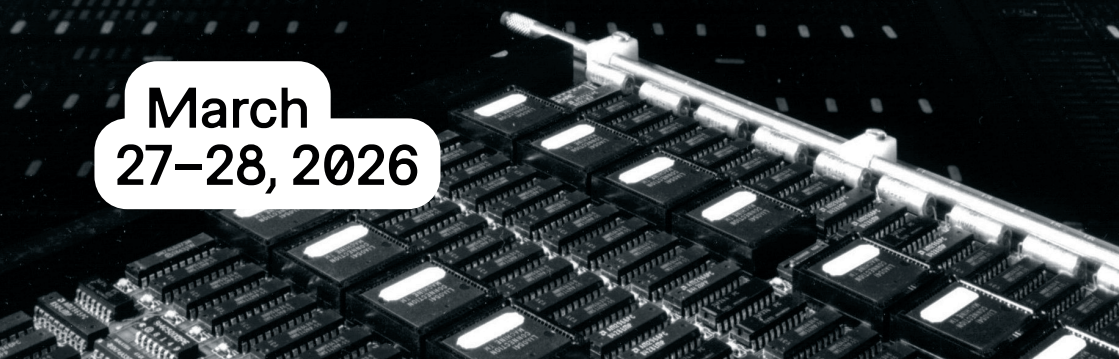
ZKM Karlsruhe

ENVISIONING AI: Legacy and Impact of the Connection Machine

A conference at ZKM | Center for Art and Media Karlsruhe and online

March 27–28, 2026



Content

Introduction
Envisioning AI: Legacy and Impact of the Connection Machine

While the ZKM | Center for Art and Media Karlsruhe continues to shape a program of artistic research into the evolving landscape of artificial intelligence (AI), we take a moment to reflect on a pivotal moment in the history of computing — one that has had a profound impact on technology, culture, and imagination. *Envisioning AI: Legacy and Impact of the Connection Machine* is an interdisciplinary hybrid conference marking the 40th anniversary of the Connection Machine (CM) series of computers — a landmark in the development of massively parallel architectures and their far-reaching implications.

Organized by ZKM | Karlsruhe, in collaboration with the Karlsruhe Institute of Technology (KIT), and CM product designer and artist Tamiko Thiel, this event revisits the origins of parallel computing as both a technical and cultural phenomenon. By bringing together voices from technology, design, theory, and art, the conference fosters dialogues that connect past innovations with contemporary developments in AI.

In his 1985 MIT thesis, W. Daniel "Danny" Hillis envisioned a machine "to perform the functions of the human mind — a thinking machine." The realization of this vision led to the creation of the Connection Machine, the first commercial supercomputer based on a massively parallel architecture. This system not only influenced the trajectory of high-performance computing and artificial intelligence, it also transformed how machines are designed, perceived, and represented — shaping the aesthetics of technology itself.

Envisioning AI engages with this legacy across two complementary perspectives. Day One of the conference explores the technical heritage and systemic impact of the Connection Machine, examining its role in the evolution of parallel computing architectures, massively parallel processing, and new approaches to large-scale computation. At the same time, it challenges the widespread discourse that frames the rise of Big Tech and AI as historically inevitable. By reconstructing the specific institutional, military, academic, and economic constellations that enabled the Connection Machine, the program makes visible how AI emerges from contingent decisions, funding structures, and ideological commitments — revealing it as a historically formed system rather than a natural or unavoidable technological destiny.

Day Two of the conference turns to the design of the Connection Machine and its use for artistic projects, as well as critical perspectives on the current and future AI landscape. Here, artistic and theoretical perspectives interrogate the

cultural narratives embedded in AI — from the aesthetics of "thinking machines" to the invisible infrastructures of data extraction and algorithmic governance. Rather than accepting AI as an inevitable technological destiny, the second day opens a space to question its epistemologies, imaginaries, and socio-political consequences — foregrounding artistic research as a vital mode of resistance, reflection, and reconfiguration.

By connecting engineering expertise with artistic and theoretical inquiry, the conference creates a framework in which computational innovation and societal reflection inform one another — revealing AI as a cultural, political, and epistemic phenomenon.

We gratefully acknowledge the generous support of all our funders, collaborators, and partners — the Ministry of Science, Research and Arts Baden-Württemberg (MWK), the Karlsruhe Institute of Technology (KIT), the Supercomputing Centre at the Forschungszentrum Jülich, and the MIT Museum in Cambridge, Massachusetts — whose commitment made this conference possible.

We would also like to express our sincere thanks to all speakers, contributors, and participants whose engagement and insights have shaped this event.

Alistair Hudson, Michael Beigl, Daria Mille, Tamiko Thiel

Friday, March 27
Day 1, Session 1: Technical Legacy and Impact of the Connection Machine
Location: ZKM Media Theater & Live Streaming

Moderated by: Michael Beigl, Hanna Jurisch, Daria Mille, Tamiko Thiel

14:00	**Welcome and Introduction** Alistair Hudson, Michael Beigl, Tamiko Thiel
14:15*	**Introduction and Greetings** W. Daniel Hillis
14:30*	**Keynote Lecture and Q&A** Thomas Haigh **Why Did They Say the Machines Were Thinking?**
15:10*	**Greetings** MIT Museum Cambridge, Massachusetts
15:15	**Lightning Talks** Brewster Kahle, Lew Tucker, Joseph Bates*
16:00–16:30	Coffee Break
16:00**	**Screening** Essay film by Max Clausen **Thinking Machines Corporation**
16:30	**Lecture** Heiner Igel **The Joy of Programming the CM: 3D Waves in a Complex Earth**
	Performance by Steve Reich **Clapping Music** Performed by Thibault Keith, Xinlu Wei, Finn Kiefl, Tolga Anlar, Minoru Saito, Shawn Hsiao (University of Music Karlsruhe, class of Prof. Vanessa Porter)
17:00	**Lecture and Q&A** Thomas Lippert **From Connection Machine to Exascale: Reflections on Parallel Computing**
17:45*	**Lecture and Q&A** Johannes Schemmel **Learning from the Brain: Neuromorphic Computing and the Future of AI**
18:30	Break
18:45	**Panel Discussion**, moderated by Michael Beigl and Tamiko Thiel With Heiner Igel, Brewster Kahle, Thomas Lippert, Klaus Schilling, Lew Tucker
19:45–20:00	Closing Remarks

All times are given in Central European Time (CET).
* digital
** livestream only

Saturday, March 28
Day 2, Session 2: Computational Aesthetics: Design and Creative Practice on the Connection Machine
Location: ZKM Media Theater & Live Streaming

Moderated by: Margit Rosen

11:00	**Welcome and Introduction** Alistair Hudson
11:05	**Impulse Lecture** Tamiko Thiel & Gordon Bruce **Designing the Connection Machine: Let the Machine Speak for Itself**
11:30	**Impulse Lecture** Natalie D Kane **Is This Thing On? Imagination, Computation, and Speculation with the CM-2**
11:45	**Impulse Lecture** Paul Galloway **Art in our Time: The Connection Machine at MoMA**
12:00	**Panel Discussion,** moderated by Margit Rosen With Michael Beigl, Gordon Bruce, Paul Galloway, Natalie Kane, Tamiko Thiel
12:30	**Screening** Computer Animations by Karl Sims, with introduction by Margit Rosen **Particle Dreams** (1988) **Panspermia** (1990) **Primordial Dance** (1991) **Liquid Selves** (1992) **Evolved Virtual Creatures** (1994)
12:45*	**Impulse Lecture** Gary Oberbrunner **From Connection Machine to Creative Machines**
13:00–14:00	Lunch Break

Saturday, March 28
Day 2, Session 3: From Thinking Machines to Today's AI Landscape
Location: ZKM Media Theater & Live Streaming

Moderated by: Alistair Hudson, Daria Mille

14:00	**Welcome and Introduction** Daria Mille
14:10	**Keynote Lecture and Q&A** Sarah Ciston **Don't (?) Be Evil: Reckoning with the Risks of Technofascism from ELIZA to Anthropic (or: How I learned to worry just enough to keep loving what I code)**
15:00*	**Greetings** MIT Museum Cambridge, Massachusetts
15:05	**Lecture and Q&A** Tiara Roxanne **Automated Extraction at the Borderlands**
15:50	**Lecture and Q&A** Cecilie Waagner Falkenstrøm **Artistic Practice in the Age of LLMs: From 2016 to Today**
16:35	Coffee Break
17:10	**Lecture Performance** Kim Albrecht **Artificial Worldviews**
17:40*	**Lecture and Q&A** Nora N. Khan **Imagining Computation: Presence & Absence**
18:30–19:15	**Wrap-up Discussion,** moderated by Alistair Hudson With Kim Albrecht, Sarah Ciston, Cecilie Waagner Falkenstrøm, Nora N. Khan,* Tiara Roxanne

All times are given in Central European Time (CET).
* digital
** livestream only

Day 1, Session 1
Technical Legacy and Impact of the Connection Machine

Day One of the conference offers a profound exploration of the technological foundations and enduring influence of the Connection Machine (CM). It was the first commercial supercomputer built on a massively parallel architecture — a groundbreaking achievement that fundamentally shaped the development of high-performance computing and artificial intelligence. While its innovations have reverberated across computing technologies for decades, its formative role has rarely been appreciated in the histories of AI and computational design.

The conference program foregrounds the CM's technical complexity and systemic impact by examining how its architecture anticipated key concepts in today's computing environments. The program offers a unique opportunity to reconsider the material foundations of AI technologies and to reflect on how early visions of intelligent machinery continue to shape today's technological landscape.

W. Daniel ("Danny") Hillis

Danny Hillis is an inventor, entrepreneur, and scientist who pioneered the development of parallel computers to enable artificial intelligence. He was the principal architect of the Connection Machine, which was the subject of his MIT PhD thesis, and co-founded Thinking Machines Corporation.

Hillis also co-founded Applied Invention, an interdisciplinary group of engineers and scientists that develops technology solutions in partnership with other companies. His current projects are focused on agriculture, cyber security, and better tools for deciding what to believe. He is also the designer of the 10,000-year Clock of the Long Now.

Abstract

This short presentation explores the necessity that drove Hillis to create the Connection Machines: a vision of harnessing massive parallel computation to expand human knowledge and amplify intelligence. It reflects on their lasting legacy—from the first multi-core processor patent to the modern GPUs as a "CM on a chip"—as well as their role in advancing scientific computing. The talk revisits Hillis's early vision of cluster and cloud computing as an evolution of the CM concept, enabling modern artificial intelligence and high-performance supercomputers, and even supporting Nobel laureate Richard Feynman's early thinking about quantum computing. To conclude, it addresses how we can balance AI's transformative benefits with its risks.

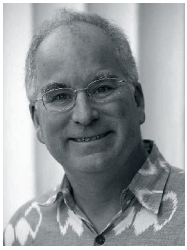
Thomas Haigh

Thomas Haigh is a Professor and Chair of the History Department at the University of Wisconsin-Milwaukee where he also runs a retrocomputing laboratory. After studying computer science at Manchester University, he won a Fulbright award to study in the USA where he earned a PhD in the history and sociology of science from the University of Pennsylvania. He is the lead author of *A New History of Modern Computing* (2021) and *ENIAC in Action* (2016), both published by MIT Press. Haigh's publications have won prizes from the Business History Conference and the Society for the History of Technology. Haigh works with ACM, as director of its Turing Award History Project, and with the IEEE Computer Society as Chair of its history committee. His latest book, *The Brand That Wouldn't Die: A History of Artificial Intelligence* is forthcoming with MIT Press.

Why Did They Say the Machines Were Thinking?

The decision to name a parallel computing company the Thinking Machines Corporation reflected both a sense that the brain is a massively parallel processor and the environment of the mid-1980s in which artificial intelligence and novel computer architectures had been successfully marketed as emerging technologies crucial to the USA's future military and economic strength. Drawing from his current research project on the history of artificial intelligence, Haigh will situate the Connection Machine within the broader history of US government support for AI. Thinking Machines depended for business on DARPA, the Defense Department's Advanced Projects Research Agency. Haigh will sketch the evolution of DARPA's support for computing and AI in three main phases, beginning in 1962. In the 1980s DARPA ran the Strategic Computing Initiative, a massive project launched partly in response to warnings that a new Japanese initiative threatened to do with the USA's lead in computing what Japan had already done to the USA's motorcycle, car, and personal electronics industries. His story ends in the early 1990s as the environment changed with the end of the Strategic Computing Initiative, the onset of the AI winter of the 1990s, and the slowdown in military spending with the end of the Cold War. Like other supercomputing firms, Thinking Machines struggled to survive these changes.

Brewster Kahle



A passionate advocate for public Internet access and a successful entrepreneur, Brewster Kahle has spent his career centered on a singular focus: providing Universal Access to All Knowledge. He is the founder and Digital Librarian of the Internet Archive, one of the largest libraries in the world. Soon after graduating from the Massachusetts Institute of Technology where he studied artificial intelligence, Kahle helped found the Thinking Machines Corporation. In 1989, Kahle created the Internet's first publishing system called Wide Area Information Server (WAIS), later selling the company to AOL. In 1996, Kahle co-founded Alexa Internet, which helped catalog the Web, selling it to Amazon.com in 1999. The Internet Archive, which he founded in 1996, now preserves 210+ unique petabytes of data — the books, Web pages, music, television, and software of our cultural heritage, working with more than 1,400 library and university partners to create a digital library that is accessible to all.

Abstract

From designing the pioneering CM-1&-2 multicore chips and early parallel computing systems, to creating the pre-Web Wide Area Information Server (WAIS) as a "publishing system for the Internet," influencing cloud evolution, and ultimately founding the Internet Archive to emulate the Library of Alexandria in the digital age, Brewster Kahle's talk will connect AI hardware innovation, big data search, and digital knowledge preservation.

Lew Tucker

Lew Tucker, PhD, is a computer scientist and technology executive with more than 40 years at the frontier of high-tech innovation. Earlier in his career, he was a research scientist in Neurobiology at Cornell University Medical College before completing his doctorate and joining Thinking Machines Corporation, where he led research in computer vision and parallel algorithms on the Connection Machine. He went on to help launch Java programming language at Sun Microsystems, build the AppExchange at Salesforce — one of the first SaaS marketplaces — and serve as Vice President and Chief Technology Officer of Cloud Computing at Cisco Technology Inc. He has served on the boards of the OpenStack Foundation, Cloud Native Computing Foundation, and Cloud Foundry. He holds a BA from Cornell University and a PhD in Computer Science from Polytechnic Institute of New York University.

Parallel Thinking

In 1985, a small Boston start-up called Thinking Machines Corporation built the Connection Machine — a radical computer with tens of thousands of processors working in parallel, capable of outrunning the fastest supercomputers of its era. It was considered audacious. It also turned out to be exactly right.

This talk traces the arc from the Connection Machine's founding ideas — massive parallelism, data-parallel programming, high-speed interconnects, and collective operations — to the AI datacenters that now train the world's largest language models. The algorithms invented at Thinking Machines in the late 1980s run billions of times per second in today's GPU (Graphics Processing Unit) clusters. The architectural blueprint drawn by the CM-5 in 1993 is the blueprint NVIDIA follows today.

Thinking Machines Corporation closed in 1994. It may have been ahead of its time — but its impact is still felt in every AI model running in the world today.

Joseph Bates

Joseph Bates leads Billion Core PBC, based in Boston. His research spans automated mathematics, computational drama, and approximate computing. He spent over 20 years as a professor and scientist for at Carnegie Mellon University, the Massachusetts Institute of Technology Artificial Intelligence and MIT Media Laboratories, and Cornell University–where he received his PhD–as well as at Johns Hopkins University, which he entered at age 13.

Democratizing Billion Core Computing

Real AI is nearly upon us. As foreseen in the last century, it will be enormously powerful. Concentrating enormous power in the hands of a few has been a danger for humanity through history. Democratizing access to hardware may help limit this danger in the AI age.

Modern CM-like machines can be both powerful and affordable enough to enable next-generation AI research in public settings, such as universities. Bates will sketch Billion Core, an initiative aimed at enabling open AI research through spatial and approximate computing.

Heiner Igel

Heiner Igel studied geophysics in Karlsruhe, Germany, and Edinburgh, Scotland. He obtained his doctorate in 1993 from the Institut de Physique du Globe in Paris, France, developing parallel forward and inverse modeling tools for seismic wave propagation problems on the Connection Machines CM-2 and CM-5. He then moved to the Institute of Theoretical Geophysics in Cambridge, UK, where he worked on wave simulation techniques for regional and global seismic wave propagation. In 1999 he became Professor of Seismology at the Ludwig-Maximilians-University Munich. His current interests include full-waveform inversion, high-performance computing, and rotational ground motions. He is a member of the German National Academy of Sciences Leopoldina and a Fellow of the American Geophysical Union.

The Joy of Programming the CM: Waves in a Complex Earth

In the spring of 1990 a Connection Machine CM-2 was delivered to the Geophysical Tomography Group (GTG) at the Institut de Physique du Globe in Paris. Professors Albert Tarantola and Peter Mora (who previously worked for Thinking Machines) had the vision that parallel computing will be transformative for the Earth Sciences. Around a dozen PhD students had exclusive access to this revolutionary machine supported by Thinking Machines application engineers who helped to develop some of the first parallel simulation codes for Earth System modeling. The focus of the GTG group was the simulation of seismic wave propagation in 3D media and the solution of the inverse problem based on adjoint techniques in a probabilistic Bayesian framework. The Earth models were evenly distributed to the memory of the CM-2 using domain decomposition. The core of the simulation algorithm was a finite-difference approximation (FD) of the elastic wave equation. The advantage of the FD method is the fact that the algorithm leads primarily to near-neighbor communication between the 64k processors of the CM, a procedure that was highly optimized, for example, using the circular shifting of an array (cshift, a musical equivalent is the "clapping music" by Steve Reich). We report on aspects of parallel programming of the CM that was very simple from a user point of view (compared to the explicit message-passing approaches like MPI) with the CM-Fortran (or other) compilers.

Clapping Music

by Steve Reich

Performed by Thibault Keith, Xinlu Wei, Finn Kiefl, Tolga Anlar, Minoru Saito, Shawn Hsiao (University of Music Karlsruhe, class of Prof. Vanessa Porter).

Clapping Music (1972) is considered a classic of minimal music compositions. Originally written for two performers, the piece consists of a single rhythm of twelve eighth notes. While one performer maintains in the same rhythm throughout the whole entire piece, the other shifts it by exactly one eighth note. After twelve shifts, or exactly 144 bars later, the two rhythms are back in unison. Despite its simplicity, the composition gives rise to a wide variety of rhythmic combinations based on the principle of "phase shifting," a mechanical system with which Reich experimented with in his early works, equivalent to the cshift procedure used on by the Connection Machine.

Performed by students from Professor Vanessa Porter's class at the University of Music Karlsruhe the two parts feature six pairs of clapping hands.

Thomas Lippert

Prof. Dr. Dr. Thomas Lippert has served as the Director of the Jülich Supercomputing Centre (JSC) at Forschungszentrum Jülich since 2004. After spending 15 years as a Professor of Computational Theoretical Physics at the University of Wuppertal, he took on the role of Professor of Modular Supercomputing and Quantum Computing at the Department of Computer Science and Mathematics at Goethe University Frankfurt in 2020. Since 2004, he has led the Helmholtz program in the field of supercomputing, titled *Engineering Digital Futures*. He serves on the board of the Gauss Centre for Supercomputing and is the Managing Director of the John von Neumann Institute for Computing.

Thomas Lippert has held a number of roles at the European level in the field of high-performance computing (HPC), including the establishment and management of Partnership for Advanced Computing in Europe (PRACE), participation in the advisory boards of EuroHPC, and involvement in various European research projects. Since 2014, he has been instrumental in developing AI capabilities at Forschungszentrum Jülich, including the installation of JUWELS, a supercomputer designed as a training system for large fundamental models already when it was commissioned in 2020. The JUPITER exascale computer, for which architecture he is responsible, will enable Germany to train AI more than 20 times faster than previously possible.

From Connection Machine to Exascale: Reflections on Parallel Computing

Drawing on his early experiences working with the Connection Machine, Thomas Lippert reflects on a formative moment in the history of parallel computing and its lasting influence on contemporary high-performance computing. The Connection Machine represented a radical rethinking of computational architecture, enabling scientists to explore massively parallel approaches to complex scientific problems. In this talk, Lippert revisits the intellectual and technical environment surrounding the use of the Connection Machine, highlighting how researchers adapted algorithms, programming models, and scientific workflows to this new paradigm.

Building on this historical perspective, the talk considers how the ambitions and ideas associated with early massively parallel systems resonate in today's supercomputing landscape—from large-scale simulation to data-driven science and AI. By tracing continuities and transformations from the Connection Machine to modern exascale systems, Lippert reflects on how past experiments in parallelism continue to shape the evolving infrastructure of scientific computing.

Johannes Schemmel

Johannes Schemmel leads the Electronic Vision research group at Heidelberg University since the year 2000. In 2024 he became a full professor of Neuromorphic Computing Architectures at the Institute of Computer Engineering (ziti). His research interests include mixed-mode Very Large Scale Integration systems (VLSI) for information processing, like image sensors, massively parallel analog computing, and artificial neural networks, as well as Electronic Design Automation (EDA) tools for mixed-signal System-on-Chip (SoC) design. In recent years his focus has shifted to the analog implementation of biologically realistic neural network models in VLSI as well as physical computing. He is the lead architect of the Spikey and BrainScaleS accelerated analog neuromorphic hardware systems. His research group operates the BrainScaleS neuromorphic hardware platform (PaaS) within the European EBRAINS research infrastructure.

Learning from the Brain: Neuromorphic Computing and the Future of AI

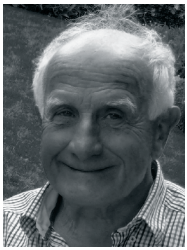
This lecture addresses neuromorphic computing as a key technology that transfers biological principles to electronic hardware in order to transcend the efficiency constraints of classical computer architectures. Historically, it first contextualizes the Connection Machine: the massively parallel architecture of which anticipated concepts that are essential for the interconnected processing inherent in contemporary brain models.

The main body of the lecture analyzes two distinct technological pathways that reached maturity within the framework of the Human Brain Project (HBP). First, SpiNNaker is introduced: this digital system utilizes an immense number of small processors to simulate the communication of nerve cells flexibly and in biological real time.

As a contrast, the lecture presents the BrainScaleS system. This approach employs analogue electronic circuits to emulate neurons physically, rather than merely calculating them numerically. A decisive advantage here is speed: BrainScaleS operates up to 10,000 times faster than its biological counterpart, enabling the investigation of learning processes—which require days in nature—within fractions of a second.

To conclude, the lecture examines how these platforms will shape future AI systems.

Klaus Schilling



Klaus Schilling studied physics from 1956 to 1959 at the University of Tübingen and specialized in theoretical nuclear physics at the University of Bonn. His 1963 master's thesis, *Radial Anomalies of Nuclei Near Magic Nuclear Numbers*, received an excellent grade. Since 1960, he has been a member of the Studienstiftung des Deutschen Volkes.

From 1963 to 1966, he studied theoretical elementary particle physics at the University of Hamburg, focusing his PhD work (supervised by G. Kramer) on the phenomenological analysis of e–p collisions. After defending his thesis *Peripheral Photoproduction Processes at High Energies* with the grade summa cum laude in 1966, he continued there as a postdoctoral researcher until 1968, when he was awarded a fellowship by the Max-Kade Foundation for a research stay in 1968/69 at Caltech and SLAC.

From 1969 to 1971, he worked as a research associate in the CERN Theory Division. In 1971, he was appointed associate professor of theoretical physics at Bielefeld University (BU). From 1974 to 2002, he served as full professor of theoretical physics at the Gesamthochschule Wuppertal (the University of Wuppertal, BUW), where his research focused on the verification of quantum chromodynamics (QCD), the theory of strong interactions, through computer simulations using lattice gauge theory (LGT).

In 1986, he co-initiated a joint BUW–BU DFG Research Group that significantly advanced LGT research on supercomputers, both locally and nationally: (a) through the installation of CM-2 and CM-5 systems at BUW (funded by the DFG) and (b) through the establishment of a new LGT research group at the KFA in Jülich (funded by DESY). He directed this group from 1994 to 2000.

Day 2, Session 2
Computational Aesthetics: Design and Creative Practice on the Connection Machine

Integrating computation with a bold philosophy of visualization, the CM translated abstract principles such as massive parallelism into tangible form — a spatially expressive "electronic brain" that made complex internal processes perceptible. The CM-2 stands out not only for its technological significance but also as an object whose external form was deliberately conceived to render a highly complex architecture visually and spatially intelligible, allowing viewers to sense how parallel processes were organized rather than concealing them behind an anonymous casing.

In an era in which contemporary AI systems, particularly large-scale neural networks, often operate as visually opaque black boxes, the Connection Machine serves as a valuable reference point for understanding how design mediates between algorithmic complexity and broader comprehension. At the same time, artists such as Karl Sims used the CM's parallel processing power to create pioneering simulations and evolutionary animations, showing how advanced computational research could also become a medium for experimental visual art.

Impulse Lecture: Tamiko Thiel & Gordon Bruce

Designing the Connection Machine: Let the Machine Speak for Itself

Tamiko Thiel

In 2024 Tamiko Thiel was recognized with the SIGGRAPH Distinguished Artist Lifetime Achievement Award in Digital Art and inducted into the AWE XR Hall of Fame for her socially critical media artworks exploring place, space, the body, and cultural identity.

She was the lead product designer on the first commercial AI supercomputers Connection Machines CM-1/CM-2 (1986/87), which influenced Google's technology and Steve Jobs' design aesthetic. Her works in VR include *Starbright World,* first metaverse for children (1994–1997, with Steven Spielberg) and *Beyond Manzanar* (2000, in the collections of the San Jose Museum of Art and the Smithsonian Institution).

Her works in AR began with *ARt Critic Face Matrix* in an intervention into MoMA NY (2010) and *Shades of Absence* in a Venice Biennale Intervention (2011). AR works in collections include *Unexpected Growth* (2018, Whitney Museum NY), *ReWildAR* (2021, Smithsonian Institution), *ARpothecary's Garden* (2022, Kunstsammlung Roche Basel), and *Vera Plastica* (2023, BROICH Digital Art Foundation).

Abstract

From 1983–1985, Tamiko Thiel was the lead product designer for Danny Hillis' Connection Machines CM-1 and its successor, the more performant CM-2, at Thinking Machines Corporation. Inspired by the human brain, this first commercially successful AI supercomputer was composed of 64,536 simple processors spread out over 4,096 chips, connected in an internal 12-dimensional hypercube network — revolutionary at a time when "parallel processing" meant perhaps 2, or at the most 4, processors in one computer.

Wanting to enable the machine to "speak for itself," Tamiko will talk about how, in order to find a form for the machine, she had to re-think the meaning of the adage "Form Follows Function," extending it to encompass the invisible workings of a computers — a "symbolic processor." The final form of the machine, first symbolized in her design for the company t-shirt, expressed both the cube-of-cubes physical network connecting the processors, and the "soft" data structures that could seemingly ignore the hardware constraints of the wires.

Gordon Bruce

As a design consultant for over 45 years, Bruce worked with many multinational companies, such as IBM, Mobil, and General Electric. From 1991 to 1994, ArtCenter College of Design hired him as a Vice President to open a campus in Kyoto, Japan. From 1995 to 1999, he co-developed the *Innovative Design Lab of Samsung* in Seoul, South Korea. In 2003, he worked for Porsche Design's North American office. For many years, he was head design consultant at Lenovo's Innovative Design Center in Beijing and Huawei Technologies in China, Bühler in Switzerland, and OSIM in Singapore. Bruce is a visiting professor in the USA and China, and a lecturer at Harvard University's Master's in Design Engineering program. He authored a book for Phaidon Press and articles for international magazines. Gordon's designs have been exhibited and are in the permanent collections of MoMA, the Smithsonian, Centre Pompidou, and the Computer History Museum. He received a Lifetime Achievement Award from ArtCenter College of Design and has been a Red Dot Design Award jury member for 18 years.

Abstract

Prior to being hired by Thinking Machines Corporation in 1984, Gordon Bruce and fellow designer Allen Hawthorne had worked together for many years as industrial design consultants for numerous multinational corporations at Eliot Noyes & Associates, which included working on the movie 2001 Space Odyssey followed by NASA's first space station — Skylab — in the mid-1960s.

Danny Hillis requested Bruce and Hawthorne to begin the process by exploring multiple conceptual variations — even impractical ideas — that would be expressive of a unique character for the first massively parallel processor. Working closely with Tamiko Thiel and Danny Hillis, Hawthorne and Bruce explored and refined the selected design direction, the "cube-of-cubes." Bruce will discuss the design process and refinement issues that evolved while developing the Connection Machine's design character — human-centered, sensible, simple, refined, culturally acceptable, artistic, memorable, and a real sense of "WOW."

Natalie D Kane

Natalie D Kane is a curator and writer based in London. They are Curator of Digital Design at the *V&A*, where they research and collect digital design and society, including its preservation, display and access. They have led research projects on the complexity of Born Digital and Hybrid digital objects with the AHRC through the Towards a National Collections project, and written on collecting digital objects within museums and the role of digital culture, design and ethics in our lives. With the *V&A*, they curated *Design and Disability* (2025) and the official UK pavilion at the 2019 XXII Milan Triennale, showing the work of Forensic Architecture. Natalie is a Trustee of the British Games Institute / National Videogames Museum and on the Advisory Board for the Society for Computers and Law. Recently, they have joined the Barbican Renewal's Access and Inclusive Design Advisory Group. They are editor of *Design and Disability* (2025), published with the *V&A*.

Is This Thing On? Imagination, Computation, and Speculation with the CM-2

The Connection Machine CM-2 is often remembered for its massively parallel processing power. However, its most enduring contribution may be its radical departure from the "beige box" era of commercial computing. In this impulse lecture, Natalie Kane explores the CM-2 as an influential piece of industrial design that transformed hardware from a functional tool into a cultural icon. Kane examines how the CM-2's visual language created a new semiotics of "the digital." The blinking lights were more than diagnostic tools; they were designed, aesthetic choices to reveal the unseen. The CM-2 in its radical shift in design aesthetics was a tool for worldbuilding, a signal of human-machine interactions and relationships.

The lecture traces the "genetic markers" of the CM-2 in modern technical products, arguing that the machine's influence is hidden in plain sight: from the rhythmic "breathing" of the legacy Apple sleep indicator to the glowing status rings of contemporary smart home hubs, the CM-2 established the expectation that hardware should possess a "pulse." They will discuss the complex semiotics of what we understand computers to reveal to us, and where industrial design can extend or obscure agency through "symbolic processes" in the way of Alfried Gell's technologies of enchantment.

Concluding, Kane reflects on how the CM-2 shaped the pop-cultural representation of artificial intelligence.

Paul Galloway

Paul Galloway is the Senior Collection Specialist for the Architecture & Design Department at The Museum of Modern Art (MoMA), New York City. During his time at MoMA he has curated *Designer's Choice: Norman Teague-Jam Sessions* and co-curated the exhibitions *Never Alone: Video Games and Other Interactive Design* and *Automania*. Galloway has authored and contributed to multiple MoMA publications, including *Shigetaka Kurita: Emoji*, as well as catalogs from the Fondation Louis Vuitton and the Montreal Museum of Fine Arts.

Art in our Time: The Connection Machine at MoMA

The Thinking Machines CM-2 Supercomputer is a triumph of design. A unique combination of diverse innovations, it demonstrates the principles of good design in a timeless, iconic product. At first recognizable for its elegant physical form, this friendly-looking box of twinkling lights was also a computing powerhouse. As an artifact from an era when supercomputers were intended to be seen like corporate status symbols, the CM-2 stands in marked contrast to our present day, when supercomputers have become massive conglomerations of standardized parts, existing (from the average user's perspective) in a disembodied cloud that belies their very real physical and ecological footprint. MoMA argues that the CM-2 is crucial for understanding the history of design and technology. Acquired by MoMA in 2016, it has been included in multiple exhibitions, swiftly becoming an icon of the museum's collection. In this presentation, the Senior Collection Specialist explores the place of the CM-2 at MoMA and in history, offering insight into the intersections of art, design, and technology in culture today.

Karl Sims

Karl Sims is a digital media artist and visual effects software developer. His interactive works have been exhibited worldwide including at the Centre Pompidou, Ars Electronica, DeCordova Museum, Boston Museum of Science, and the National Museum of Mathematics, New York. He founded GenArts, Inc. which created special effects software tools for the motion picture industry, and he also held positions at Thinking Machines Corporation, Optomystic, and Whitney/Demos Productions. Karl studied computer graphics at the MIT Media Lab and Life Sciences as an undergraduate at MIT. He is the recipient of various awards including two Ars Electronica Golden Nicas, a MacArthur "Genius" Grant, and an Emmy Award.

Screening of Computer Animations by Karl Sims

In the late 1980s and early 1990s, Sims created several pioneering animations on the Connection Machine CM-2. His early works like *Particle Dreams* (1988) used particle systems executed in parallel to simulate complex phenomena such as explosions, snowstorms, and waterfalls on the CM-2. *Panspermia* (1990) depicted a selfreplicating, intergalactic life form, combining dynamic simulations, procedural plant growth, and artificial evolution techniques to generate complex structures. Later pieces like *Liquid Selves* (1992) also used particle systems, image warping, and evolving 3D parametric shapes to explore transformations of human forms. In 1994, Sims extended his work to the Connection Machine CM-5 with *Evolved Virtual Creatures*, an animation showing populations of virtual block creatures evolved via genetic algorithms for tasks such as swimming and locomotion in a simulated environment. Here, artificial evolution created both body morphology and behavior, demonstrating how variation and selection can produce emergent lifelike motion in simulated agents. Sims' work with these systems links parallel computation and evolutionary methods to art and artificial life, revealing how an artist with the help of computational processes can generate complex animated forms and behaviors.

Gary Oberbrunner

Gary Oberbrunner is a software engineer and technology executive with over 40 years of experience in high-performance computing, GPU programming, and visual effects. He began his career at Masscomp creating A/D converters, then moved to Thinking Machines Corporation, developing massively parallel graphics and visualization software on the CM. In 1997 he joined Karl Sims at GenArts as its second employee, co-developing Sapphire Plug-ins, the industry-leading visual effects suite for film and television. Oberbrunner and Sims won an Engineering Emmy Award in 2019 for their work on Sapphire. Oberbrunner served in various roles with GenArts for nearly 20 years, continuing as Chief Technology Officer of Boris FX after its acquisition. He then founded Dark Star Systems, where he created BioViz Studio for scientific data visualization.

Oberbrunner continues to create various open-source tools and projects. He is director of the Academy Software Foundation Open Effects standards committee which oversees the OFX standard for visual effects plug-ins, and he is president of the Long Now Boston organization, a nonprofit focused on long-term thinking.

From Connection Machine to Creative Machines

The Connection Machine's "processor per pixel" architecture — massively parallel, data-driven, elegant — turned out to be a blueprint for the future. Modern Graphic Processing Units owe more to that lineage than most people realize: SIMD execution, virtual processors, data-parallel abstractions, even constructs like C*'s "where" all have direct descendants in today's GPU programming models. Surprisingly, some of the Connection Machine's higher-level software ideas still haven't been matched.

This talk traces that thread from the CM graphics group in the early 1990s, through GPU programming for film visual effects at GenArts, to today's AI-saturated computing landscape — where those same GPUs are now powering something no one quite anticipated. Along the way, Oberbrunner will touch on what the CM got right (and what the world is still catching up to), the strange economics that carried parallel computing from supercomputer labs to gaming to AI datacenters, and some experiments he have been doing with AI-driven creativity: shader evolution systems that echo the old artificial life work in new ways.

Day 2, Session 3
From Thinking Machines to Today's AI Landscape

This chapter turns to the present, examining today's AI landscape through the historical lens of the Connection Machine and its early visions of distributed intelligence. While massively parallel architectures once embodied technological optimism about "thinking machines," contemporary AI systems — from large language models to data-driven infrastructures — raise urgent questions about power, bias, and responsibility.

Bringing together artists and theorists, this section approaches AI from critical and intersectional perspectives. What kinds of knowledge, labor, and data underpin today's large-scale AI systems? Whose voices remain invisible or are deliberately silenced? In what ways do current AI systems reproduce colonial logics? And how might artistic practices help to expose, challenge, and reimagine the socio-technical systems behind AI?

Sarah Ciston

Sarah Ciston (they) is Professor of Computational Thinking and Aesthetic Doing at the Academy of Media Arts Cologne. Their artistic research builds tools to bring intersectional, critical–creative approaches to machine learning. Winner of the 2025 Ars Electronica STARTS Grand Prize, they are the author of *A Critical Field Guide for Working with Machine Learning Datasets* and co-author of *Inventing ELIZA: How the First Chatbot Shaped the Future of AI* (MIT Press, Spring 2026).

Don't (?) Be Evil: Reckoning with the Risks of Technofascism from ELIZA to Anthropic (or: How I learned to worry just enough to keep loving what I code)

Despite the optimism inherent to invention, we cannot control how the tools we create are used by others. Many engineers, artists, and makers end up disillusioned after witnessing emergent technologies being co-opted and misused. The problem is not new—but it is urgent. Rather than giving up making, or giving up caring, what is to be done? In order to trace others' attempts to reckon with the high-stakes impacts of their tools, this talk travels from Joseph Weizenbaum's ELIZA chatbot in 1966 to Anthropic/Palantir's newest AI decision-making systems used in warfare. Along the way it also visits the Connection Machine's vision for massive parallel computing, Phil Agre's "critical technical practice," and other moments in sociotechnical history. Together we will ask: How can one reclaim creative and ethical agency, particularly when today's systems are designed to be unfathomably huge, proprietary, and opaque? What responsibility do tech makers (and users and researchers) have to ensure their tools retain their values, while accounting for their impact? And how can emergent technologies resist fascism rather than enable it?

Tiara Roxanne

Dr. Roxanne is a scholar and performance artist whose work rethinks the ethics of AI through an anticolonial, eco-feminist, and cyberfeminist lens. They are currently a research fellow at Disruption Network Institute Berlin. Their research critiques how digital technologies rely on the extraction of resources from Indigenous lands and examines how these infrastructures carry colonial legacies inscribed in land, bodies, and memory. They are the author of a forthcoming book with University of California Press (2027), which develops their concepts of *digital attunement* and *the technological haunt*.

Tiara has presented at Ars Electronica (Linz, Austria), Images Festival (Toronto, Canada), Squeaky Wheel Film and Media Art Center (New York, USA), Trinity Square Video (Toronto), Leuphana University (Lüneburg, Germany), European Media Art Festival (Osnabrück, Germany), University of Applied Arts (Vienna, Austria), SOAS (London, UK), SLU (Madrid, Spain), Transmediale (Berlin, Germany), Duke University (Durham, NC, USA), Cambridge University (UK), among others.

Automated Extraction at the Borderlands

Amid ongoing political upheaval surrounding border control, ICE agents are flooding towns and cities throughout the USA. Drone deployment, surveillance, and the tactics of the Kill Cloud, which is a growing interconnected network infrastructure with global reach, have been amplified. During this talk, Dr. Tiara Roxanne will share examples of how ICE is using surveillance technologies to surveil and capture Mexican Indigenous peoples and immigrant and vulnerable communities in the US.

Cecilie Waagner Falkenstrøm

Cecilie Waagner Falkenstrøm is an award-winning artist who has been pioneering the use of artificial intelligence (such as LLM, GPT), since 2016. Her works have been exhibited at Victoria and Albert Museum (V&A), Ars Electronica, The Kennedy Center, Wellcome Collection and Copenhagen Contemporary. Notably, she created the first-ever AI and blockchain artwork in space aboard NASA's part of the International Space Station. Her contributions to digital art have been recognized by major media outlets like Forbes and the New York Times. Falkenstrøm has received numerous global awards, including the Lumen Prize for Digital Art in 2017 and 2021, an Honorary Mention from Prix Ars Electronica in 2023, and the TECHNE Award from the British Arts and Humanities Research Council. She studied Fine Art at University of the Arts London and Royal College of Art in London.

Artistic Practice in the Age of LLMs: From 2016 to Today

In this talk, Cecilie Waagner Falkenstrøm traces the history of generative AI in art through her own practice since 2016, from *Frank* and *A Faustian Friendship* to *The Caring Machine* and *I See It, So You Don't Have To*. Across these works, she examines the emotional, ethical, and existential dimensions of AI development, addressing data bias, power structures embedded in technological systems, and the seductive pull of humanized machines. Her work engages themes of anthropomorphism, caregiving, and the shifting dynamics of human–machine relationships, offering a critical artistic perspective on contemporary AI.

Cecilie also explores alternatives to dominant cloud-based systems in artistic practice by focusing on small language models that can be trained and run locally on devices. She shows how local AI can offer a more transparent, accessible, and democratic approach for artists and developers. This includes her work with edge computing in the large-scale participatory AI artwork *Celestium*, exhibited in space aboard NASA's segment of the International Space Station and accessible to thousands of people on Earth. It also includes her new open-source small-language-model inference engine, *NobodyWho*, which enables creative coders and developers to integrate local LLMs into their own projects and applications for free.

Kim Albrecht

Kim Albrecht, born on a German island in the North Sea, is a Professor of Information Design at the Folkwang University of the Arts. His work explores the intersection of data visualization, technology, and culture, delving into the aesthetic and conceptual dimensions of data. Albrecht holds a BA in Graphic Design, an MA in Interface Design, and a PhD in Media Theory from the University of Potsdam, Germany. His career includes research appointments at the Center for Complex Network Research, Northeastern University, Boston, Massachusetts, under Albert-László Barabási, and at metaLAB (at), Harvard University, with Jeffrey Schnapp, where he served as a principal. He is also a Faculty Associate at the Berkman Klein Center for Internet & Society at Harvard. Albrecht's work bridges teaching, research, and practice, offering new perspectives on how data shapes and reflects contemporary culture.

Artificial Worldviews

Artificial Worldviews is a series of inquiries into the system underlying ChatGPT about its descriptions of the world. Utilizing prompting, data gathering, and mapping, this project investigates the dataframes of artificial intelligence systems.

AI and machine learning methods are often referred to as black boxes. However, this is a trait shared by all living beings: we come to know a person not by examining their brain structures but by conversing with them. The so-called black box is not impenetrable since we can gain an understanding of its inner workings by interacting with it. Through individual inquiries, we can only acquire anecdotal evidence of the network. However, by systematically querying ChatGPT's underlying programming interface, we can map the synthetic datastructures of the system.

In his research, Kim Albrecht methodically requests data about large-scale, indefinable human concepts and visualize the results. These outputs visualize expansive data structures and unusual, sometimes unsettling worldviews that would otherwise be unimaginable.

Nora N. Khan

Nora N. Khan is an independent critic, essayist, curator, and educator. Her writings on the philosophy of AI and emerging technologies is referenced widely across fields. Formally, this work attempts to theorize the limits of algorithmic knowledge and locate computation's influence on critical language.

She is a member of the Curatorial Ensemble of the 2026 edition of *Counterpublic*, one of the USA's largest public civic exhibitions, titled *Coyote Time*. She co-curated with Andrea Bellini the Biennale de L'Image en Mouvement 2024 (Centre d'Art Contemporain Genève). As curator of *Manual Override* at The Shed (2020), she worked on new commissions, in an exhibition that featured major works by Simon Fujiwara and Martine Syms.

She is currently Faculty in Creative Technologies at UCSC, and has served as Arts Council Professor at UCLA in Design Media Arts, History, and Theory faculty at SCI-Arc, and professor in Digital + Media at Rhode Island School of Design, where she was nominated for the John R. Frazier Award for Excellence in Teaching. Her books are *AI Art and the Stakes for Art Criticism* (2026), Seeing, *Naming, Knowing* (2019), *and Fear Indexing the X-Files* (2017), with Steven Warwick.

Imagining Computation: Presence & Absence

This short presentation examines the Connection Machine as a designed proposition about the nature of thinking, and as a model for seriously considering how the visual representation of computation shapes our beliefs about what machines can do and be. As the CM became a generative visual grammar for imagining computation, circulating through film, games, and so on, we'll look at other similarly deliberate aesthetic arguments for framing massively parallel intelligence as radically present, as an object in the world to be considered. Over the last ten years, artists working in direct collaboration with artificial intelligence and machine learning have extended this inheritance in unexpected ways, developing practices that engage the aesthetics, opacity, and presence of computational systems as creative and critical material. Drawing on ongoing work on discernment as a critical methodology, this presentation asks what it means to place these contemporary hybrid practices in conversation with the CM's legacy: how the machine's designed presence opened space for thinking about human-AI collaboration that we are still, productively, working out.

Moderators of the conference

Michael Beigl

Since 2010, Michael Beigl is Professor at the Karlsruhe Institute of Technology (KIT), where he holds the Chair of Pervasive Computing Systems. There he heads the TECO research group and serves as Co-Speaker of the KIT HealthTech Center. From 2012 to 2015, he was Dean of the Faculty of Computer Science. Previously, he was Professor for Distributed and Ubiquitous Systems at TU Braunschweig (2006–2010) and Visiting Associate Professor at Keio University, Japan (2005). From 1996 to 2005, he was a researcher at the University of Karlsruhe, where he received his Dr.-Ing. (PhD in engineering) in Computer Science in 2000 with a dissertation on ubiquitous computing environments. His research focuses on human–machine synergy in ubiquitous computing, combining wearable sensors and devices with firmware, software architectures, and AI models to realize interactive and continuous human-centered services, including health monitoring and adaptive systems. In industrial and applied projects, he works on Health Technology, IoT, applied AI, mobile computing, and Industry 4.0.

Alistair Hudson

Alistair Hudson is the Scientific-Artistic Chairman of the ZKM | Center for Art and Media Karlsruhe. Hudson is a curator and museum director with broad-ranging international experience. He combines contemporary curatorial expertise with a particular focus on the relationship between art, technology, and society. Alistair Hudson's concept of a "useful museum" envisions artistic institutions and cultural institutions as centers of social responsibility and transformation.

After completing his studies in art history and fine art at Goldsmiths' College London, he worked at the Anthony d'Offay Gallery in London (1994–2000), the Government Art Collection (2000–2004), Grizedale Arts (2004–2014), and the Middlesbrough Institute of Modern Art (2014–2018), where he radically reinvented the museum, working with the residents of the city to give it a social purpose. From 2018 to 2022, he served concurrently as director of the Manchester Art Gallery and The Whitworth, University of Manchester, where he was also Professor of Useful Art.

Hanna Jurisch

Hanna Jurisch is a curator, art mediator, and researcher, currently working at ZKM | Center for Art and Media Karlsruhe. She studied art history, media philosophy, and scenography in Heidelberg, Karlsruhe, and León. In her work she focuses on mediating between scientific research in a playful way and with a sociological approach. She co-curated the exhibition *Ulrike Rosenbach. today is tomorrow* (2023/24) and was project manager for the re-enactment of Ulrike Rosenbach's performance *The Lonely Walker* on July 23, 2023, at ZKM. She also worked as a project assistant for the ZKM exhibitions *Aldo Tambellini. Black Matters* (2017), *John Sanborn. Between Order and Entropy* (2022), *Walter Giers. Electronic Art* (2022/23), and *Analivia Cordeiro. From Body to Code* (2023).

Daria Mille

Daria Mille currently works as a curator and research associate at the ZKM | Center for Art and Media Karlsruhe. Her research interests lie at the intersection of new media, art, science, and technology—both in relation to contemporary processes of digital transformation and from a historical perspective. A particular focus of her work is the interplay between artistic practice and technological innovation, for example in the fields of immersive environments and XR (Extended Reality), artificial intelligence, data-driven art, as well as algorithmic and participatory systems. Another area of interest for Mille is experimental practices that conceive of art institutions as agents of change. She investigates institutional strategies that critically question established canons, strengthen diversity and accessibility, and implement more sustainable working and production methods. She has curated large-scale exhibition projects in Germany and internationally, both in physical spaces and in digital environments.

Margit Rosen

Margit Rosen is Head of the Department of Knowledge – Collection, Archives and Research at ZKM | Center for Art and Media Karlsruhe. Her work focuses on the history of digital culture, the preservation of electronic and digital art, and the relationship between art, technology, and society. She has curated and co-curated numerous exhibitions on the history of computer-based art, including *The Algorithmic Revolution* (2004), *bit international* (ZKM, 2008) *Max Bense and the Arts* (2010), *Hiroshi Kawano. The Philosopher at the Computer* (2011), *The Algorithm of Manfred Mohr* (2013), and *Waldemar Cordeiro. Constellations. From Concrete Art to Computer Art* (2025). She has published widely on the history of computer art, including the edited volume *A Little-Known Story About a Movement, a Magazine, and the Computer's Arrival in Art* (MIT Press, 2011). She has held guest professorships at the University of Fine Arts Münster, the Università degli Studi di Milano, and the Central Academy of Fine Arts (CAFA), Beijing.

Tamiko Thiel → see page 20

Photo credits

Natalie D Kane: Photo: Lily Bertrand
Sarah Ciston: Photo: Paige Zangoglia
Tiara Roxanne: Photo: Augustin Farias
Kim Albrecht: © Photo: ECDF/PR/berlin-eventfotograf
Nora N. Khan: Photo: Alexa Viscius
Alistair Hudson: Photo: Marvin Systermans
Michael Beigl: © Photo: KIT
Hanna Jurisch: Photo: Nis Petersen
Daria Mille: Photo: Andreas Friedrich
Margit Rosen: Photo: Felix Grünschloß

Imprint

Conceived and developed by: Michael Beigl, Alistair Hudson, Daria Mille, Tamiko Thiel

Project assistance: Hanna Jurisch

Event: Viola Gaiser, Wolfgang Knapp, Henning Möller, Lucia Stockinger

Video studio: Moritz Büchner, Max Clausen, Seline Herzog, Andy Koch, Marcus Thiel, Christina Zartmann

Communication and marketing: Marlen Ernst, Angela Fritz, Sebastian Klein, Franziska Klöck, Lilli Roser

Copy editing: Gloria Custance, Daria Mille

Graphic design: Sascha Fronczek

Many thanks to: Mira, Hirtz, Hosna Karnama, Sasha Meyer Clara Runge, Dominique Theise, Almut Werner, ZKM-Shop and Information Desk.

ZKM Board: Alistair Hudson (CEO) and Holger Neinhaus (COO)

Head of administration: Boris Kirchner

ZKM Center for Art and Media Karlsruhe

ZKM | Center for Art and Media Karlsruhe
Lorenzstr. 19, 76135 Karlsruhe, Germany
+49 (0)721/8100-1200
info@zkm.de, www.zkm.de

Access the live stream here:

In cooperation with

KIT MIT MUSEUM

Supported by

Baden-Württemberg
Ministerium für Wissenschaft,
Forschung und Kunst

JÜLICH Forschungszentrum | JÜLICH SUPERCOMPUTING CENTRE

Founders of ZKM

Baden-Württemberg
Ministerium für Wissenschaft,
Forschung und Kunst

Karlsruhe

Partner of ZKM

EnBW