moved on from the predominance of computer-aided design with 3D printers and laser cutters towards methods of working with an entire range of emerging new materials, resulting in the establishment of the Material Lab at the Ars Electronica Center, also in 2019. The Material Lab was conceptualized to look into issues of an increasing scarcity of resources as well as highly problematic working conditions in the related supply chains, and to thus raise awareness for ways of achieving sustainable and responsible production. In the research focusing on future materials, aspects of intelligent fabrics also come into play. This brings to mind an observation made by Hiroshi Ishii, director of the Tangible Media Group at the MIT Media Lab and a long-time collaborator with the Ars Electronica Futurelab and Ars Electronica as a whole, when in 2016 he reflected on the progress of his own work from "Tangible Bits" towards "Radical Atoms": "Blurring the boundary between the machine and materials is one of our dreams. … machines become materials … and materials become machines."[8]

MaterialLab (2019) and BioLab (2019), Ars Electronica Center

8 Ishii, Hiroshi, "Radical Atoms: Beyond the 'Pixel Empire,'" in: Stocker, G., Schöpf, C. & Leopoldseder, H., *RADICAL ATOMS and the alchemists of our time,* Ars Electronica 2016. Hatje Cantz, Berlin, 2016, p. 21.

“Blurring the boundary between the machine and materials is one of our dreams. ... machines become materials ... and materials become machines.”

Source: Ishii, Hiroshi, “Radical Atoms: Beyond the ‘Pixel Empire,’” in: Stocker, G.; Schöpf, C. & Leopoldseder, H., *RADICAL ATOMS and the alchemists of our time,* Ars Electronica 2016. Hatje Cantz, Berlin, 2016, p. 21

Hiroshi Ishii (*1956, JP/US). Computer scientist. Professor of media arts and sciences at the MIT Media Laboratory. Founder of the Tangible Media Group at MIT in 1995. Presented the exhibitions “Tangible Bits” and “Radical Atoms” at the Ars Electronica Center.

“RADICAL ATOMS” exhibition (2016). *musicBottles,* a work by MIT’s Tangible Media Group led by Hiroshi Ishii is an interactive installation for visitors to interact with soundwaves encapsulated in bottles.

The Dutch fashion designer Anouk Wipprecht realized the project *Agent Unicorn* during her SPARKS Residency at the Ars Electronica Futurelab in 2016. In her research and in her creations, she looks at issues of humans in relation to wearables, fabrics, and robotics. Consequently, she refers to the notion of symbiosis, and points to the problematic "invasiveness" of certain technologies: "I am interested in a symbiosis of humans and technology, preferring to create a partnership with technology instead of letting technology dictate our behavior with it. Therefore, I strive to avoid invasive technologies, which are not sensitive to us. As a designer, sometimes the 'invasive' way might be easier to pursue, but why not put a bit more effort into something to make it less invasive? Artists can make the case here for a more gentle and sensible way of designing things."[9]

In their research collaboration titled *Future Ink Project,* the Ars Electronica Futurelab and Wacom started prototype research on the concept of *Bio Ink* in 2021, as Futurelab researcher Yoko Shimizu explains: "In the *Bio Ink* project, we go beyond the digital and human-centric technologies by exploring the concept of living ink that grows freely—a creative symbiosis with other organisms and nature. In nature, we co-exist and interact with many organisms. Working with other organisms helps us better understand other beings and ourselves."[10] In this project, the tablet and pen technology—the digital ink—by Wacom is used for creating drawings and messages, which are received by a drawing robot. The drawing robot transfers the drawings to biological inks comprised of microorganisms, which then grow in a controlled environment and form visible patterns that go beyond the original input, thus realizing a creative symbiosis.

Agent Unicorn (2016). During her SPARKS Residency at Ars Electronica Futurelab, Anouk Wipprecht developed a unicorn-shaped headset that is designed for children with ADHD.

9 Anouk Wipprecht, in a conversation with the author, May 2021.

10 Yoko Shimizu, in a conversation with the author, June 2021.

“I am interested in a symbiosis of humans and technology, preferring to create a partnership with technology instead of letting technology dictate our behavior with it. Therefore, I strive to avoid invasive technologies, which are not sensitive to us. As a designer, sometimes the ‘invasive’ way might be easier to pursue, but why not put a bit more effort into something to make it less invasive? Artists can make the case here for a more gentle and sensible way of designing things.”

Source: Anouk Wipprecht, in a conversation with the author, May 2021.

Anouk Wipprecht (*1985, NL). Fashiontech designer, engineer, and innovator. Work with wearable robotics and research on behavioral aspects of interactions of body-based electronic design. Created “Agent Unicorn,” a health tech device monitoring brainwaves of children with ADHD, during a SPARKS residency at the Ars Electronica Futurelab in 2016.

Bio Ink

Type: Research
Location: Biolab, Ars Electronica Center, Linz, Austria
Year(s): 2021

Special features / key technologies:
Bioart, robotic, digital drawing tablet, and pen

As part of the Future Ink research collaboration with Wacom, the *Bio Ink* project explores the concept of living ink that grows freely—a creative symbiosis with other organisms and nature. In the project, biological inks comprised of various microorganisms are created in the bio lab. A robot holding a bio pen/brush in the lab receives the drawings and messages created with a digital pen and draws on the nutrient agar plate in a petri dish. The artworks then are incubated in a controlled environment to allow the living ink to grow.
The microscopic organisms of the *Bio Ink* are invisible in the beginning, but they gradually multiply and form colonies that are visible to the naked eye, morphing into beautiful patterns beyond human input.

https://u.aec.at/EDAE8A5F

“In the *Bio Ink* project [with Wacom], we go beyond the digital and human-centric technologies by exploring the concept of living ink that grows freely—a creative symbiosis with other organisms and nature. In nature, we co-exist and interact with many organisms. Working with other organisms helps us better understand other beings and ourselves.”

Source: Yoko Shimizu, in a conversation with the author, June 2021.

Yoko Shimizu (*1977 JP). Artist and researcher. Studied biology and chemistry at Kobe University. Member of the Ars Electronica Futurelab since 2020. Began her career as a creative director and consultant for corporations, and later founded her lab, where she developed innovative technologies and installations that combine science and art.

The Folded Geometry of the Universe (2018), Matthew Gardiner

Oribotics

A different kind of "symbiosis" was conceived by Matthew Gardiner, when he approached the creation of quasi-natural creatures in a fusion of material culture with robotics, while drawing from the observation of natural processes and from the traditional Japanese art of paper folding called "origami." He called his invention "Oribotics" and described it as "a field of research that thrives on the aesthetic, biomechanical and morphological connections between nature, origami and robotics. At the highest level, Oribotics evolves towards the future of self-folding materials."[11] When he came to Linz, Matthew Gardiner brought "Oribotics" to the Ars Electronica Futurelab. In 2010 he created an installation of luminous oribotic flora, titled *Oribotics [futurelab]*, which were "grown" in the 3D printer at the FabLab over the course of 1,800 hours. On this occasion, observing the connections between the FabLab, where his quasi-natural creatures were "grown" in the 3D printer, and the BioLab, where plants were cloned using genetic technology, Matthew Gardiner drew parallels between the folding of proteins in nature and his new folding robotic creatures. As the domain of Oribotics evolved further, questions of new self-folding materials gained importance, which ultimately touch upon the programming of matter itself: "Matter can be programmed by folds, giving form and kinetics. … Folding is a language of structure. … Folding is also a language of nature. As a higher level expression of genetic code it defines the sculpture of genetic expression."[12]

11 Gardiner, Matthew, "Oribotics [futurelab] – The Future Unfolds," in: Leopoldseder, H., Schöpf, C. & Stocker, G. (eds.): *repair,* Ars Electronica 2010, Hatje Cantz Verlag, Ostfildern, 2010, p. 278.

12 Matthew Gardiner, http://www.orilab.art/#abstract

"Oribotics is a field of research that thrives on the aesthetic, biomechanical and morphological connections between nature, origami and robotics. At the highest level, Oribotics evolves towards the future of self-folding materials."

Source: Gardiner, Matthew, "Oribotics [futurelab]—The Future Unfolds," in: Leopoldseder, H., Schöpf, C. & Stocker, G. (eds.): *repair,* Ars Electronica 2010, Hatje Cantz Verlag, Ostfildern, 2010, p. 278

Matthew Gardiner (*1976, AU). Artist and researcher. Member of the Ars Electronica Futurelab since 2011. Most well known for his work with origami and robotics. Coined the term Oribot in 2003, and since then has worked in the field of art/science research called Oribotics: a field of research that thrives on the aesthetic, biomechanical, and morphological connections between nature, origami, and robotics.

Oribotic Cranes, Matthew Gardiner, Artist Lab, Ars Electronica Festival 2016

Oribotics

Type: Research
Location: Tabakfabrik Linz, Ars Electronica Festival, Linz, Austria
Year(s): 2010

Special features / key technologies:
Origami, robotics, electronics, computation, proximity sensors, servo motors, digital fabrication

Oribotics is a field of research that thrives on the aesthetic, biomechanical, and morphological connections between nature, origami, and synthetic fabrics. In cooperation with the Institute of Polymer Product Engineering (IPPE) at Johannes Kepler University Linz, Australian origami- and media artist Matthew Gardiner, who coined the term “Oribot” in 2003, cultivated interactive flowerbeds. All 1,050 folds of a single Oribot blossom showcased at the Ars Electronica Festival 2010 were mechanically interlinked. As soon as one single fold of a blossom was activated, all the others went into motion, too. Matthew Gardiner, who was an artist in residence at Ars Electronica Futurelab at the time, spent three years developing the ideal folding pattern and material for this generation of Oribots.

https://u.aec.at/A6D2DA9B

Coding for Matter—Computing Goes Biological

In his 1994 book *Out of Control: The New Biology of Machines,* the American writer Kevin Kelly had somehow envisioned the setting for BioLab, *Bio Ink,* and Oribotics: "The realm of the *born*—all that is nature—and the realm of the *made*—all that is humanly constructed—are becoming one. Machines are becoming biological and the biological is becoming engineered. ... the world of our own making has become so complicated that we must turn to the world of the born in order to understand how to manage it. ... Our future is technological; but it will not be a world of grey steel. Rather our technological future is headed toward a neo-biological civilization."[13] When he introduced the discussion about issues of the new "life sciences" as one of the topics of the Ars Electronica Festival in 1999, Gerfried Stocker—still a few years before the major breakthroughs in biotechnology—had pointed to the inherent dynamic of this field of research: "Since Thomas H. Morgan successfully proved the linear arrangement of genes and chromosomes in 1910, this field has opened up in a comparatively short time a body of knowledge and an effective domain whose scope and depth are comparable only to those of digital technology."[14]

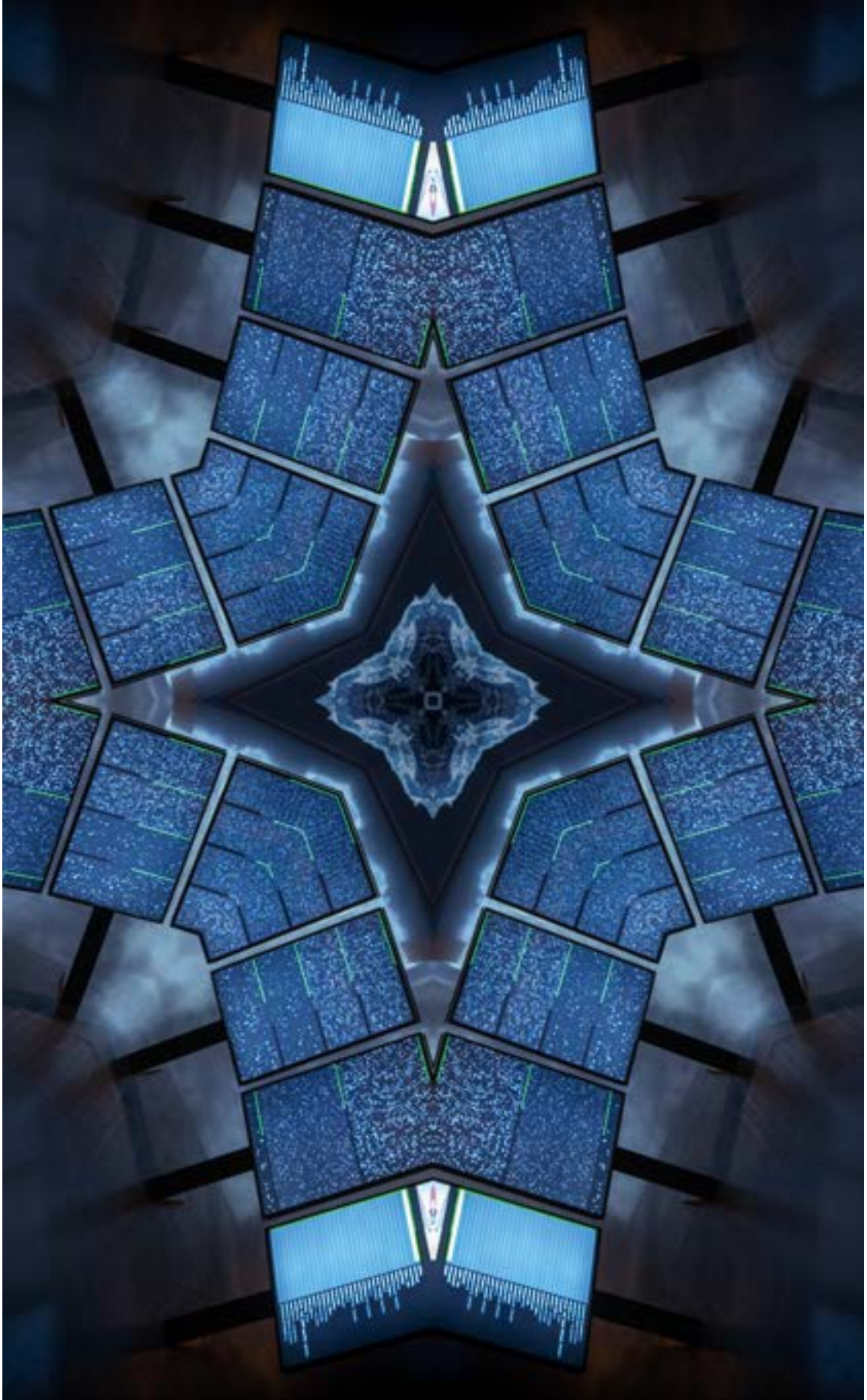
In 2016, Ars Electronica Futurelab co-director Hideaki Ogawa came back to the topos of "code" as the core constituent of computer technology and drew a wide arc across the ages: "Humans developed various forms of 'codes' when they created a medium that can convey ideas and functionalities. Long before the invention of computers, humans crafted analog code, such as 'modeling' out of clay, 'carving' out of wood, or 'building' architecture. The emergence of computers introduced us [to] a new code for computers: digital coding. And code is now expanding its limits for coding for matter: coding for 'growing' biological cells, 'catalyzing' specific chemical reactions, or 'animating' living organisms. ... code is not just a language to control something behind black screens, but a series of dynamic transitional activities to be undertaken by artists and innovators."[15] In his 2011 book *The Information: A History, a Theory, a Flood,* James Gleick sketched the path of information theory as it had been conceived by Claude Shannon: "Information theory began as a bridge from mathematics to electrical engineering and from there to computing." For Horst Hörtner, Shannon's insight had always been at the core of his dedication to computer science and engineering, in a way a guiding line running through his work at the Ars Electronica Futurelab. From computing, Gleick spun his argument further towards wetware: "Now even biology has become an information science, a subject of messages, instructions, and code. ... Life *spreads* by networking," to finally arrive at the question of matter: "... as scientists finally come to understand information, they wonder whether it may be primary: more fundamental than matter itself."[16]

13 Kelly, Kevin, *Out of Control: The New Biology of Machines,* Fourth Estate. London, 1994, p. 2.

14 Stocker, Gerfried, "New Images of Mankind," in: Stocker, G. & Schöpf, C. (eds.): *LifeScience,* Ars Electronica 1999, Springer, Wien/New York, 1999, p. 20.

15 Ogawa, Hideaki, "the alchemists of our time," in: Stocker, G., Schöpf, C. & Leopoldseder, H., (eds.): *RADICAL ATOMS and the alchemists of our time,* Ars Electronica 2016. Hatje Cantz, Berlin, 2016, p. 69.

16 Gleick, James: *The Information: A History, a Theory, a Flood,* Fourth Estate / Harper Collins Publishers, London, 2011, pp. 8–10.



Artificial Intelligence

Forging Companions for Creative Work

Contemplatively, andante, the pianist strikes a few keys and then draws his hands back again. A moment later, the piano commences playing a piece on its own, allegro this time, vivid variations based on the theme from before: A-E-F-A-E-C. Change of scene: A gray-haired gentleman in a dark suit walks along the display of chess boards on the wall, then resumes his position at the table, observing the tournament. These two—seemingly unrelated—events took place in the same city, Linz, the city of Ars Electronica. Four decades lie between them.

The man at the piano is Ali Nikrang, a key researcher at the Ars Electronica Futurelab and a trained pianist. The piano is a Bösendorfer Imperial 290 CEUS, which has the ability to store and repeat even the most subtle nuances in the performance of a pianist as well as to play any piece according to input from a music software. The composition software in this case bears the name *Ricercar,* a term from the history of music, which refers to preludial ways of "searching" for a theme. The software was conceived by Ali Nikrang, who studied computer science as well as composition, and uses artificial intelligence to serve as a companion for composers. *Ricercar* created the variations on the theme that Ali Nikrang provided as a starting point. The theme A-E-F-A-E-C, of course, is an acronym derived—in celebration of "25 Years of Ars Electronica Futurelab" in 2021—from the place where this scene took place, the Ars Electronica Center, and the laboratory where Ali Nikrang developed his AI-based tool, the Ars Electronica Futurelab.

Key researcher Ali Nikrang on the *Bösendorfer 290 Imperial CEUS* computer grand piano

“For the moment, neural network based AI systems are used as tools rather than counterparts. They can serve as a new source of inspiration for human creativity by opening up new perspectives and detecting connections in the data that human observers might have not been aware of. Even more, they can be helpful for deepening our understanding of our own creativity.”

Source: Nikrang, Ali, “Frozen Artificial Intelligence and Creativity,” in: Stocker, G., Schöpf, C. & Leopoldseder, H. (eds.): *Out of the Box: The Midlife Crisis of the Digital Revolution,* Ars Electronica 2019, Hatje Cantz Verlag, Berlin, 2019, p. 396–397

Ali Nikrang (*1980, IR/AT). Classical musician and AI researcher. Studied computer science at the Johannes Kepler University Linz and composition with a focus on new media at the Mozarteum University Salzburg. Diploma in piano performance from the Mozarteum.
Member of Ars Electronica Futurelab since 2011.
Key researcher for Creative Intelligence.

The gentleman at the chess board was the engineer and mathematician Claude Shannon (1916–2001), considered the "father" of information theory. The setting of the scene was the "Third World Computer Chess Championship," held at the Brucknerhaus in Linz in the framework of the second Ars Electronica Festival, in September 1980. The winner of the championship was "Belle," the dominating chess machine of that time, which had been developed at Bell Laboratories, where Shannon had previously worked. The final round had taken place between the brute-force Type A Strategy machine "Belle" and a Type B Strategy machine called CHAOS. This in fact was a playoff between two strategies for chess computers, both of which Shannon had originally formulated in his groundbreaking paper "Programming a Computer for Playing Chess" of 1949.[1]

During the four decades between those two events a great deal has happened in the field of artificial intelligence, with two occurrences gaining the most attention due to the symbolic significance attributed to them. On May 11, 1997, in New York City, Deep Blue defeated Garry Kasparow. Deep Blue, which had been developed by IBM, became the first computer system to win against a reigning world chess champion in a match under tournament regulations. In March 2016 in Seoul, South Korea, AlphaGo won against Lee Sedol, the 18-time world champion. AlphaGo, a computer program playing the board game Go, had been developed by the British artificial intelligence laboratory DeepMind Technologies, which was acquired by Google in 2014. The two tournaments—and the companies and their artificial intelligence systems involved—signified the substantial changes in the IT industry between 1997 and 2016 as well as the rapid advances of artificial intelligence due to machine learning and neural networks, accelerated also by substantial improvements in processor technology. The fact that a computer system mastered the game of Go, which is considered to require a good sense of intuition as well as creative abilities, combined with strategic thinking, seemed to deal a severe blow to the human self-image of being superior to machines. Machine learning and neural networks—series of algorithms that seek underlying relationships in a set of data through a process inspired by the signaling of biological neurons—had been around for some time, but it took such a symbolic event to draw public attention towards the fact that artificial intelligence had meanwhile turned from an academic endeavor into big business: numerous systems in which huge amounts of data about users of social media platforms, consumers buying online or in stores, or citizens utilizing transport systems or simply strolling around in their city, were collected and processed with the help of AI. For several years, the spread of AI-based tools had widely gone unnoticed by the general public.

1 Shannon, Claude E., "Programming a Computer for Playing Chess," in: Philosophical Magazine, Ser. 7, Vol. 41, No. 314, March 1950.

2 Horst Hörtner, in a conversation with the author, May 2021.

The Urgency of Understanding AI

The turning of the attention of mainstream media—with their inherent tendency toward over-simplification and focusing on extremes—to the advances of AI has led to many dystopian future scenarios. A crisis is anticipated, including the much-discussed (also in academic circles) "singularity" of a coming superintelligence that would surpass humans in general intelligence. Evidently, processes of change are underway. Any change that happens very quickly will, by virtue of its speed alone, result in a crisis. Horst Hörtner advocates for a timely and holistic look at problems in the use of artificial intelligence, beyond any dystopian or utopian scenarios: "We should now work on creating a kind of techno sphere and the appropriate system architectures that we want to live with. So far, humans have turned any intelligences that they came upon into slaves. The question remains, whether we will be able to abandon the desire for holding slaves and reach the point at which we view neither other human beings nor autonomous machines as slaves."[2]

Neural Network Training (2019), installation by Ars Electronica Futurelab for the exhibition "Understanding AI" at the Ars Electronica Center

Vector Space: Prix Ars Electronica Universe (2019), Ars Electronica Futurelab

Impression of the exhibition “Understanding AI” (2019)

ShadowGAN (2019) by Ars Electronica Futurelab, recognizes the silhouettes of people and then fills them in with generated pictures of mountains.

In 2017 the Ars Electronica Festival featured the topic "AI – Artificial Intelligence – The Other I." On this occasion, Gerfried Stocker pointed out how Ars Electronica reacted to the dynamic of the developments in the area: "What we are experiencing at present can very justifiably be termed the Cambrian explosion of digitization. ... artificial intelligence is already a universal metaphor for humankind's ambivalent relationship with the technology our kind has created. ... maybe we should stay focused on how we want to configure technology's upcoming quantum leap."[3] The approach taken by Ars Electronica contained two elements that were also characteristic of the Futurelab. On one hand, the Ars Electronica Futurelab developed installations with the aim of making the complex topics of machine learning and neural networks understandable. At the same time, it created art projects that might raise unexpected questions and cast a critical eye on the uses of AI in our societies. The objective was—as Ali Nikrang put it—"to illuminate and demystify the technology."[4] This also required installations that could make transparent how the various methods of training an AI system actually work and what kinds of biases—gender, ethnic, or others—can arise from this, which in turn may affect, for instance, recruiting systems of companies or selection mechanisms in education. AI-based technologies are already massively shaping our world, and the speed of their development creates a kind of urgency to understand them. Horst Hörtner compares the process of preparing the exhibition "Understanding AI," which opened at the Ars Electronica Center in 2019, with the image of the hourglass, where—instead of gravity—the driving force is the underlying artistic intention, which pulls the sand corns from one side and transforms them into the outcome on the other side. For Hörtner the hourglass symbolizes Ars Electronica's method of diving deep into a system (a topic like AI for example), filtering out the key aspects of that system and its implications, and then creating insights in the form of installations, interventions, or artworks, that open up the spaces necessary for forming one's own informed, inspired, and critical opinion, ideally to join the discourse regarding one's own perspective on the meaning of such systems for the future.

3 Stocker, Gerfried, "AI—Artificial Intelligence—The Other I," in: Stocker, G., Schöpf, C. & Leopoldseder, H. (eds.): *AI—Artificial Intelligence—The Other I,* Ars Electronica 2017, Hatje Cantz Verlag, Berlin, 2017, p. 17.

4 Nikrang, Ali, "Frozen Artificial Intelligence and Creativity," in: Stocker, G., Schöpf, C. & Leopoldseder, H. (eds.): *Out of the Box: The Midlife Crisis of the Digital Revolution,* Ars Electronica 2019, Hatje Cantz Verlag, Berlin, 2019, p. 396.

Understanding Artificial Intelligence

Type: Exhibition
Location: Ars Electronica Center, Linz, Austria
Year(s): Since 2019

Special features / key technologies:
GAN, AI, neural networks, robotic, algorithmic bias, image recognition

As part of the comprehensive thematic redesign of the Ars Electronica Center in 2019, a focus was placed on Artificial Intelligence. At the center of the "Understanding Artificial Intelligence" exhibition are questions about how machines "think," how they "learn," and what distinguishes them from us humans. The exhibition examines various aspects of AI and current fields of application, but also critically reflects on the future role of AI.
"Understanding AI" presents the most important technical aspects of artificial intelligence as well as concrete examples of how it is used. Visitors learn how machines and their sensors "perceive" the world in comparison to humans, what machine learning is, how automatic facial recognition works, and they also learn about various social and ethical issues.
Besides curatorial work, several creative applications for the exhibition were developed by Ars Electronica Futurelab, which, in addition to numerous artistic works and other projects, give insight into the field of AI. *pinocchio* is an installation of two industrial robots playing the role of two marionettes. With *Pix2Pix: GANgadse* visitors can draw free sketches which are then turned into cat pictures by a conditional generative adversarial network (cGAN). *ShadowGAN* recognizes the silhouettes of people and then fills them in with generated pictures of mountains, and the project *Neural Network Training*—the heart of the exhibition—lets visitors experiment with a convolutional neural network, train different neural networks, and see how artificial intelligence behaves based on their input on site.

https://u.aec.at/EDA16325

Among the projects of the Ars Electronica Futurelab for the exhibition “Understanding AI” was, for instance, the installation *ShadowGAN,* which fills the silhouettes of visitors with generated pictures of mountains. The conditional generative adversarial network (cGAN) behind it had been trained only with images of mountain landscapes and consequently interpreted mountains into everything it saw. With this installation by the Ars Electronica Futurelab, the paramount importance of the kind of data with which AI systems are trained becomes immediately evident. At the installation *Neural Network Training,* visitors can themselves gather experience with exploring a so-called “convolutional neural network” (CNN) by placing various objects in front of a camera. On a wide horizon of screens, the visitors then can observe in real time how the AI system interprets the object, ultimately resulting in the system’s identifying it. The piece *What a Ghost Dreams Of* by the artist group h.o confronts visitors entering the exhibition floor with being observed by a large “eye” and then with numerous screens displaying in rapid sequence images generated by an AI system based on the input from the observations. The role of AI in digital surveillance quickly becomes apparent here.

Ghosthouse, h.o

Artist and Futurelab member Peter Freudling looked at the concepts behind the technology and voiced a critique of terms like "artificial intelligence" or "machine learning," which dominated and also shaped the discussion: "The word 'intelligence' carries the danger of anthropomorphism, i.e. the humanization (of the abilities) of machines. The same applies to 'machine learning'—it contains the word learning and therefore it sounds as if the machine is learning as humans do. As long as we use terms for machines that could also be used for humans, we will overestimate their meaning."[5] Two paradigm shifts are behind the recent developments in AI. One paradigm shift happened within artificial intelligence research, where machine learning and neural networks delivered fast and impressive results, which allowed them to overrule—at least in any commercially driven research and development context—the previous approaches of decades, of trying to build an artificial intelligence modeled after the human mind. The other paradigm shift had already appeared in various research areas of the Ars Electronica Futurelab, from Spaxels to *Swarm Arena,* from self-driving cars to robotics to *Future Ink.* It is the epoch-making shift from automation towards autonomy, which of course has artificial intelligence at its core. However, the AI systems themselves are less "visible" than the physical autonomous machines we may encounter. Otto Naderer is the key researcher at the Ars Electronica Futurelab for "Algorithmic Apperception," which looks deeper into issues of autonomous machines' beginning to share the same physical space with human beings: "Algorithmic Apperception investigates ways to admit artificial systems into [physical] space [and] to enable machines to not only sense their environment but make sense of it."[6] Peter Freudling looks at the challenges involved here under the aspect of policy decisions that humans will have to make: "There can only be one way for us to live together with technology. It is not about what technology can do. It is about what human[s] can do with technology. We must find democratic and, above all, ethically clean solutions before we allow technology to operate autonomously in our midst. That is the challenge in connection with so-called artificial intelligence."[7]

Test run of *Vector in Space: Prix Ars Electronica Universe* (2019) in Deep Space 8K

5 Peter Freudling, in: "It's about what people can do with technology," interview by Katia Kreuzhuber, Ars Electronica Blog, 2019—https://ars.electronica.art/aeblog/en/2019/11/27/shadowgan-human-unlimited/

“ … the key point when it comes to AI is the paradigm shift. So far we have mainly used technology for automation. … There can only be one way for us to live together with technology. It is not about what technology can do. It is about what human[s] can do with technology. We must find democratic and, above all, ethically clean solutions before we allow technology to operate autonomously in our midst. That is the challenge in connection with so-called artificial intelligence.”

Source: Peter Freudling, “It’s about what people can do with technology,” interview by Katia Kreuzhuber, Ars Electronica Blog, 2019, https://ars.electronica.art/aeblog/en/2019/11/27/shadowgan-human-unlimited/

Peter Freudling, (*1976, AT). Lead producer and artist. Joined the Ars Electronica Futurelab during his studies of industrial design at the University of Art and Design Linz. As a researcher in the Virtual Environments group, he helped to create several projects in the field, including the CAVE at the Ars Electronica Center.

“Algorithmic Apperception investigates ways to admit artificial systems into physical space and to enable machines to not only sense their environment but make sense of it. … A meaningful combination of obtained features in conjunction with a sociological and cultural understanding assures natural interaction, simplicity and intuition.”

Source: https://ars.electronica.art/futurelab/de/research-algorithmic-apperception/

Otto Naderer (*1982, AT). Key researcher for Algorithmic Apperception. Otto Naderer realizes projects with an emphasis on enabling machines’ capabilities of perceiving and interpreting their surroundings. Joined Ars Electronica Futurelab’s Creative Engineering team in 2006 after an internship during his bachelor’s program in computer science.

pinocchio (2019). Human skills serve as an inspiration for machine choreography. The delicate manipulation of the fragile marionettes meets high-tech industrial robots.

Besides policy decisions and necessary regulations for a transparent use of AI, there are also design decisions regarding AI systems to be considered, as the Fashiontech designer Anouk Wipprecht—who had been an artist in residence at the Ars Electronica Futurelab in 2016—points out: "Instead of modeling our technologies after our self-image as human beings, I would strive to make systems think more like animals, which are in fact possibly much smarter than we are. When I was a child, I got deeply interested in nature and with fascination studied the behavior of insects. Learning from nature helps us 'think outside the box,' which is badly needed in the world of innovation."[8] In her "Robotic Spider Dress" and, more recently, in her "Proximity Dress," she uses proximity and thermal sensors instead of cameras, which might easily utilize face recognition and end up collecting data. She thus strives for a balance, which "you can bring by creating simplified settings and keeping things as close and personal as you can while designing a system, while thinking of less to non-invasive ways to do so." Avoiding "invasive technologies" is a key aspect in the approach towards a humane use of technologies, and is also part of the Ars Electronica Futurelab's efforts toward "humanizing technology."

The American roboticist Sarah Petkus, who also completed residencies at the Ars Electronica Futurelab, develops projects like *Moon Rabbit* that try a different kind of approach towards "humanizing technology." Together with her partner Mark J. Koch, she is "parenting" their "AI children" with the aim of helping them grow into individuals. This attitude involves a different quality of attention towards AI systems, which goes far beyond considering them as mere tools. Sarah Petkus draws the connection from our attitude towards machines to the human sphere: "I feel it's important that we think about what humanity means as we continue to innovate because it is my observation that more and more humans tend to view and treat everything like a tool; even other people."[9]

6 https://ars.electronica.art/futurelab/de/research-algorithmic-apperception/

7 Peter Freudling, in: "It's about what people can do with technology," interview by Katia Kreuzhuber, Ars Electronica Blog, 2019—https://ars.electronica.art/aeblog/en/2019/11/27/shadowgan-human-unlimited/

8 Anouk Wipprecht, in a conversation with the author, June 2021.

9 Sarah Petkus, "The Wandering Artist Project," interview by Martin Hieslmair, Ars Electronica Blog, 2017 - https://ars.electronica.art/aeblog/en/2017/05/30/the-wandering-artist-project/

"I feel it's important that we think about what humanity means as we continue to innovate because it is my observation that more and more humans tend to view and treat everything like a tool; even other people."

Source: Sarah Petkus, "The Wandering Artist Project," interview by Martin Hieslmair, Ars Electronica Blog, 2017—https://ars.electronica.art/aeblog/en/2017/05/30/the-wandering-artist-project/

Sarah Petkus (US). Roboticist and illustrator. Together with her partner, Mark J. Koch, she creates wearable devices and robotic entities. Residency at the Ars Electronica Futurelab and the European Space Agency (ESA) in 2017 in the "Digital Art and Science Network." Residency at the Leiden Observatory and the Ars Electronica Futurelab as part of the "European ARTificial Intelligence Lab" in 2021.

Mother of Machine—Sarah Petkus. *NoodleFeet* is the functioning robotic manifestation of an illustrated character that is built from light metals, 3D printed parts, and found objects.

Creative Intelligence

An artistic view on issues regarding the use of AI of course also includes looking into the implications of AI systems for concepts of creativity and for the specific work of artists. Ali Nikrang made creative intelligence his key research field, drawing from his hybrid education as a computer scientist and as a composer and pianist. Ali Nikrang thus also approached one of the key questions in this area: "Can machines create? In recent years, there has been a great deal of academic interest in the application of the new, much more efficient generation of neural networks (called Deep Learning) applied to creative tasks such as creating texts, images or music with fascinating results. ... Technically speaking, Deep Learning models can only learn the statistical patterns of the data. Thus, they often can learn relationships in the data that human observers have not been aware of, and thereby serve as a new source of inspiration for human creativity."[10] The conclusion drawn by Ali Nikrang from exploring not only the capabilities, but also the boundaries and downsides of such systems, shows a key deficit of many AI systems for creative work: "While the development of AI-based creative applications has seen a surge of considerable advances in recent years, interaction and collaboration between these systems and humans was not given much attention. ... Given this lack of satisfactory interaction possibilities, our research focuses not only on the technological aspects of AI in creative and artistic applications, but also on new ways of interaction and collaboration between humans and AI systems."[11] Horst Hörtner also expresses a certain form of skepticism towards the potentials of actual creation from machines and emphasizes the aspect of balance: "... at the Ars Electronica Futurelab [we] are ... asking ourselves the question of whether machines can create at all: Machines can achieve a very, very high performance, but still we repeatedly find that in working with the machine, with this new technology, the human aspect is the essential part of what we're trying to achieve here. It is important for us to find the right balance, to integrate new technologies in cooperation with us humans."[12]

10 Nikrang, Ali, "Creative Intelligence – Can Machines Create?," in: Stocker, G., Schöpf, C. & Leopoldseder, H. (eds.): *In Kepler's Gardens,* Ars Electronica 2020, Hatje Cantz Verlag, Berlin, 2020, p. 381.

11 Nikrang, Ali, "Creative Intelligence – Can Machines Create?," in op. cit., Hatje Cantz Verlag, Berlin, 2020, p. 381.

12 https://ars.electronica.art/aeblog/en/2020/10/13/future-ink-wo-ist-meine-seele/

AI x Music

Type: Exhibition
Location: Ars Electronica Center, Linz, Austria
Year(s): Since 2019

Special features / key technologies:
AI, Deep Neural Network, Performance RNN, Piano Genie, Magenta, MuseNet, OpenAI, Bösendorfer 290 Imperial CEUS

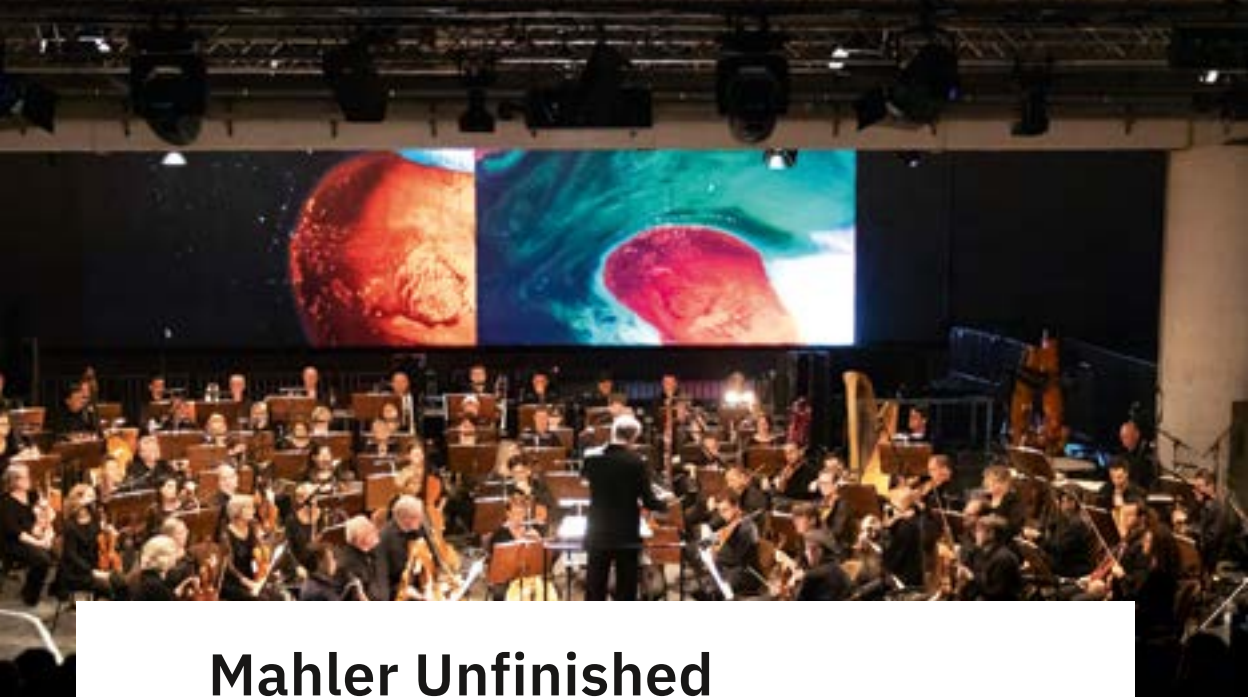
AI x Music is an exhibition about the encounter between Artificial Intelligence and music, as well as human creativity and technical perfection at the Ars Electronica Center.
A separate room within the exhibition, "The Piano Room," hosts a Bösendorfer 290 Imperial CEUS computer grand piano, equipped with one of the most advanced and precise integrated recording and reproduction systems available today. Projection screens and sensors facilitate visualizations that interact in real time with the volume and timbre of the music. "The Piano Room" serves as venue and stage for live concerts such as the "Ars Electronica Home Delivery … in concert" series with pianists Maki Namekawa and Dennis Russell Davies and (real-time) visualizations by Cori O'lan.
AI technologies in the field of music seem to be much less socially acceptable than AI being used in the automated production of texts, statements, and decisions. Ars Electronica Futurelab demonstrates how these technologies are applied in music and what results they produce.
The Bösendorfer 290 Imperial CEUS computer grand piano is linked to four applications from current research into artificial intelligence in music: *Performance RNN* from the Google project *Magenta* is based on a recurrent neural network that independently generates polyphonic music using a long/short term memory and generates rather clumsy improvisations. *Piano Genie,* also by Magenta, lets visitors play the 88-key piano via an 8-key controller. The interface simplifies and supports music-making for all users. The space also features two pre-composed music examples using MuseNet (OpenAI), demonstrating how AI is able to take a musical structure as input and continue it in a completely different style of music, leading to an entirely new composition.

https://u.aec.at/971CF9E9

Due to its proximity to mathematics, music is a natural choice for further research into potential collaborations of human composers with an AI system. A prerequisite for exploring ways to reach a level of exchange that deserves the designation "collaboration," is a realistic assessment of the current results from AI systems, which Ali Nikrang summarized in this way: "... assembling strings of notes or words after having statistically processed a comprehensive set of data hardly compares to a human writing a novel or creating a composition. The crucial difference is intent—after all, literature is more than a combination of words, music is more than a set of musical notes."[13] Starting from there, Ali Nikrang experimented with ways of involving an AI system as a partner in the composition process. He used an AI system—the model MuseNet by OpenAI—to complete the unfinished movements of the *Symphony No. 10* by Gustav Mahler (1860–1911). MuseNet was fed the first ten notes of the musical theme and used the melody, played by unaccompanied violas, as a starting point for the continuation of the composition. Ali Nikrang then orchestrated the results from the AI by hand, and the project *Mahler-Unfinished* was performed by Bruckner Orchestra Linz, conducted by Markus Poschner, at the Big Concert Night of the Ars Electronica Festival 2019.

Inspired by the meaning of the term *Ricercar*—Italian for "searching out"—as a way of experimenting with a theme or musical idea, exploring its qualities and potentials in regard to variation and harmonics, Ali Nikrang developed *Ricercar* as an interactive AI-based music composition system. By calling *Ricercar* an "AI-based musical companion," he emphasized its qualities in the collaboration with a human composer. *Ricercar* can discover the potential of a musical idea and offer results from its artificial form of creativity, which are then used by a human composer, who brings in aspects of intention and creative decisions, which lead to a personalized piece of music. *Ricercar* arose from a transdisciplinary way of thinking between art and science, which is cultivated at the Ars Electronica Futurelab and which approaches new technologies in an open-minded, critically reflecting, and artistically innovative way—in short, a tangible example of "Art Thinking."

13 Nikrang, Ali, "Frozen Artificial Intelligence and Creativity," in: Stocker, G., Schöpf, C. & Leopoldseder, H. (eds.): *Out of the Box: The Midlife Crisis of the Digital Revolution,* Ars Electronica 2019, Hatje Cantz Verlag, Berlin, 2019, p. 396.



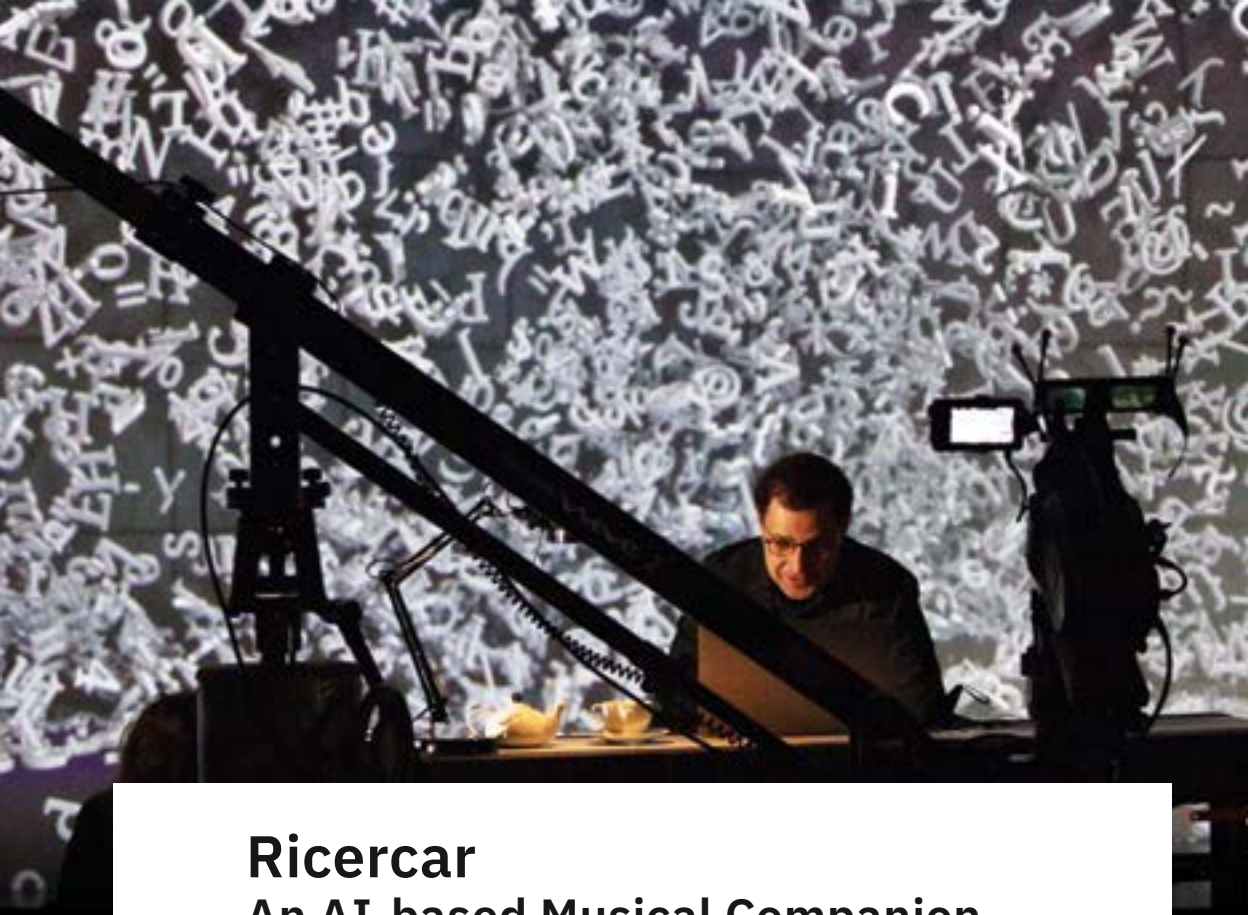
Mahler Unfinished

Type: Performance
Location: POSTCITY Linz, Austria
Year(s): 2019

Special features / key technologies:
OpenAI, MuseNet, Bruckner Orchestra Linz

Music made by man and machine: *Mahler Unfinished.* Gustav Mahler's last (unfinished) *Tenth Symphony* begins like a mystery: The main theme of the symphony is introduced by unaccompanied violas; not even the tonality of the symphony is clear at the beginning. Can a state-of-the-art AI system compose music based on this deeply emotional and human musical theme? MuseNet, at the time the most powerful AI system for music composition developed at OpenAI by Christine Payne, was used to answer this question.
Futurelab researcher and musician Ali Nikrang used MuseNet to compose a piece of music based on the main theme of the symphony. The results from MuseNet were surprisingly fascinating. The AI system was able to capture the emotional character of the musical theme and continue it in a very natural and human way. As the raw AI result did not contain any information about instrumentation, it had to be orchestrated by a human to be playable by a full symphony orchestra, which was done by Ali Nikrang. The finished product was performed by the Bruckner Orchestra Linz at the *Große Konzertnacht* as part of the Ars Electronica Festival 2019, together with the original symphony by Gustav Mahler. Thanks to the excellent performance of the Bruckner Orchestra Linz (which made no distinction between music composed by a master like Gustav Mahler and music composed by a machine), according to the press and the audience, it was almost impossible for non-experts to tell which piece was composed by a human and which by AI, as both pieces sounded deeply human.

https://u.aec.at/ADE08F23



Ricercar
An AI-based Musical Companion

Type: Software
Location: Linz
Year(s): 2020

Special features / key technologies:
AI and Creativity, AI x Music, human-machine collaboration, AI-based music composition, digital humanities, digital art

An interactive AI-based music composition system that aims to create an intuitive interface between human artists and an AI-based composition system, where human users and the AI system can discover the potential of a musical idea (fed into the system by the users or initialized by the system itself) in a collaborative way. The interaction takes advantage of the benefits of artificial creativity, together with the ability to control and personalize the output of the system by human users.
A *ricercar* (literal meaning: "to search out") is a kind of late Renaissance / mostly early Baroque instrumental composition. Composers often experimented with a theme, musical idea, key or mode in *ricercars,* playing with permutation and variation possibilities as well as the harmonic potential.

https://u.aec.at/D3674A08

Art Thinking

Future Catalysts Become Alchemists of the Future

A Creative Catalyst Gives Weight to Your Shadow

The couple stands in front of the tall box of light. They strike a pose and watch the image of their silhouettes appear on a display. Soon they will receive their "shadowgram" as a vinyl sticker cut out in the shape of their shadow, which they will place on the wall next to numerous other such stickers with the outlines of people in many kinds of poses. Next to their sticker they will also place a bubble with a statement, thus contributing to the discussion evidently going on there on this message board. They have just joined the thousands of people, in places from Tokyo to Linz, who over the years have enjoyed using this installation by the Ars Electronica Futurelab, called *Shadowgram. Shadowgram* is an extension of the concept of the Fab Lab designed for interactive fabrication in a social brainstorming process. While the term "shadowgram" refers to an analog photographic technique for creating shadow images of objects that have been placed on photosensitized paper and exposed to light, the installation by the Ars Electronica Futurelab "gives weight" to the person's shadow. The installation is meant to serve as a "creative catalyst" with the aim of playfully encouraging visitors to discover their own creativity and to use their shadowgram in communication with others. This process—as Hideaki Ogawa describes his experience with the installation, which he accompanied to places like Tokyo Midtown in 2010 and the Urfahraner Markt fair in Linz in the spring of 2011—goes through three stages, each more difficult than the previous one: "Attraction is fairly easy, engagement a bit more demanding, and the actual catalyzing is the most difficult part. But then you experience these unexpected outbursts of creativity, which go beyond the frame."[1]

Shadowgram (since 2010) is an innovative tool for social brainstorming.

1 Hideaki Ogawa, in a conversation with the author, March 2021.

The first exhibition of Shadowgram was at TOKYO MIDTOWN in 2010.

Shadowgram

Type: Art piece
Location: Multiple
Year(s): Since 2010

Special features / key technologies:
Social brainstorming, light wall, cutter, discourse, participation, creative catalysts, Art Thinking

Shadowgram is an innovative and creative form of social brainstorming. Participants stand in front of an illuminated screen and are photographed. The result is a shadow image of the human silhouette(s). The shadow image is printed on adhesive paper and cut out. The silhouette sticker can then be affixed on a map or a wall that displays specific scenarios and a speech bubble to express individual comments and opinions to a given subject can be added.
The core artistic intention was to create a system that enables the audience to discover, play with, and use their creativity to express their opinions. This extension of the FabLab concept to the next stage of interactive fabrication is an important part of technical and conceptual research, one that has the potential to yield highly entertaining works.
Shadowgram made one of its first appearances at the annual fair in Linz. Installed in an exhibition tent entitled “LINZ CHANGES,” visitors were invited to share their ideas and visions for the future of their city and put them up for discussion. Over the years, *Shadowgram* has been presented internationally and several editions with new features have been developed.

https://u.aec.at/4648AAB1

The artist Hideaki Ogawa was born in Tokyo and came to Linz in 2007. He first arrived at the Ars Electronica Futurelab—together with his wife, the artist Emiko Ogawa—as an artist in residence, and in the following years became involved in different parts of Ars Electronica. With all this inside knowledge of the Ars Electronica ecosystem, Hideaki Ogawa somehow kept his role as an "outsider" in a different culture and put this position to a productive use. He understood his role as that of a "creative catalyst" and cultivated a special way of achieving a synthesis of different elements, together with striking linguistic framing. Experiences like the work on *Shadowgram* and on the large-scale participatory project *Klangwolke ABC* allowed him to develop integrative and at the same time unexpected concepts like that of "robotinity," which also led to his curating the exhibition of the same name. In retrospect, the smart move of developing the concept of *Art Thinking* as a synthesis of different aspects of the practice of the Ars Electronica Futurelab, appears to have been the next logical step. Hideaki Ogawa's explanation of *Art Thinking* goes like this: "Art is a catalyst for shaping a better future society, a way to open up new perspectives, encourage curiosity to look at what is behind the scenes and to stimulate creative solutions. … As a research domain, but also as an attitude, *Art Thinking* has the potential to catalyze innovation, new modes of education and strategy. We believe that art and artistic thinking is the best way to understand even the most complex issues and systems created by humankind—be they societal, economic, political, or technological."[2] The path for the Ars Electronica Futurelab to finally arrive at *Art Thinking* included several steps and integrated a number of influencing factors.

2 Ogawa, Hideaki, "Art Thinking – What is the latest role of art? And how can we apply this art to the future of society?," in: Stocker, G., Schöpf, C. & Leopoldseder, H. (eds.): *In Kepler's Gardens,* Ars Electronica 2020, Hatje Cantz Verlag, Berlin, 2020, p. 379.

“Art is a catalyst for shaping a better future society, a way to open up new perspectives, encourage curiosity to look at what is behind the scenes and to stimulate creative solutions. … As a research domain, but also as an attitude, *Art Thinking* has the potential to catalyze innovation, new modes of education and strategy. We believe that art and artistic thinking is the best way to understand even the most complex issues and systems created by humankind—be they societal, economic, political, or technological.”

Source: Ogawa, Hideaki, “Art Thinking – What is the latest role of art? And how can we apply this art to the future of society?,” in: Stocker, G., Schöpf, C. & Leopoldseder, H. (eds.): *In Kepler’s Gardens*, Ars Electronica 2020, Hatje Cantz Verlag, Berlin, 2020, p. 379

Hideaki Ogawa (*1977, JP). Creative catalyst, artist, educator, curator, and researcher in the field of art, technology, and society. Artistic director of the media artist group h.o. Member of Ars Electronica Futurelab since 2007. Founding director of Ars Electronica Japan since 2016. Co-director of Ars Electronica Futurelab since 2019.

Art Thinking

Type: Research
Location: Ars Electronica Futurelab, Linz, Austria
Year(s): since 2014

Special features / key technologies:
Art Thinking, discourse, creative questions, methodology, mind-set, catalyst

Art Thinking is a process of applying artistic thinking and perspective to a broad range of societal and technological challenges. The goal is to empower citizens of the future to take on the challenges we are faced with in today's fast-paced and fluctuating environment, and to adopt this new *Art Thinking* approach.
This research domain and transdisciplinary methodology sees art as a catalyst for shaping a better future society by opening up new perspectives, encouraging curiosity to look at what is behind the scenes, and stimulating creative solutions.
This research initiative is driven by the belief that art and artistic thinking are the best ways to understand even the most complex issues and systems created by humankind, be they societal, economic, political, or technological. Art holds the power to scrutinize existing beliefs, cast doubt on common perceptions, and find a way to think outside the box.

https://u.aec.at/3BC6EE7E

Future Narratives for Shaping the Future We Want

Of course, *Art Thinking* is about the future. The entire work of the Ars Electronica Futurelab deals with the future in different ways, but it is neither futurology, nor prognostics, nor scenario building. It is rather about working on future narratives, inducing understanding of technology, and influencing our actions in the present day, which in turn, of course, shape the future. In 2017, Gerfried Stocker emphasized the role of art in this process: "Artists are able to create the stories and the images that society needs, not to understand how science works, but to understand what science and technology mean to us. This is one of the very promising and interesting aspects of these art and science encounters: To create messages that are telling us how science and technology are changing our lives. This is maybe even a responsibility of art."[3] Maria Pfeifer is the key researcher for Future Narratives at the Ars Electronica Futurelab and pursues this line of thought: "Art acts as an agent of change; on the one hand it offers a fine sensorium for relevant social developments and technological applications beyond superficial trends, on the other hand art is a communicator for perspective shifts and inspiration."[4] Maria Pfeifer's research on Future Narratives explores the ways in which stories of the future exert meaning in societies, and locates tension fields, where future-relevant topics emerge. Future Narratives is also about forging methods not merely to examine, but also to create meaningful stories of the future, namely as part of processes of behavioral change and societal transformation. In a way, Future Narratives is a kind of "particle research" on the constitutive elements of what the work of the Ars Electronica Futurelab is actually about.

Ars Electronica Futurelab has carried out a comprehensive study for the Austrian Road Safety Board on how mobility and logistics careers in the transport sector could change by 2050.

"Art acts as an agent of change; on the one hand it offers a fine sensorium for relevant social developments and technological applications beyond superficial trends, on the other hand art is a communicator for perspective shifts and inspiration."

Source: Pfeifer, Maria, "Future-oriented thinking and action strategies for the world of tomorrow," in: Stocker, G., Schöpf, C. & Leopoldseder, H. (eds.): *Out of the Box: The Midlife Crisis of the Digital Revolution,* Ars Electronica 2019, Hatje Cantz Verlag, Berlin, 2019, p. 394

Maria Pfeifer (*1982, AT). Member of the Ars Electronica Futurelab since 2016. Key researcher for Future Narratives, where she investigates the question of how stories about the future can change the here and now. Studied art, comparative literature, and cultural studies in Vienna and has worked for the Ars Electronica Festival and Futurelab on and off since 2011.

3 Stocker, Gerfried, Hirsch, Andreas J., *The Practice of Art and Science,* Ars Electronica, Linz / Hatje Cantz, Berlin, 2017, p. 89.

4 Pfeifer, Maria, "Future-oriented thinking and action strategies for the world of tomorrow," in: Stocker, G., Schöpf, C. & Leopoldseder, H. (eds.): *Out of the Box: The Midlife Crisis of the Digital Revolution,* Ars Electronica 2019, Hatje Cantz Verlag, Berlin, 2019, p. 394.

How to Transform a Practice into Ways of Reflection

The practice of many years of work of the Ars Electronica Futurelab provided the soil out of which the plants of *Art Thinking* could grow. The history of *Art Thinking* could also be read as a kind of intellectual history, or—if understood as a process of maturing—as an ideational realization of the Ars Electronica Futurelab. The development of the practice of the Ars Electronica Futurelab did not follow a strategic masterplan, but rather unfolded in a project-driven way in connection with demands from clients and partners, and, notably, from the Ars Electronica ecosystem, which—significantly embodied by the artistic directorship of Gerfried Stocker—gave essential impulses and provided opportunities for entering new fields of research. The creation of the Ars Electronica Center in 1996 and the development of the Spaxels for the Ars Electronica Klangwolke in 2012 are just two prominent examples of this.

There is a golden thread running through the feedback from many clients of the Ars Electronica Futurelab, an emphasis on the special quality of the open-minded dialogue with the Futurelab and the inspiring and innovative effects of its approach, which is experienced as unconventional and highly creative. These aspects already indicate why *Art Thinking* is not a method in the strict sense, but rather a mindset, from which the perceived qualities of the Ars Electronica Futurelab result. Rolf-Dieter Heuer, former Director General of CERN, recalls about his encounters: "Getting in touch with the Ars Electronica Futurelab, I noticed the playfulness of their way of doing research. There was the self-confidence to be creative in the interplay of art and science, which in fact is the basic principle of all research."[5]

The act of lifting practice to a meta level of reflection also exerted influences on the work inside the Ars Electronica Futurelab itself and on the self-understanding of the people working there. In his 2016 essay "The Futurelab as Catalyst: From Artist to Alchemist," Matthew Gardiner mentioned such an effect: "The alchemists of our time are artists who have transformed their practice into fields of research, beyond projects and immediate concerns, where social relevance is paramount."[6] The title of Gardiner's text indicates that by then the self-image as "creative catalyst" had already spread from Hideaki Ogawa to the Ars Electronica Futurelab as such.

5 Rolf-Dieter Heuer, in a conversation with the author, March 2021.

6 Gardiner, Matthew, "The Futurelab as Catalyst: From Artist to Alchemist," in: Stocker, G., Schöpf, C. & Leopoldseder, H., *RADICAL ATOMS and the alchemists of our time,* Ars Electronica 2016. Hatje Cantz, Berlin, 2016, p. 356.

“Getting in touch with the Ars Electronica Futurelab, I noticed the playfulness of their way of doing research. There was the self-confidence to be creative in the interplay of art and science, which in fact is the basic principle of all research.”

Source: Rolf-Dieter Heuer, in a conversation with the author, March 2021.

Rolf-Dieter Heuer (*1948, DE). Physicist. Director General of the European Organization for Nuclear Research (CERN) from 2009 until 2015. President of the German Physical Society from 2016 until 2018. Member of the European Commission’s Group of Chief Scientific Advisors from 2015 until 2020 and Chair of this Group from 2016 until 2020.

Rolf Dieter Heuer, director general of CERN and Futurelab team members Matthew Gardiner, Roland Haring, Christopher Lindinger, Horst Hörtner at a press conference in 2011.

The Encounters of Art and Science Pave the Way for *Art Thinking*

Naturally, this process at the Ars Electronica Futurelab did not take place in isolation. From the very beginning, the Ars Electronica Futurelab was a pioneer with its close collaboration of art and science, at a time when such forms of transdisciplinarity were unusual and often met with skepticism and resistance. In the meantime, things have changed. Media art has found its way into art schools, museums, and finally also the art market. After years of promoting the encounters of art and science also in universities, Victoria Vesna, director of the Art|Sci center at UCLA, also sees the attention that artistic approaches are getting: "We are looking towards those who break the limits, who overcome those artificial segregations between art and science."[7] Also, parts of the industry began to recognize their responsibilities towards societies and issues of sustainability. Those who opened up to encounters with the Ars Electronica Futurelab may be seen as early adopters, who had the openness and the understanding to actively look for this encounter with *Art Thinking,* even if it did not yet come under that name. Horst Hörtner described those changes in 2016: "Lately, the Ars Electronica Futurelab has recognized a growing demand for new or changing forms of collaboration with the private sector. Industries have begun to focus on their role within our society, and started to open up towards projects that aim to discuss the relationship between themselves and a future society."[8]

7 Victoria Vesna, in a conversation with the author, February 2021.

8 Hörtner, Horst, "The Future of the Lab," in: Stocker, G., Schöpf, C. & Leopoldseder, H., *RADICAL ATOMS and the alchemists of our time,* Ars Electronica 2016. Hatje Cantz, Berlin, 2016, p. 358.

“We are looking towards those who break the limits, who overcome those artificial segregations between art and science. Coming back to that point, where things were not separated, is in fact a matter of survival.”

Source: Victoria Vesna, in a conversation with the author, February 2021.

Victoria Vesna (*1959, US). Digital media artist. Professor at the UCLA Department of Design | Media Arts and director of the Art|Sci center at UCLA. Visiting professor at the Interface Cultures Department of the University of Art and Design Linz.

Ars Electronica Futurelab: 25th Anniversary Series, Creative (Artificial) Intelligence. Deep Virtual (2021).
Artist and key researcher Ali Nikrang explores the latest research on artificial intelligence and creativity by asking the question “Can machines create?”

Ultimately, it is the people who drive and shape *Art Thinking* in the practice of the Ars Electronica Futurelab. The team members are given the freedom to follow their own research agendas; several of them also continue with their personal work as artists outside the Futurelab. A significant number of former Ars Electronica Futurelab members have gone on to pursue academic career paths. Over the course of 25 years, the team size of the Ars Electronica Futurelab has undergone a certain amount of oscillation, finally settling down to a size with which the different processes around the key research areas, client projects, and—presumably—also the application of *Art Thinking,* seem to be working best. In this setting, there are usually not several researchers competing on the same topic, but configurations and reconfigurations of teams composed of people with different backgrounds. Looking at the Ars Electronica Futurelab from a large academic institution, Meinhard Lukas, the rector of the Johannes Kepler University Linz, observes: "New ways of thinking are essential for disruptive innovation in a world of growing complexity. Bringing people from very different backgrounds together in a setting that is free of destructive hierarchies and narrow specialization is a key for the success of the Ars Electronica Futurelab."[9] Creating the right framework for cross-disciplinary work is also essential for Horst Hörtner: "Laboratories like the Ars Electronica Futurelab in Linz, the MIT Media Lab in Cambridge or Art+Com in Berlin have a permanent team in place from different disciplines. … These places are something like a role model for having additional trans-disciplinary approaches. Here artists and scientist can meet on a platform where crossing disciplines is a daily practice."[10]

Ars Electronica Futurelab team testing Spaxels in the basement rehearsal studios.

9 Meinhard Lukas, in a conversation with the author, December 2020.

10 Stocker, Gerfried, Hirsch, Andreas J., *The Practice of Art and Science,* Ars Electronica, Linz / Hatje Cantz, Berlin, 2017, p. 84.

“New ways of thinking are essential for disruptive innovation in a world of growing complexity. Bringing people from very different backgrounds together in a setting that is free of destructive hierarchies and narrow specialization is a key for the success of the Ars Electronica Futurelab.”

Source: Meinhard Lukas, in a conversation with the author, December 2020.

Meinhard Lukas (*1970, AT). Professor of civil law at the Johannes Kepler University Linz (JKU). Rector of the JKU since 2015. Opened the campus of JKU for the Ars Electronica Festival “Kepler’s Gardens” in 2020.

Inside Futurelab (2020). The Ars Electronica Futurelab creates visions for tomorrow and, through its research projects, actively participates in shaping our future.

Tokyo—The Luminescent Megacity, NHK. Under the title *Beyond the Frame—8K Future Project,* Ars Electronica Futurelab, together with Japan's largest public broadcaster NHK, has been pursuing questions about the future of the next generation of 8K ultra-high definition TV technology since 2018.

Ars Electronica and Japan

In the emergence of *Art Thinking,* another factor played an important role, which might at first glance have seemed unexpected. As Hideaki Ogawa recalls, it was the necessity to explain Ars Electronica to partners in Japan that provided the ultimate catalysis needed to transform the practice of the Ars Electronica Futurelab into *Art Thinking.* The relationship between Ars Electronica and Japan goes back to the early days of Ars Electronica, when in 1982 a journalist from Asahi Shimbun-sha came to participate in the Festival for the first time. Itsuo Sakane not only became a regular visitor and frequently wrote about Ars Electronica; he also turned into an influential figure in the international media art scene and proved successful in forging collaborations between Ars Electronica and institutions in Japan. Besides, Ars Electronica had repeatedly invited key artists from Japan, such as the composer and pioneer of electronic music Isao Tomita (1932–2016), who also realized the Linzer Klangwolke (Linz Cloud of Sound) in 1984. The intensifying ties from Linz to Japan went along several different channels and led to collaborations of the Ars Electronica Futurelab with leading corporations from Japan, including companies like Honda, NHK, NTT, and Wacom. Several team members came from Japan and cooperation projects with academic researchers like Hiroshi Ishiguro and other players in the field of robotics ensued. The interest that the media art scene, art and science institutions, universities, and the public in Japan showed in Ars Electronica ultimately led to the establishment of Ars Electronica Japan, with Hideaki Ogawa as director, in 2016. The Ars Electronica Futurelab contributed to exhibitions in Japan, which were staged in quite different kinds of settings. The installations met their audiences at highly urban settings like Tokyo Midtown on the one hand and a place like Tojogaoka Historical Park in Matsudo, where the Ars Electronica Futurelab was participating in the Matsudo International Science Art Festival in 2019, on the other hand. There, the ambience of the traditional Japanese buildings surrounded by spacious green areas entered into an interesting dialogue with the media art installations of the Ars Electronica Futurelab and provided the preconditions for the kind of resonance that Futurelab key researcher Kyoko Kunoh sees as a key point in her work: “Digital technology now is stepping into creating resonance from connecting between people and technology. … [We strive to] open a new field of aesthetic awareness about digital technology and promote the future of digital technology that empowers people.”[11]

11 Kunoh, Kyoko, “Digital Resonance: What resonance can we create beyond interaction?,” in: Stocker, G., Schöpf, C. & Leopoldseder, H. (eds.): *In Kepler’s Gardens,* Ars Electronica 2020, Hatje Cantz Verlag, Berlin, 2020, p. 383.

School of the Future Festival 2019, TOKYO MIDTOWN

School of the Future Festival 2019, TOKYO MIDTOWN. Photo showing *Balance from Within* by Jacob Tonski.

Future Innovators Summit Tokyo (2018). Selected participants convened in the TOKYO MIDTOWN Atrium to consider Tokyo as the laboratory of the future.

TOKYO MIDTOWN Design Touch (2010)

Ars Electronica Japan

Type: Initiative
Location: Various locations in Japan
Year(s): Since 2016

Special features / key technologies:
Pop-up festival, discourse, social innovation, Ars Electronica Tokyo Initiative

With a sustainable presence and activities in Tokyo and Osaka, Ars Electronica Japan is engaged in artistic projects, collaborations with universities and museums, as well as research, development, and consulting projects with many Japanese leading companies. Ars Electronica Japan is a separate division within the Ars Electronica ecosystem directed by Ars Electronica Futurelab, which puts cultural programs, consulting, and innovative research into practice in Japan. The idea of a "Pop-Up Ars Electronica Festival" aims to bring the special feeling of Ars Electronica to Japan, as well as to create new platforms for discussing future society together with artists and citizens.
Ars Electronica and Japanese artists have been collaborating on creative projects for the annual Ars Electronica Festival, Ars Electronica Center, and Ars Electronica Export exhibitions since the early days and many Japanese creators have been awarded the Prix Ars Electronica over the years. The Ars Electronica ecosystem has proven to be a fertile ground for creating future dialogues between art, technology, and Japanese society.

https://u.aec.at/49D3485B

Since 2014, Ars Electronica had also cooperated with Hakuhodo, one of the oldest advertising agencies in Japan, having been founded in 1895. Today Hakuhodo is a leading communications-design and marketing-solutions company in Japan, with several thousand employees and offices in major cities in Asia, Europe, and the Americas. The core philosophy of Hakuhodo is centered around "People Thinking" (sei-katsu-sha insight). The first joint project of Ars Electronica and Hakuhodo was *Future Catalysts,* followed by the Ars Electronica Tokyo Initiative. There, generating innovations and sketching future society scenarios took place in a combination of *Art Thinking* from Ars Electronica with *People Thinking* from Hakuhodo. Among the different kinds of processes used by agencies like Hakuhodo or IDEO was also *Design Thinking,* which addressed specially difficult problems in design with cognitive and strategic methods. The term *Design Thinking* goes back to concepts of "creative engineering" from the 1950s and has evolved to signifying an entire consulting industry.

People Thinking Lab (2016). By means of the *Shadowgram,* the Future Catalysts (Ars Electronica Futurelab x Hakuhodo) engage people in collective brainstorming about the future.

“Digital technology now is stepping into creating resonance from connecting between people and technology. ... [We strive to] open a new field of aesthetic awareness about digital technology and promote the future of digital technology that empowers people.”

Source: Kunoh, Kyoko, “Digital Resonance: What resonance can we create beyond interaction?,” in: Stocker, G., Schöpf, C. & Leopoldseder, H. (eds.): *In Kepler's Gardens,* Ars Electronica 2020, Hatje Cantz Verlag, Berlin, 2020, p. 383

Kyoko Kunoh (*1972, JP). Artist and key researcher. Member of the Ars Electronica Futurelab since 2017. Has worked as an artist in a wide range of fields such as presenting interactive art works, directing in the public and commercial space, design of exhibit products, and joint projects with companies and universities.

Open Futurelab (2020), Cascade—8K Future Projects, joint research by NHK (Japan Broadcasting Corporation) and Ars Electronica Futurelab on the new possibilities of 8K technology. With the simple gesture of rotating a display by 90 degrees, a symbolic shift from ”landscape view” to ”portrait view,” the relationship between the human body and broadcast content are reframed.

TOKYO MIDTOWN x Ars Electronica School of the Future

Type: Event
Location: TOKYO MIDTOWN, Tokyo, Japan
Year(s): Since 2017

Special features / key technologies:
Art Thinking, discourse

With *School of the Future,* Ars Electronica Futurelab has been bringing discussions about technology, society, and art into the heart of Tokyo since 2017. In a series of exhibitions and discussion rounds within the TOKYO MIDTOWN urban complex, visitors are invited to explore the impact technologies have on society—and vice versa.
The pop-up setting at TOKYO MIDTOWN enables the discussion of certain topics right in the middle of the people and is a model city that opens up the environment into a learning space where people can discuss new realities and social issues and develop their own opinions.

https://u.aec.at/D12744EF

Future Innovators Summit Tokyo (2018). Over three days selected participants convened in the TOKYO MIDTOWN Atrium to consider Tokyo as the laboratory of the future.

Finally, with ways of thinking closely related to the ways art is created and artists approach problems at the core of the work of Ars Electronica in general and more specifically the Ars Electronica Futurelab, there was this almost compelling step to arrive at the term *Art Thinking.* In this step, the ability to raise questions even in a new field, to take apart stereotypes in a questioning process and thus to identify future potentials, became associated with *Art Thinking.* Hakuhodo and the Ars Electronica Futurelab created a joint consulting program with the aim of incorporating *Art Thinking* into the management as well as the research and design divisions of companies, research institutions, and government agencies. In their work to introduce *Art Thinking* in Japan, Hakuhodo and the Ars Electronica Futurelab formed creative communities, which allowed persons from different backgrounds to share their ideas. Resulting from the initial effort to explain Ars Electronica to partners in Japan, the spirit and the mindset of the Ars Electronica Futurelab became understandable under a process approach, and thus also entered the sphere of consulting. However, the Ars Electronica Futurelab did not change into a consulting business, but added various formats to its portfolio of activities, which could be adapted to different contexts and cultures. Martin Honzik, once a member of the Ars Electronica Futurelab, and since 2006 its key partner as director of the Festival, Prix, and Exhibitions divisions of Ars Electronica, values the benefits of *Art Thinking* in dealing with complexity: "Our complex world is permeated by technology that shapes our societies. *Art Thinking,* manifest in the work of the Ars Electronica Futurelab, is a way of looking at complexity and becoming able to communicate about it. Even before the concept *Art Thinking* had been coined, it played an integral role in the founding of both the Ars Electronica Center—Museum of the Future and the Ars Electronica Futurelab."[12]

12 Martin Honzik, in a conversation with the author, June 2021.

Future Innovators Summit (FIS)

Type: Event, workshop format
Location: Ars Electronica Festival Linz, Austria
TOKYO MIDTOWN, Tokyo, Japan
Year(s): Since 2014

Special features / key technologies:
Discourse, think tank, Art Thinking, interdisciplinarity

Future Innovators Summit (FIS) is a special and comprehensive workshop format within the Ars Electronica Art Thinking School program. This hands-on discussion program and interdisciplinary think tank was jointly developed by Ars Electronica and the Japanese ad agency Hakuhodo for the purpose of generating creative questions about the future, shaped by innovators from all over the world who convene for several days during the Ars Electronica Festival. The Future Innovators come from a wide variety of different backgrounds and include experts such as artists, designers, scientists, technologists, researchers, activists, entrepreneurs, and philosophers.
The difference between Future Innovators Summits and hackathons or other creative conferences is that the outcomes of the FIS are not solutions or answers but questions. Of course, the group can think about answers, but the most important thing is to come up with the ultimate creative questions that will lead us to thinking of missions for tomorrow. FIS is designed to focus attention not directly on the looming societal problems that need to be solved but rather on the visions, ideas, and approaches to these issues.
Since its launch in 2014, the Future Innovators Summit (FIS) has been an integral part of each Ars Electronica Festival.

https://u.aec.at/E3D4C42D

The story of *Art Thinking* casts light on another important aspect, which has been affecting the identity of the Ars Electronica Futurelab since the beginning. Certainly, the Futurelab is the embodiment of *Art Thinking,* while at the same time, core elements of *Art Thinking* have their original roots in the beginnings of Ars Electronica in 1979. At that time, Hannes Leopoldseder formulated that mental triangle of "art, technology, and society," which contains the essence of what would over the years evolve into an understanding of the so-called "DNA of Ars Electronica." On the other hand, the seed of *Art Thinking* was sown when Gerfried Stocker took over the assignment to create the Ars Electronica Center as the prototype of the "Museum of the Future" and summoned Horst Hörtner to join him in this effort, which then led to the founding of the Ars Electronica Futurelab. As an outcome of this incubation phase, there would always be multiple open membranes between the Ars Electronica Futurelab and the entire ecosystem of Ars Electronica. Many members of the Futurelab see it as their home base, but work freely in exchange with different divisions of Ars Electronica. The term "ecosystem" receives its justification from the intense and multidirectional exchange between the various parts of Ars Electronica. Being embedded in this ecosystem of Ars Electronica also provides something for the Ars Electronica Futurelab that many research or educational facilities lack: independence. Victoria Vesna sees this independence as one of the Futurelab's key assets: "The Ars Electronica Futurelab already is what the future should be like. Its independence is a smart thing."[13]

School of the Future Festival 2019, TOKYO MIDTOWN. Photo showing *πTon* by Cod.Act.

13 Victoria Vesna, in a conversation with the author, February 2021.

“Our complex world is permeated by technology that shapes our societies. *Art Thinking,* manifest in the work of the Ars Electronica Futurelab, is a way of looking at complexity and becoming able to communicate about it. Even before the concept *Art Thinking* had been coined, it played an integral role in the founding of both the Ars Electronica Center—Museum of the Future and the Ars Electronica Futurelab.”

Source: Martin Honzik, in a conversation with the author, June 2021.

Martin Honzik (*1970, AT). Artist. Studies in visual experimental design at the University of Art and Design Linz as well as in culture and media management. Member of the Ars Electronica Futurelab from 2001 until 2005. CCO of Ars Electronica and Managing Director of Ars Electronica Festival, Prix Ars Electronica, and Exhibitions since 2006.

Those open membranes work not only within Ars Electronica, but also towards the outside, in exchange with partners and clients, but especially also with artists coming to the Ars Electronica Futurelab in the framework of one of the—meanwhile numerous—artist-in-residence programs. The flow of ideas, which the presence of artists in residence initiates, is somehow symbolized by the social brainstorming triggered by installations like *Shadowgram.* A similar kind of flow commenced with the so-called *Ideas Expedition.* This annual internal contest among the members of the Ars Electronica Futurelab was launched in 2020 and has contributed to making the ideas generated inside the Futurelab far more visible. For a long time, the Ars Electronica Futurelab had cultivated the character of a "black box," which stimulated various kinds of myth building. With the format of the *Ideas Expedition* and the activities around the 25th anniversary of the Ars Electronica Futurelab in 2021, it seems that a new era of increased transparency has begun.

Over the years, the Ars Electronica Futurelab got in touch with many institutions that had been a source of inspiration. Prominent among those is one that had been in operation only between 1919 and 1933. The Bauhaus in Weimar, and later in Dessau, stands as the epitome of a revolutionary way of pursuing creative work in a transdisciplinary setting. When the national socialist regime came to power in Germany in 1933, the Bauhaus had to close down after harassments and political interventions from the fascists. Rolf-Dieter Heuer, former Director General of CERN, a huge research institution possible only on the basis of an international collaboration among many nations, reminds us of the importance of an open atmosphere in society for something like the Ars Electronica Futurelab and for the attitude of *Art Thinking* to flourish: "For science and for art you need an open atmosphere in society. We need freedom to perform, to think and to express. Both science and art need freedom, openness and trust."[14]

14 Stocker, Gerfried, Hirsch, Andreas J., *The Practice of Art and Science,* Ars Electronica, Linz / Hatje Cantz, Berlin, 2017, p. 61.

Ars Electronica Futurelab

Perspectives

Creating New System Architectures for a Changing World

Technologies, societies, economies, and the environment are changing at an accelerating speed. In such a changing world, quite a few organizations, after 25 years in operation, may discover their impact and relevance to be dwindling. The contrary is the case with the Ars Electronica Futurelab. The relevance of its work is increasing further and the urgency of the issues it addresses has become paramount. At the time of its inception in 1996, at the height of the "digital revolution," the Ars Electronica Futurelab belonged to the pioneers of a new era, in which everything—from work to leisure time, from urban life to arts and culture—was evidently going to be different. Today, everything is in fact different, albeit not as expected. During that quarter of a century, the Ars Electronica Futurelab—by reinventing itself over and over—went through a series of remarkable transformations, and at the same time managed to stay true to its core principles and values. In its early years, the artistic workstyle and unconventional transdisciplinarity of the Futurelab raised more than a few eyebrows in industry and academia. 25 years later, much of what was then unusual has become mainstream. Once-visionary prototypes have become ubiquitous amenities considered to be a given. Once-innovative collaborations between art and science have become a trendy buzzword. However, in the midst of the multiplying effects of the digital transformation, the Ars Electronica Futurelab has stayed ahead of the different hypes and moved on towards the next topics that have caught its members' curiosity and inspired their creativity.

With humankind meanwhile facing a rising number of challenges in several areas simultaneously, the proven ability of the Ars Electronica Futurelab to ask the important questions and to make increasingly complex issues around new technologies tangible, is in great demand. For the technical systems that form the backbone of human civilization, we urgently need a new kind of "system architecture" that can integrate a widened problem horizon far beyond the technical aspects alone. The implications of new technologies for life in societies around the globe, and also their ecological impact, have become matters not only of concern, but of survival. Digital capitalism and totalitarianism are restructuring societies; social cohesion, solidarity, and empathy are being eroded, and fascism, crime, and terrorism in multiple forms are on the rise. Efforts to take rational action in the face of climate change, dwindling biodiversity, and an impending collapse of the biosphere are meeting with rising, organized hostility towards scientific expertise and fact-based policies. Ultimately, it is the ways in which new technologies are designed, and the legal and ethical frameworks in which they are used, that will form the essential system architectures we need.

Creating such new system architectures for the entire techno sphere, for digital economies, and for peaceful ways of—globally—living together will require innovative forerunners like the Ars Electronica Futurelab and its way of finding new approaches through *Art Thinking.* Only through a transdisciplinary culture, and the fruitful encounters of art and science this enables, can the necessary—and encouraging—future narratives emerge that will initiate the urgently needed paradigm changes. That said, a great deal of challenging and inspiring work awaits the Ars Electronica Futurelab and everyone else who may join them or who collaborates with them and shares their spirit.

Ars Electronica Futurelab team (2021)

Future Alchemists

The people that shaped 25 years of Ars Electroncia Futurelab.
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Dedication

This book is dedicated to the memory of Hannes Leopoldseder (1940–2021), who passed away during the work on this publication. Without his inspired vision, his strategic wisdom, and his passionate perseverance, Ars Electronica and, consequently, the Ars Electronica Futurelab as well as—after all—this book would not exist.

In the early years of the Ars Electronica Futurelab, the artist, developer, and researcher Robert Praxmarer (1976 – 2021) was a member of the team. Also later as a cooperation partner, his creative and independent spirit remained in touch with the Ars Electronica Futurelab over the years and will be sorely missed.

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Andreas J. Hirsch, Vienna, June 2021

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