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10
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SCIENCE
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LAB





Content

SCIENCE VISUALIZATION HOW IT ALL BEGAN by Alfred Vendl	5
INTERMEZZO ORIGINAL IMAGES by Stephan Handschuh, Thomas Schwaha and Manfred Walzl	35
SCI VIZ LAB TEN DYNAMIC YEARS Celebration and Outlook! by Martina R. Fröschl	41



SCIENCE VISUALIZATION

HOW IT ALL BEGAN

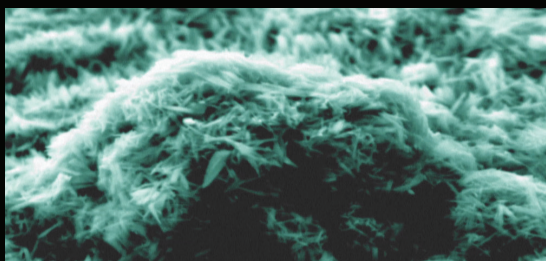
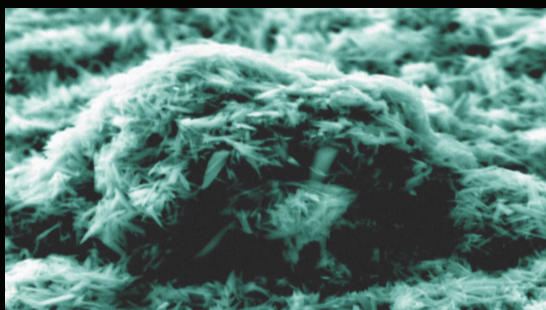
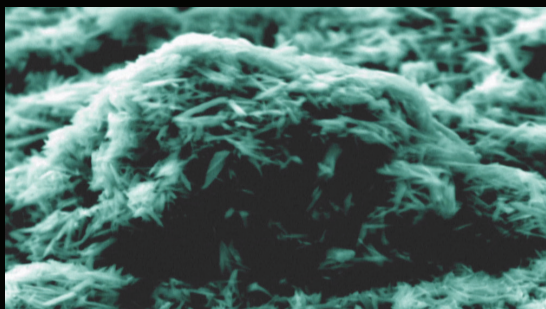
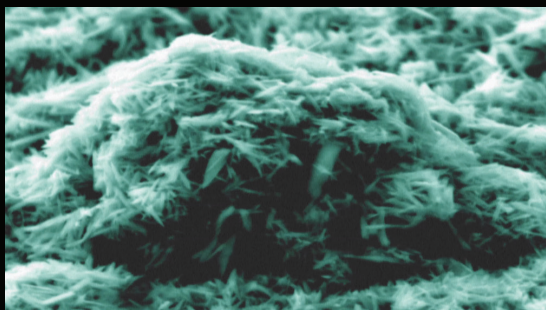
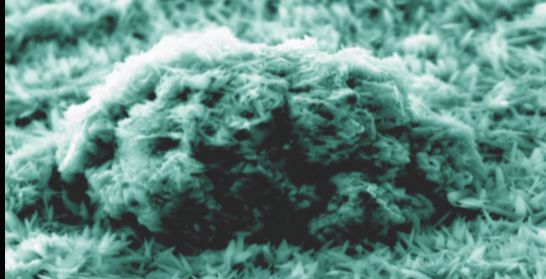
In the beginning there was the
UNIVERSUM...

...or at least the television program strand of that name, which was founded in the late 1980s at **ORF** (Austrian Television). The goal was to use documentary films of the highest visual quality to introduce a broad audience—once a week, during prime time—to the secrets of natural phenomena in an appealing, almost indulgent way. The motto was “smuggle knowledge in,” meaning to seduce viewers into learning. The role models at the time were BBC nature documentaries and productions by American broadcasters such as National Geographic and Discovery, which present the genius of nature at the highest visual standard.

Initially, the documentaries from these broadcasters were aired in the newly founded program strand. In 1990, I was commissioned—through a company for which I had already worked in a leading role as cinematographer, director, and author on several sports and cultural documentaries—to produce the first nine Austrian productions. Among them was a **film about a meteorite, whose impact on Earth was to be depicted using 3D animation.**

At that time, however, 3D animation was still in its infancy, based on analog film techniques using single-frame processes.

As head of the Chair of Technical Chemistry at the University of Applied Arts Vienna (“die Angewandte”), I was located in the same building as the newly established Master Class for Digital Art, led by Peter Weibel. Contact with the Master Class led to several students taking on the digital production of the 3D animation of the meteorite impact—the **first digital 3D animation within the framework**

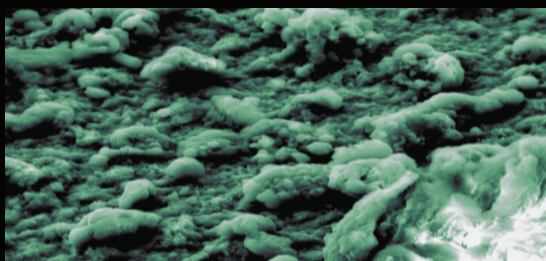
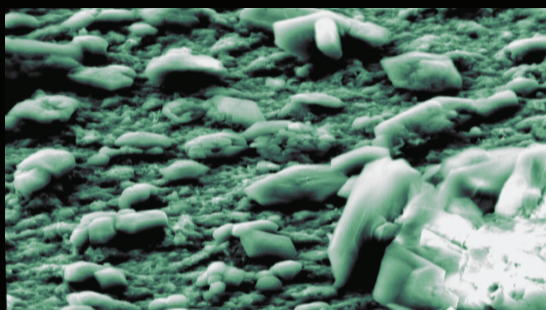
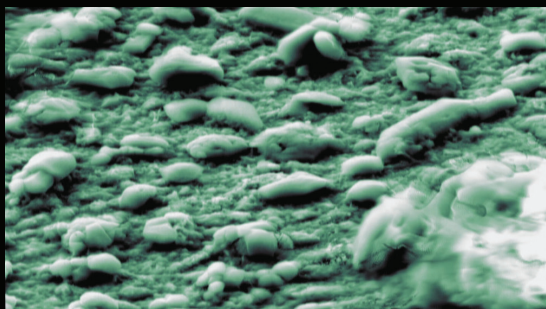
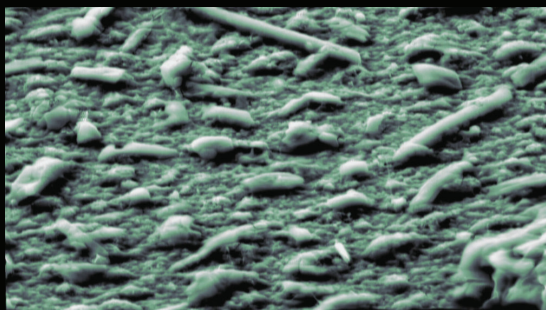
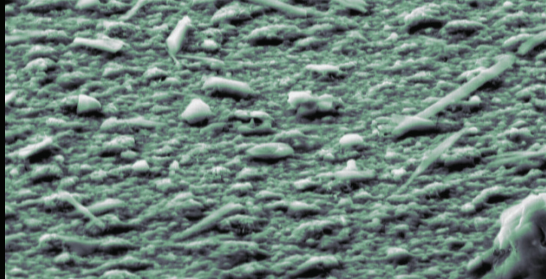


of Science Visualization. The Visualization Team back then consisted of Liam Forster, Max Kossatz, Christine Meierhofer and Michael Huber. The scientific supervisor was Christian Köberl and graphics were added by Vinzenz Horvath and Donna Jalufka. The computing power available at the time was sufficient only to render half of the meteorite—that means the meteorite was simply assembled from two identical halves. At the resolution available then, the seam was hardly noticeable anyways.

Up to that point, my work at the University of Applied Arts Vienna had been devoted entirely to research and teaching in materials science within cultural and artistic contexts. I had been appointed professor and head of Technical Chemistry ten years earlier, a department often described as the “primordial cell” of Angewandte. The term reaches back more than 150 years, to a time when a chemical laboratory was incorporated into the newly founded Museum of Applied Arts. Its purpose was both practical and visionary: to give artists direct access to a materials chemist who could help translate artistic ideas into physical form. From this original laboratory grew the School of Arts and Crafts, which, over many stages and a century and a half later, eventually became today’s University of Applied Arts Vienna.

PROTECTIVE GREEN

An important task emerged from a long-standing problem: heavy metal ions were being washed into the soil, causing increasing soil contamination. This happens especially when copper and bronze are used for roofs and other metal building elements. Normally, copper develops a protective green layer. This natural patina protects the metal from corrosion and prevents metal ions from being washed



away by rain and acid rain. For centuries, this patina formed only under very specific air conditions, involving the pollutants sulfur dioxide and nitrogen oxides.

In recent decades, sulfur dioxide levels in the air have decreased, while nitrogen levels have increased. This change has disturbed the balance needed for natural patina formation, making it much harder today for a stable green patina to develop on copper surfaces. Under the leadership of Bernhard Pichler, a project was launched to **create an artificial patina that matches the natural composition of brochantite** and provides the same protective effect.

This was only possible through microscopic visualization. Using a **scanning electron microscope (SEM)**, Rudolf Erlach observed the growth of the patina in extremely small steps over long periods. Stefan Fischer then digitally combined these images into film sequences. This made it possible to closely monitor the growth of the green protective layer and to achieve the correct final patina structure. Worldwide, this was the first time that material changes within a defined micro-area were recorded and combined into film sequences over long periods using SEM single-frame techniques.

The success of this method can be seen at the Church of St. Leopold at Steinhof. The artificially created green patina on the dome has withstood weather and acid rain for many years without any metal runoff.



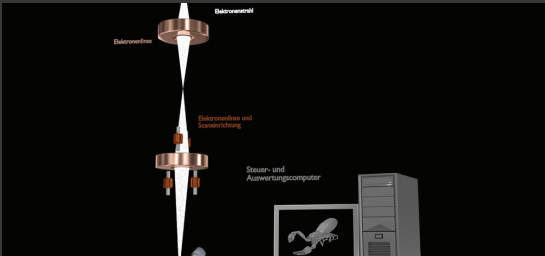
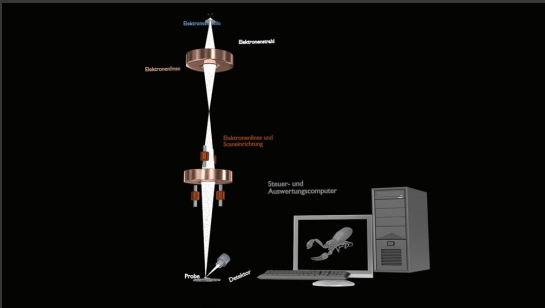
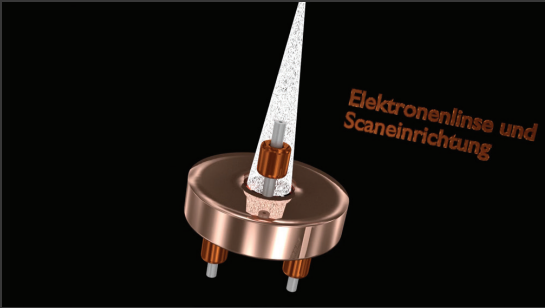
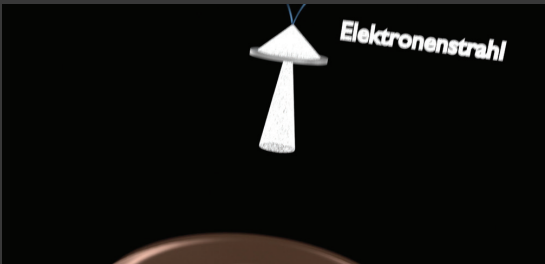
MONSTERS FROM THE MICROWORLD

As indispensable as the visualization of material microstructures is for analysis and research, diving into the microworld of life surrounding us is equally fascinating. Around 80 percent of our knowledge comes through our sense of sight—yet only a small fraction of the world and its secrets is directly visible to us.

“If the doors of perception were cleansed, everything would appear to man as it is, infinite,” wrote the mystic William Blake in the 18th century. The infinity he envisioned is today increasingly visualizable with technical assistance—from the vastness of the universe down to atoms.

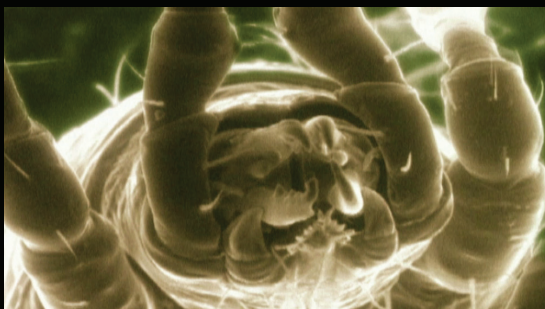
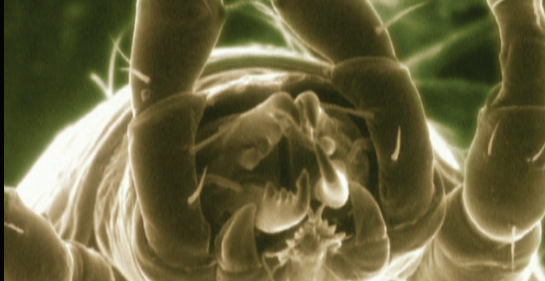
In the early 1990s, we were able to acquire the first Environmental Scanning Electron Microscope (ESEM), which allowed electron microscopic investigations at near-atmospheric pressure, through a special arrangement. The manufacturer provided the device at a greatly reduced cost on the condition that researchers from other disciplines would have access to it at any time. This was particularly interesting for biologists, as it allowed living organisms to be observed directly under the electron microscope. This led Manfred Walzl, a professor at the Department of Life Sciences at the University of Vienna, to join our team. With his support, we were able to **create exceptional images of living micro-animals, such as mites**. These images attracted international attention.

Single frames taken during the animals' movement were then digitally combined into short film sequences, making the motion visible. As a trained materials scientist, the support of visualization techniques had always accompanied my work



from the very beginning. During an extended research stay at Imperial College London, I came to appreciate the importance of the scanning electron microscope as a means of visualizing material microstructures.

The secrets of a material reveal themselves only through close examination of its microstructure, which ultimately determines the material's properties. **The acquisition and use of a scanning electron microscope (SEM) in the early 1980s therefore marked the first step toward *Science Visualization*** at the Angewandte. Initially, the most important field of application was the investigation of material states in cultural objects, primarily as preparation for conservation and restoration measures.



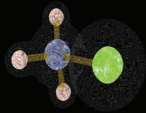
A QUANTUM LEAP IN UNDERSTANDING

Every educator aims to convey subject matter as clearly as possible. The visualization of complex natural processes—as taught through physics, chemistry and biology—offers a quantum leap in learners' understanding. Accordingly, we repeatedly collaborated with Stefan Fischer to produce **supplementary visualizations for teaching video content supported by the Austrian ministry of education (see the following pages).**

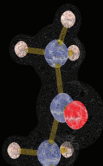
Many master's theses by conservation students were enhanced with explanatory video sequences, such as **the visual reconstruction of the Jupiter Dolichenus triangular tablet from Traismauer (page 17)**, or Late Roman hollow glass from Enns (Lauriacum). In addition, **instructional films on atomic and molecular structures were produced (page 16)**, along with interactive visualizations of chemical and physical processes. **3D animations explaining the functioning of complex instruments, such as SEM (page 12)** and ESEM, helped students better understand the investigative techniques used.

Finally, at the invitation of Gerhard Banik—Professor and Head of Paper Conservation and Restoration at the State Academy of Fine Arts Stuttgart—we provided explanatory 3D animations on the effects of water on paper for a book edited by internationally renowned experts on the subject. The global problem faced by libraries regarding water damage to paper could thus be presented visually and more easily understood. Visual teaching materials were also produced for universities in Germany.

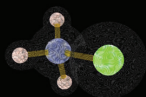
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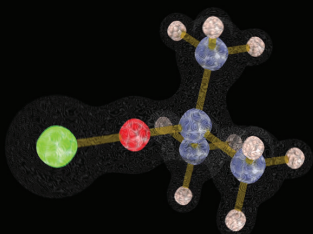
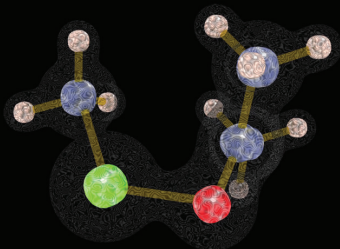
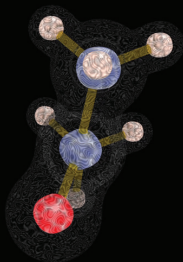
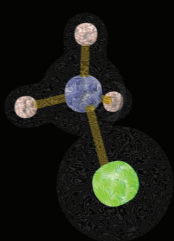
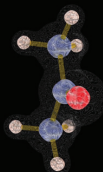
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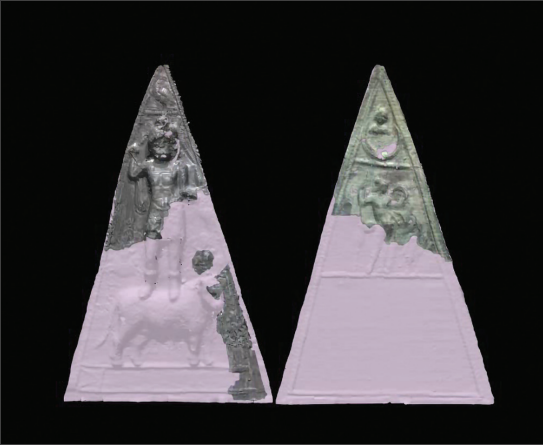


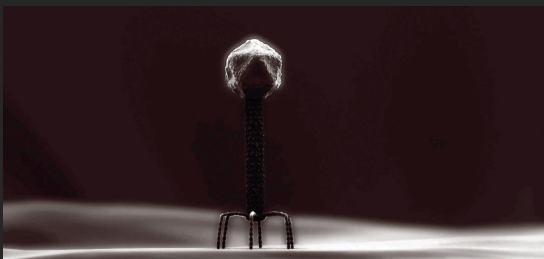
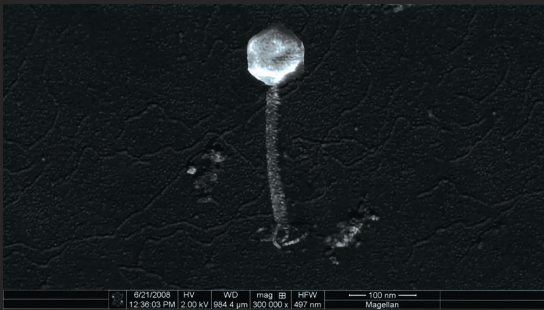
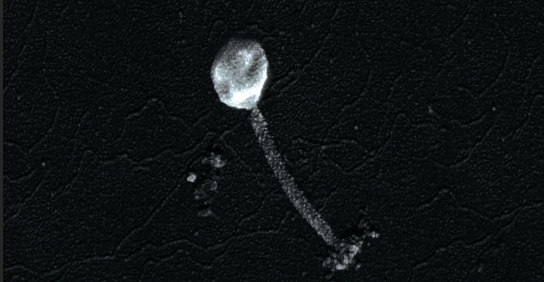
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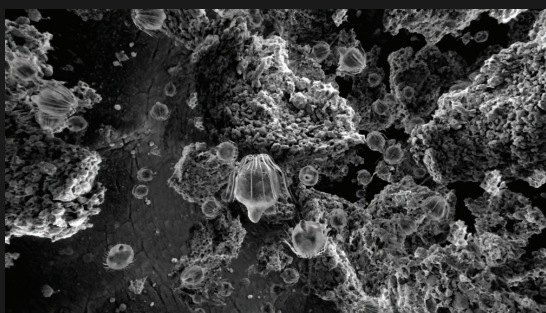
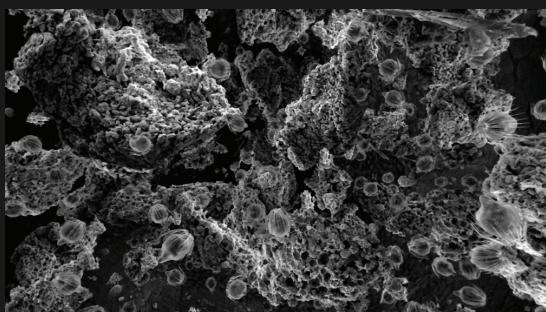
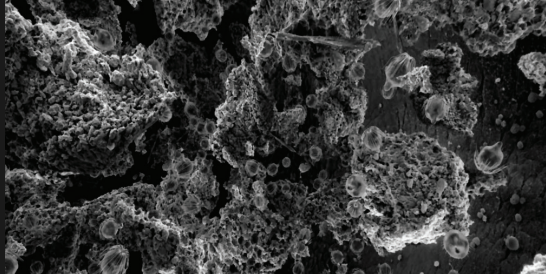


BACK TO THE UNIVERSUM

In the 1990s and 2000s, I produced numerous documentaries as international co-productions with European and American TV networks. In Austria, they were broadcast in the *UNIVERSUM* program strand. Internationally, my productions aired on networks such as ZDF, Canal+, the BBC, Smithsonian and Discovery Channel. In these productions, 3D animation was always an essential component.

During this time, I met Reinhold Fragner, a specialist in 3D animation, and his team at Industrial Motion Art GmbH created many 3D animated sequences for my film productions. The team also included Martina Fröschl, who is now head of the Science Visualization Lab at the Angewandte. I was able to bring Reinhold Fragner to the university as a lecturer in digital animation techniques.

This collaboration resulted in several 3D animation projects, including ***Attack***. The film shows an **attack of specialized viruses, so-called T-phages**, on *E. coli* bacteria. All protagonists shown are based on real electron microscope images produced using SEM or ESEM and are therefore authentic representations: an original microscopic glimpse into the living microworld.



Our “Science Visualization Group,” consisting of Rudolf Erlach (SEM), Stefan Fischer (digital animation), Manfred Walzl (micro-organisms), Reinhold Fragner (specialized 3D animation of living organisms) and myself as project coordinator and director, was soon joined by two additional biologists from the University of Vienna: Stephan Handschuh and Thomas Schwaha. The newly introduced techniques of micro-computed tomography (micro-CT), confocal laser scanning microscopy (CLSM) and serial section based reconstruction made it possible to capture original data from micro-organisms to create authentic 3D models, which were then animated in a subsequent step.

For the film ***The Impossible Journey Through a Wood Termite***, micro-CT was used to obtain the data required to construct an authentic 3D model of a wood termite. What was still missing with this method, however, were the microstructures of the depicted tissues. These microstructures therefore had to be recorded for each individual tissue of the termite using SEM and visualized at the appropriate micro-scale. Once the tissue images were integrated into the micro-CT model, a fully authentic 3D overall model became available.

Once again, our group achieved a world first by combining original electron-microscopic and micro-CT-based models of living organisms with 3D animation techniques.

The resulting animated 3D visualization takes the viewer on an extraordinarily fascinating and **authentic journey through the entire complex digestive tract of a wood termite.**



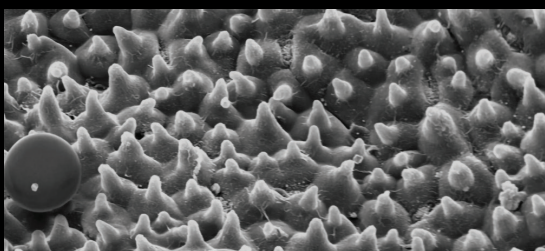
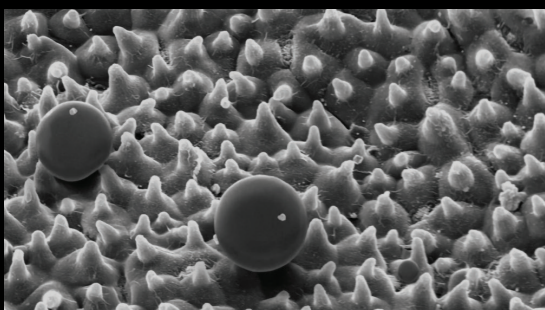
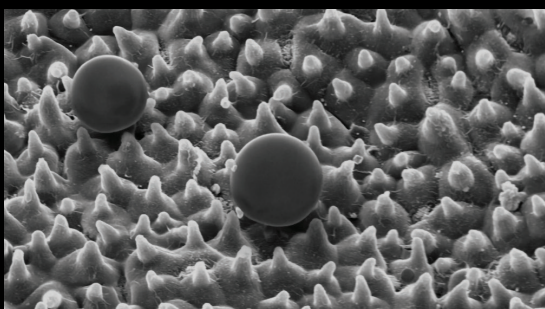
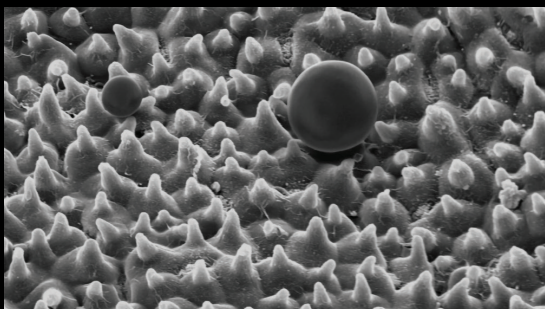
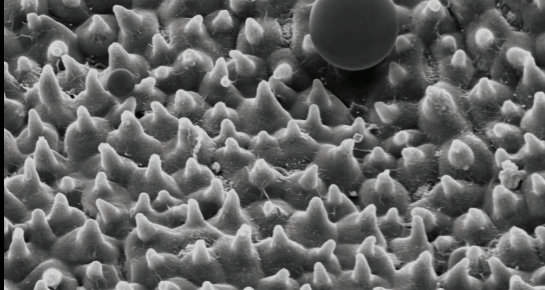
Another project using similar micro-CT and CLSM workflows was ***Tardigradia - Wild Little World***. **Main protagonist is a tardigrade or water bear.** These tiny “survival artists,” which live in small cushions of moss, can reduce their life functions to zero. They can essentially stop all signs of life—and then, after a chosen period of time, come back to life again.

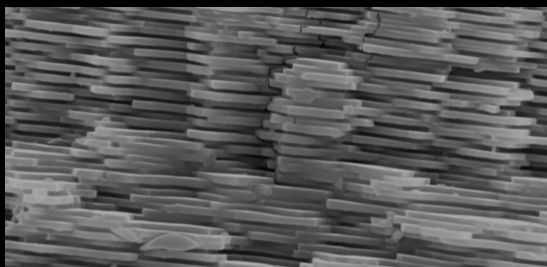
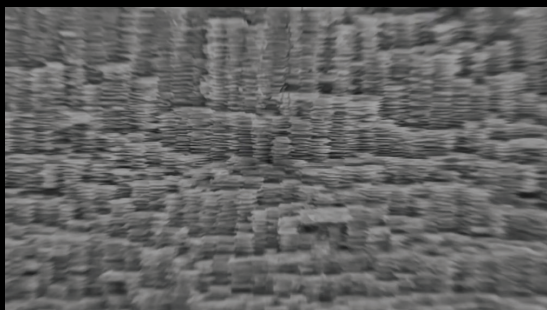
This allows them to survive long stretches in a kind of suspended animation, for example during long space journeys to distant stars. For this reason, these tiny organisms are of great interest to space research.

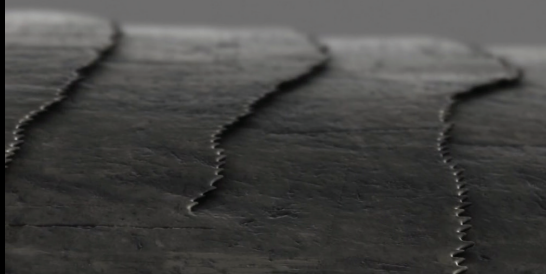
The short film about water bears charmed the audiences and got several awards. I did produce the elaborate short film and it was an effort by many people:

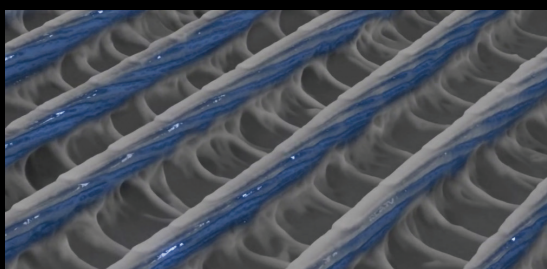
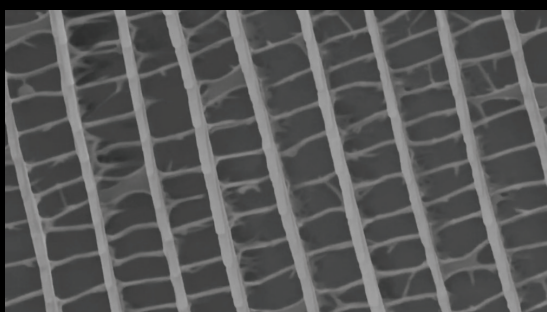
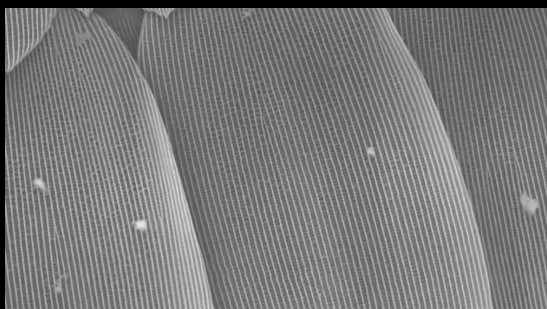
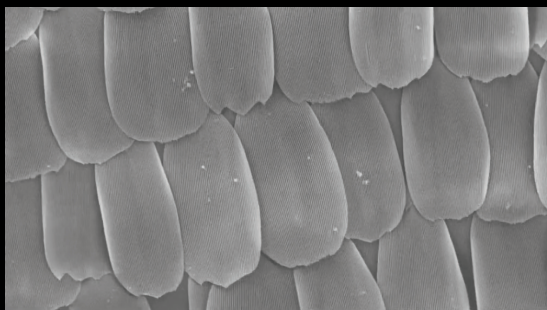
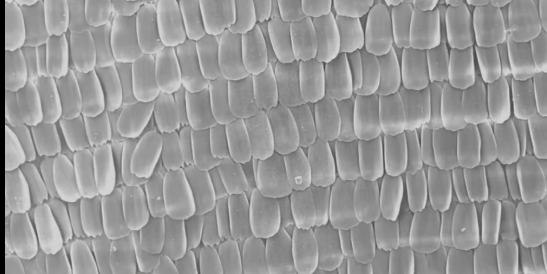
Reinhold A. Fragner, Martina R. Fröschl, Mason Doran, Simon Richter, Elisabeth Broneder, Anna Celarek, Manfred Walzl, Ingemar Jönsson, Rudolf Erlach, Thomas Schwaha, Stephan Handschuh, Denis Georgiev, Snezana Cubrilovic, Dustin Kimnich, Bernd Dormayer, Hubert Weninger, Lauren Cooke, Oliver Vendl, Christoph Staber, Ben Lutz, Andreas Siboni, Martin Hebestreit, Nenad Mitrovic, and Dunja Bernatzky.

And it was a collaboration by the institutions University of Applied Arts Vienna, University Vienna, Industrial Motion Art GmbH and my company AV Dokumenta.











In 2015, the American philosophical filmmaker Terrence Malick, Academy Award winner and recipient of the Palme d'Or at Cannes, was looking for authentic 3D-animated models of micro-organisms for his project *Voyage of Time*.

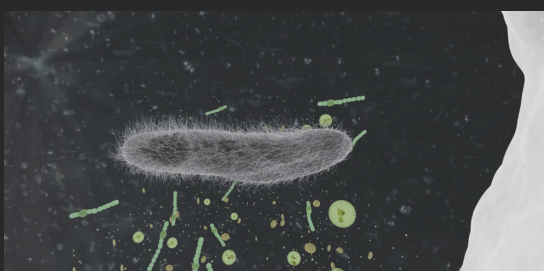
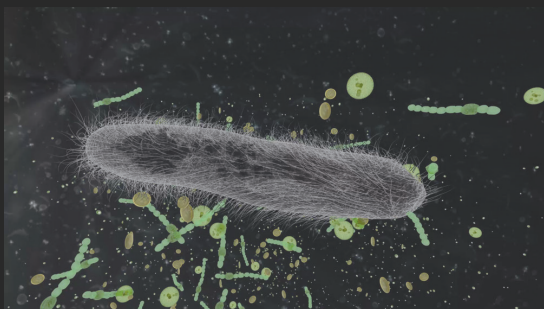
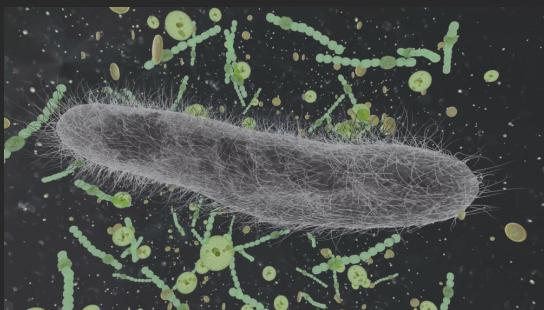
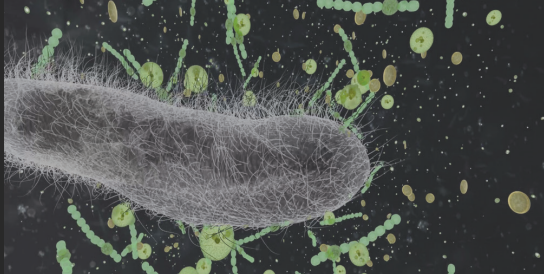
By then, the technique we had developed, combining electron microscopy and micro-CT-based models with subsequent 3D animation, had gained international recognition. This was certainly aided by the TV series NatureTech, produced using our method, which won the American Emmy Award in 2008.

We were therefore invited by the director to create authentically accurate micro-models of living organisms and bring them to life using 3D animation. Three of these original models: **a cyanobacterium (page 32), a paramecium (page 30), and an amoeba (page 28)**—captured via serial section reconstruction and transmission electron microscopy by Stephan Handschuh, Thomas Schwaha, and Martin Glösmann and animated by Martina R. Fröschl, were provided but we kept all the rights.

Several years earlier, I had met the artist Victoria Vesna in Los Angeles, she was director of the Art|Sci Center and professor at UCLA (University of California, Los Angeles).

In 2015, she planned a scientific-artistic project addressing the problem of increasing underwater noise pollution in the oceans, using fish as an example. I suggested using plankton organisms—the smallest level of life in our world—as representative affected organisms.

The first plankton models were the very organisms we had already 3D-animated: cyanobacterium, paramecium, and amoeba. Thus, the joint project *NOISE AQUARIUM* was born.

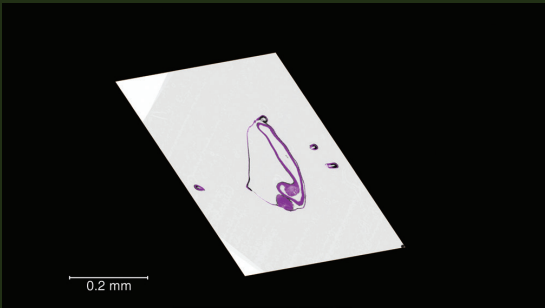
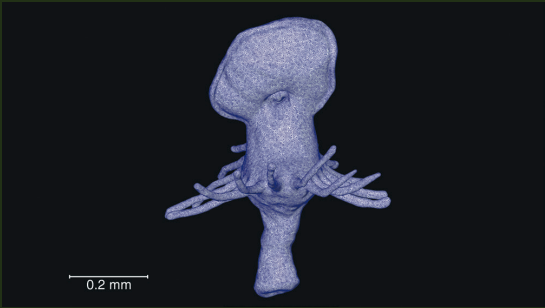
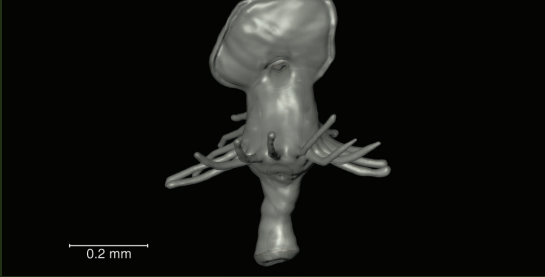


In 2016, following a proposal by Rector Gerald Bast and with strong support from Ruth Schnell, then head of Digital Arts department at the Angewandte, the Science Visualization Lab was founded and Martina R. Fröschl was appointed as animation expert.

I had the privilege of building and co-directing the Science Visualization Lab together with Martina R. Fröschl until 2023. Since then, the lab has been led by her.

Alfred Vendl, 2026

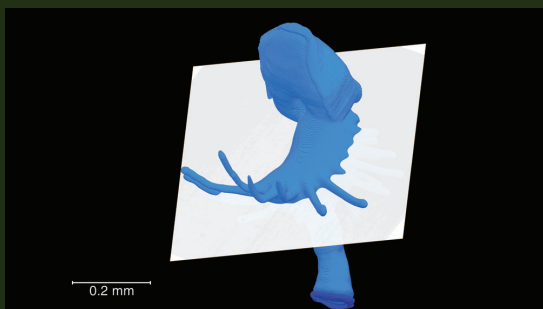


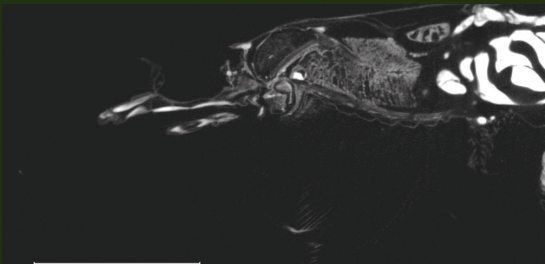
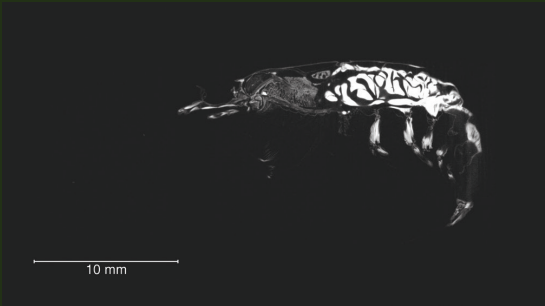
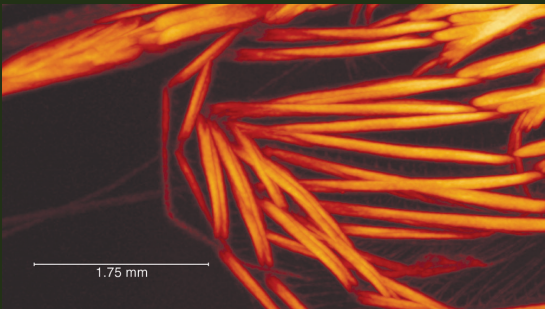
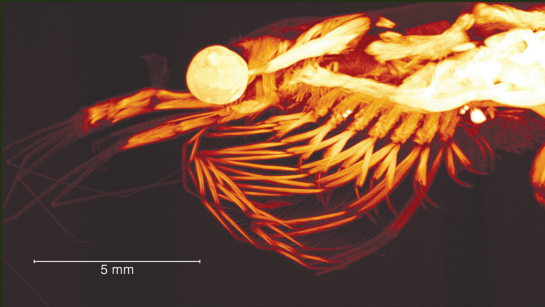


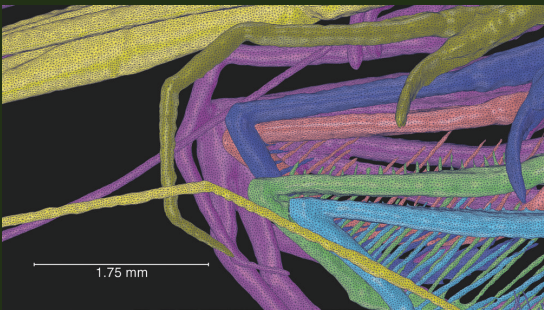
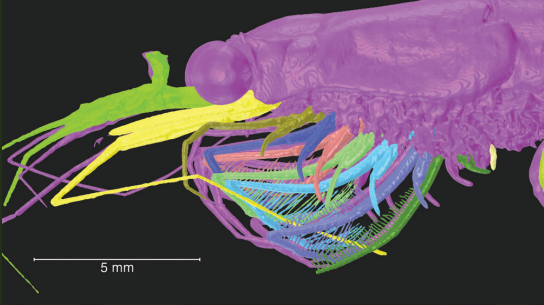
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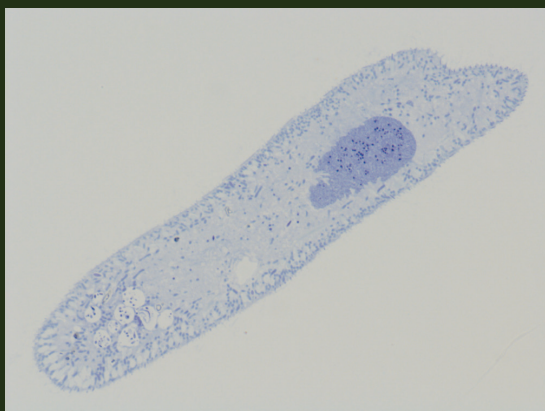
ORIGINAL IMAGES

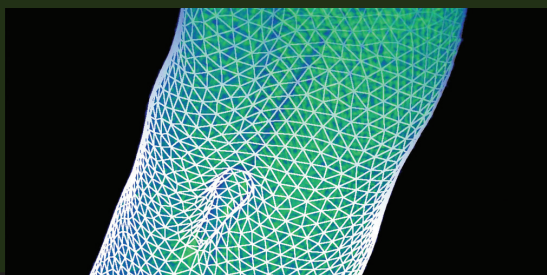
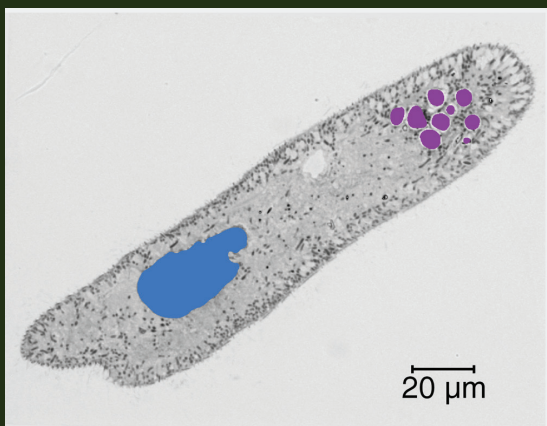
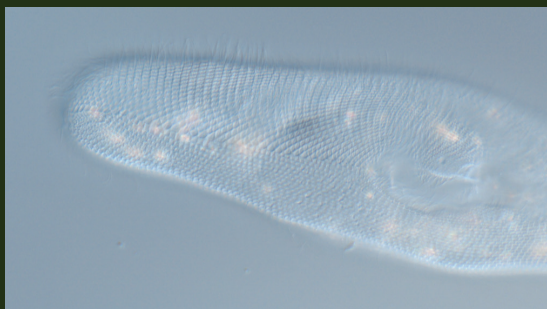
by Stephan Handschuh, Thomas Schwaha
and Manfred Walzl













di:'angewandte

Universität für Angewandte Kunst Wien
University of Applied Arts Vienna

AUSSTELLUNGSERÖFFNUNG:
DIENSTAG, 11. NOVEMBER 2014
18:30 UHR

BEHIND THE CURTAIN

AUSSTELLUNGSZENTRUM DER UNIVERSITÄT FÜR ANGEWANDTE KUNST WIEN
HEILIGENKREUZER HOF / REFektorium
SCHÖNLATERNGASSE 5 / STIEGE 8 / 1. STOCK
1010 WIEN

AUSSTELLUNGSDAUER
12. – 28. NOVEMBER 2014
ÖFFNUNGSZEITEN
MO – SA: 14:00 – 19:00 UHR

www.dieangewandte.at
pr@uni-ak.ac.at

Science Visualization
das Unsichtbare sichtbar machen

SCI VIZ LAB

TEN DYNAMIC YEARS

CELEBRATION AND OUTLOOK!

Through my work on visual effects for several film productions and through my doctoral studies since 2013, I contributed to an exhibition at Heiligenkreuzerhof, University Gallery of University of Applied Arts with the title ***BEHIND THE CURTAIN—Science Visualization—make the invisible visible*** in 2014.

In 2016, I joined the University of Applied Arts Vienna as a staff member. There, I began creating animations and visual effects full time, while exploring how these works could operate across disciplines and reach diverse audiences. At the same time, Alfred Vendl founded the Science Visualization Lab—it continues a more than 150-year-old tradition: just as the University once established a chemistry laboratory to develop new materials for the School of Arts and Crafts, the Science Visualization Lab became a space where experimentation, artistic practice and scientific inquiry come together. A place where ideas and scientific input is made visible and tangible.

2016 – FOUNDATIONAL YEAR

The work began with videos based on detailed movement studies and simulations of Amoebidae. Over time, the focus expanded to *Paramecia* and cyanobacteria such as *Cylindrospermum*. The project *The First Greed* (2016) was part of this development. The scientific imaging data and reference videos were contributed and explained by Manfred Walzl, Thomas Schwaha and Stephan Handschuh. **The invitation from Victoria Vesna to speak at a**



[HOME](#) [ABOUT US](#) [SPEAKERS](#) [PROGRAM](#)



VIS MATTERS 2017

Visualisation Matters 2017 is designed to inspire audiences and demonstrate how art, science, design and engineering can be closely connected through visual creativity.



LASER (Leonardo Art Science Evening Rendezvous) event at CNSI (California NanoSystems Institute) and her Art|Sci Center were important inspirations for interdisciplinary projects. There is a plethora of labs similar to the Science Visualization Lab, but its distinctive feature lies in the integration of scientific imaging data into computer animation.

2017 – GENES AND PLANKTON

In 2017, ***NOISE AQUARIUM*** (2016) gained momentum and the *Noise Aquarium Collective* was founded: Victoria Vesna and Alfred Vendl as main art and science leads, me as computer animator, biologists Stephan Handschuh and Thomas Schwaha, programmer Glenn Bristol, sound producer Paul Geluso and a huge support of Ruth Schnell made the project possible—see more on the project's website: www.noiseaquarium.com

In the framing of *International Spring University CAX: Dimensions of Computer-Aid in Architecture, Biological Sciences, Design and Medicine at Interdisziplinäres Labor Bild Wissen Gestaltung, Exzellenzcluster der Humboldt-Universität*, University of Berlin, immersive 3D audiovisual approaches to visualize plankton in polluted environments and connecting environmental concerns with computational design were explored. In Australia, ***NOISE AQUARIUM*** was presented in Sydney at the ***Vis Matters conference*** at EPICenter UNSW Art & Design invited by June Kim and Tomasz Bednarz, and earlier that year at the QUT Cube in Brisbane—one of the world's largest immersive visualization spaces, it was a challenge to transfer the 8k video across the globe.

CRISPR-Cas9/NHEJ: Action in the Nucleus (2017) began as a production for the former full-dome of the Digital Arts department. It was shown



di: **Angewandte**

Universität für angewandte Kunst Wien
University of Applied Arts Vienna

SYMPOSIUM

Fluid Visualisation and Sound Matters: Bridging Art, Science, and Visualisation

July 6, 2017

14:00-14:15

Welcome

Gerald Bast

Rector, University of Applied Arts Vienna

14:15-14:30

Fluid Visualisation and Sound Matters

Ingeborg Reichle

Department of Media Theory, University of Applied Arts Vienna

14:30-15:00

From Liquid to Solid and Back

Reiner Maria Matysik

Department of Design, University of Art and Design, Halle (Saale)

15:00-15:30

The Sea Around Us

Pinar Yoldas

Penny W. Stamps School of Art and Design,

University of Michigan, Ann Arbor

15:30-16:00

Aquatocene — Subaquatic Quest for Serenity

Robertina Sebianić

Artist, Ljubljana

16:00-16:15 Coffee Break

16:15-16:45

Life in Plankton: Study Methods and Diversity

Thomas Schwaha

Department of Integrative Zoology, University of Vienna

16:45-17:15

From Images to Models: Using 3D Imaging Techniques for Generating
Accurate Models of Microscopic Animals

Stephan Handschuh

VetCore Facility for Research, University of Veterinary Medicine Vienna

17:15-17:45

NOISE AQUARIUM Visualisation

Martina Fröschl and Alfred Vendl

Department of Digital Art, University of Applied Arts Vienna and Department
of Digital Art (Science Visualization Lab), University of Applied Arts Vienna

17:45-18:00 Coffee Break

18:00-19:00 Keynote

Minding the Macro-Micro BioMe

Victoria Vesna

Director, UCLA Art Sci Center, Department of Design Media Arts,
University of California, Los Angeles, and Visiting Professor at the
universities of Tsukuba and Linz

Venue:

Angewandte Innovation Lab (AIL),

University of Applied Arts Vienna

Franz-Josefs-Kai 3, 1010 Vienna

as part of the University of Applied Arts Vienna's 150th anniversary exhibition in the **Future Room** installation by Ruth Schnell at the MAK Vienna, framed by a philosophical, speculative text by Ruth Schnell, Gerald Bast, Martin Kusch and Peter Weibel.

Because the computer animations developed for the project were technically and visually novel, the work was later presented at SIGGRAPH 2018. A stereoscopic version was also produced to adapt the piece to different exhibition and screening contexts. To ensure scientific accuracy, collaborations were established with Renée Schroeder and Krzysztof Chylinski. This made it possible to base the animations on verified datasets from the public database wwPDB and on the current state of scientific knowledge at the time.

Singapore became another key place in 2017. Screenings and talks at Nanyang Technological University, including the **Media Art Nexus Screens** invited by Ina Conradi and Mark Chavez and the Art & Heritage Museum, were accompanied by a conference contribution on hybrid methods developed in collaboration between UCLA Art|Sci Center and the Science Visualization Lab.

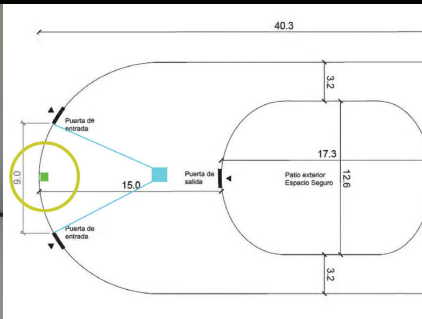
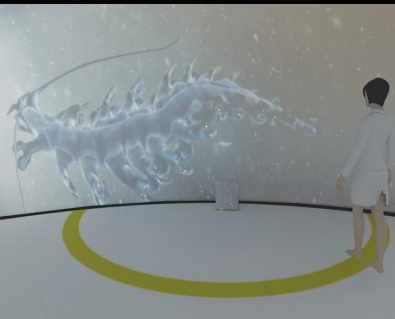
In Vienna, the microorganisms workflow was presented at the symposium **Fluid Visualisation and Sound Matters** at the University of Applied Arts Vienna, foregrounding the integration of fluids, sound, data and ecology.

In autumn, I was invited to the Blender Conference to give a talk about my scientific visualization workflow titled: *Microscopic 3D data processing in Blender*. In terms of my long-time support of the Blender community and open-source projects, it was a very distinct honor.



The PASEO Festival
September 14-15, 2018

SPACE CLOUD



Actinotrocha, die Larve der marinen Hufeisenwürmer, ist einer der Protagonisten der interaktiven Installation „Noise Aquarium“. Wie Plankton von der zunehmenden Lärmverschmutzung bedroht ist, wird dabei anschaulich gemacht.

Plankton leidet unter Lärm in den Meeren

Die marine Nahrungskette beruht auf Plankton. Doch die winzigen Meeresbewohner sind extrem gefährdet. In der Installation „Noise Aquarium“ kann man ihr Leben und Sterben hautnah miterleben.

Doris Grösser

Was Plankton ist, weiß fast jeder so ungefähr. Aber Delfine, die vor den Schallwellen fliehen, die Orientierung verlieren sinkt – wie in der realen Welt bei Lärm – tot auf den Meeresgrund. struiere ich dann die 3D-Modelle“, erklärt die Mediendesignerin zum Leben erweckt. Ihr Favorit unter all diesen spektakulären Er-

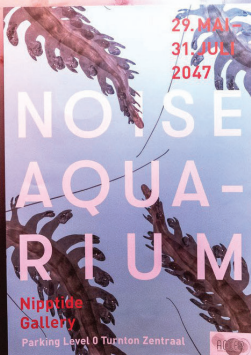
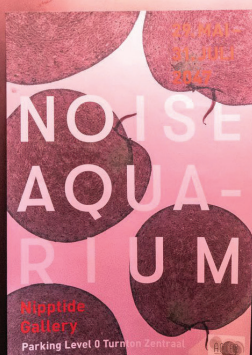
2018 – TRANSLATING THE INVISIBLE

In 2018, a major focus was on communicating complex scientific processes related to CRISPR/Cas9. The visualizations were presented at international conferences and research meetings—from SIGGRAPH in Vancouver to the ISMST (International Society for Medical Shockwave Treatment) Basic Research Meeting in Bologna, where I was invited to present a visualization of cells. The CRISPR animation was also shown in public formats, including the Long Night of Research in Vienna.

In May, another dedication to medical visualization was the organization of Medical Visualization Focus Day with guests from AKH Vienna, Medical University Vienna and the the Fraunhofer Institute for Digital Medicine MEVIS at the old location of the Science Visualization Lab plus a lecture room from the conseration institute at Salzgies. Also, I was invited to give a talk at the Under the Radar Animation Symposium titled: *Narration in Scientific Visualizations of the Science Visualization Lab Angewandte* at Museumsquartier in Vienna.

The **NOISE AQUARIUM** continued to evolve as an interactive installation and was shown for the first time in strongly immersive environments, becoming available as both augmented reality and virtual reality experiences. Presentations in the **Deep Space at Ars Electronica in Linz** invited by Gerfried Stocker and at the **PASEO Festival in Taos, New Mexico**, curated by Agnes Chavez, shifted the work toward embodied experience, spatial sound, and non-linear narration. Visitors were no longer positioned as observers, but became part of a performance unfolding within the space. This phase was accompanied by lectures and focus events addressing narration in scientific visualization and the role of aesthetics in knowledge production.

NIPPTIDE GALLERY



18. bis 8.9. 2019

Nika Schmitt LUX	Ludwig Berger I/CH	Noise Aquarium USA/A
Ecologias Sonoras BR/RCH/CH	12 Sound-installationen im Hochmoor von Gais AR	

klangmoorschopfe.ch



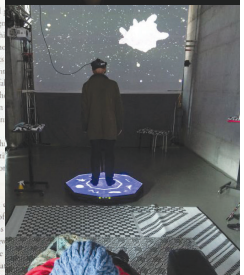
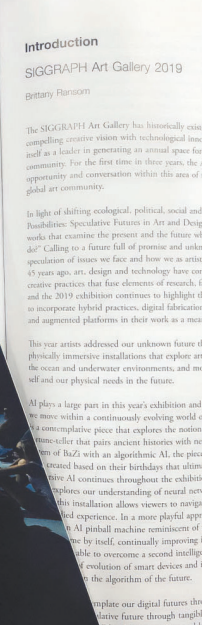
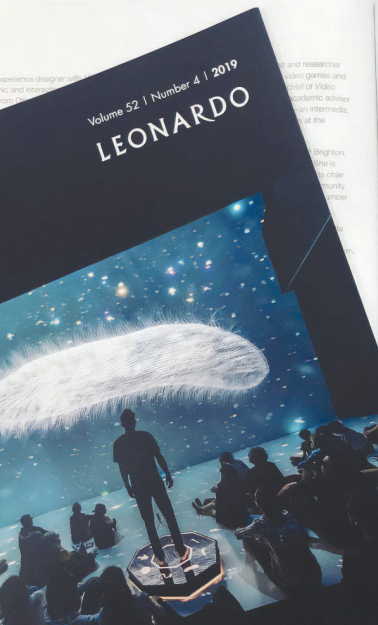
2019 – THE LAB IN MOTION

In 2019, projects *NOISE AQUARIUM* and the scientific visualizations around CRISPR/Cas9 moved beyond the framework of individual installations and began to unfold as mobile, context and location sensitive systems.

Early in the year, *CRISPR/Cas9-NHEJ: Action in the Nucleus* was shown in planetariums and exhibition halls in the United States and Australia. Scientific content was not presented in a didactic manner, but made spatially and physically experienceable, allowing visitors to engage with molecular processes through immersion.

As early summer progressed, the focus increasingly shifted toward ecological questions. ***NOISE AQUARIUM* became part of the first Biennale of Change Vienna in an exhibition of AIL (Angewandte Innovation Lab) and integrated into the exhibition Turnton 2047 by the artist collective Time's Up.** Over extended periods, the work was activated through conversations, guided tours, mediation formats and performances, for instance a performance by Lucie Strecker with our 3D printed plankton models, KinderuniKunst workshops held by Victoria Primus, an XRVienna Meetup or an exhibition tour focusing on computer animation in Blender.

Late summer brought a dense sequence of international presentations: at the **SIGGRAPH Art Gallery in Los Angeles**, as an augmented reality work in Pula and as an immersive installation at the **Klang Moor Schopfe Festival in Switzerland**. The shift between contexts—from convention centers to a sensitive moor landscape—not only changed how the work was perceived, but also sharpened awareness of environment, sound and materiality. In autumn, these experiences culminated in more



discursive formats. We received the **RAW SCIENCE FILM FESTIVAL** award, and our work was featured on the cover of **LEONARDO**, the art-science journal published by MIT Press. Lecture performances, talks on XR and design and the presentation of *NOISE AQUARIUM VR* at TEDxVienna brought questions of ecological responsibility to the forefront. A user study was conducted, drawing on the diverse TEDx audience. The year concluded with a *Lecture for Future* at the University of Natural Resources and Life Sciences Vienna, positioning art as a method for engaging with climate change.

2020 – IMMERSION UNDER EXCEPTIONAL CONDITIONS

With the onset of the pandemic, not only did production conditions shift, but the very questions posed to scientific visualization and immersive media changed as well. Projects during this period became explicitly linked to global crises: climate change, the pandemic and a sense of uncertainty overlapped both as themes and as lived experience. Victoria Vesna organized a series of online meditations in which my animations for *NOISE AQUARIUM* were frequently featured. One of these live meditations was streamed at the **Wiener Rauschen Audio Visual Festival** in Vienna's **Seestadt**, as a calming contribution to the **Ange wandte Praxis Panel Noise in Nano, Micro and Macroc osms: A Connection of Quantum Physics, Plankton and Our Solar System**. Remarkably, the festival could take place in-person, just before the autumn lockdown started.

Another pandemic story: I was involved in shaping **PIXELvienna** from its early days. After a three-year hiatus, I organized several meetings in an effort to convince Rector Bast that the *Festival of*



08.-14. November
2021



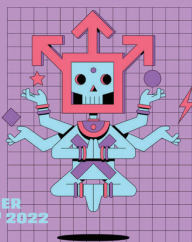
PIXELVIENNA

AUSTRIAN COMPUTER GRAPHICS
AND ANIMATION CONFERENCE

15

PLAYTIME IS OVER

NOVEMBER
3RD & 4TH 2022



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VORBERG ZOLLAMTSSTRASSE 7, A-1030 WIEN
PIXELVIENNA.COM

PIXELVIENNA16

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KLIMA ~ TATEN ~ DRANG

Wissenschaft + Kunst = Aktion

UNIVERSITY
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ZGIS

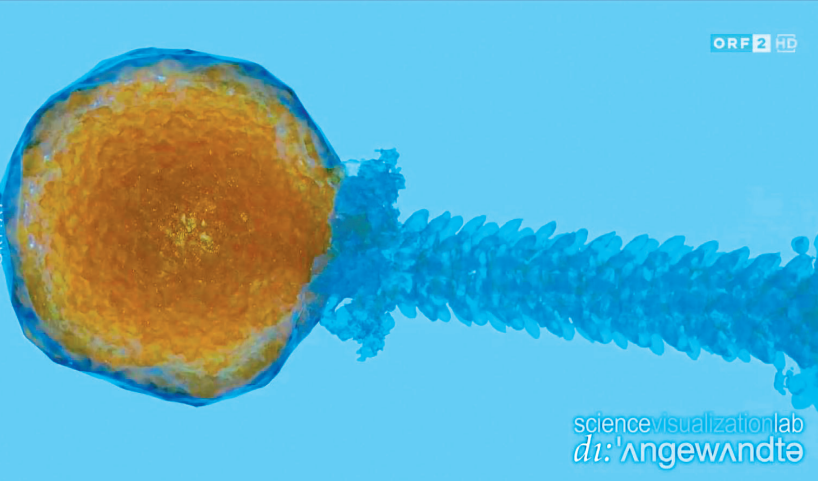
dr.'Angewandte
sciencevisualizationlab



Computer Graphics had evolved and aligned with the values the University sought to represent. With the help of dedicated volunteers, we founded the **PIXELvienna Society—Verein zur Förderung der Vernetzung in Computergrafik, Animation, Spielen, Filmen und digitaler Kunst** to establish a legal framework for a contract between Angewandte and **PIXELvienna**. Then the pandemic hit and the event had to be improvised online. For two years, only the *PIXELvienna Animation Festival*, organized by my colleague Niki Jantsch, could take place in-person, under strict safety measures, with masks and testing.

A similar story happened with the funded collaboration project *C~ART* with Stefan Kienberger from University of Salzburg's department of Geoinformatics Z_GIS. For months, we prepared the elaborate event **Klima~Taten~Drang** with actions by Hermann Josef Hack who strongly works in the environmental tradition of his former professor Joseph Beuys—and then nearly everything had to take place online.

I curated the online exhibition *Corona and Climate Change*, including the work **Virus Dice** (2020). The project processed my own sense of uncertainty during the pandemic and the urge to go on somehow. A collaboration with Josef Penninger offered insights into the past state of his research on SARS-CoV-1 and the rapidly resumed investigations into SARS-CoV-2 mutations. As early as the beginning of summer, we were already working with research data produced by the global scientific community to accurately simulate the movement and structure of the virus. International presentations increasingly shifted to digital formats, like my presentation at IEEE VR ANIVAE, raising new questions about presence, embodiment, and mediality in immersive art when physical co-presence is no longer possible.



2021 – DISCOURSE AND NEW PUBLICS

In 2021, the focus moved into institutional and public spaces where art, science and society meet directly. Exhibitions such as ***Expeditions to Hidden Worlds at MuseumsQuartier Vienna***, curated by Ruth Schnell and Tommy Schneider, opened the work of the Science Visualization Lab to a broad audience. For the exhibition the visualizations were updated with the latest scientific findings of the movements of CRISPR-Cas9 contributed by Stefan Mereiter and Peter Hinterdorfer, ensuring that the works reflected current research.

Virus Dice continued to evolve into a stereoscopic short film that visualizes infection pathways accompanied by an eerie soundscape composed by musician Michael Wedenig. An interactive installation with performance incorporating a **dice-based game** was tested at Schmiede Hallein, exploring play as a method for engaging with invisible biological threats and the uncertainties of viral spread. Panels and lectures including *Staging climate change—Klimakommunikation im Kunst- und Kulturbereich* at the MAK and the workshop *A syntax for smooth spaces* at the Complexity Science Hub foregrounded questions of responsibility, narration, and impact.

Wider audiences could be reached when my **phage animations were broadcast on ORF2 in *Welt der Seuchen***. The lab presented work at VIZBI 2021 and participated in the online exhibition ***Movement – Mapped: The Blood-Brain Barrier*** in **SciArt Magazine** and my rendering of the *Paramecium* made it to the cover and we were invited to write a chapter for the book *Plastic Ocean—Art Science Responses to Marine Pollution* edited by Ingeborg Reichle, one successful book in the Edition Angewandte at De Gruyter Brill publishing group.



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Postwar Modern
New Art in Britain
1945–1965
Until 26 Jun

Our Time on Earth
An exhibition reimagining
the relationship with
our shared planet
5 May–29 Aug

2nd
**NTU GLOBAL
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2022

2022 – INTERCONNECTION

Through the contribution of the 3D scanned amoeba to **Sonja Bäuml's project *Entangled Relations – Animated Bodies*, presented at the Triennale Milano**, an presentation at ISEA 2022 and the inclusion of ***NOISE AQUARIUM in Our Time on Earth at the Barbican Centre in London***, the connection between artistic research, scientific visualization and ecological inquiry became firmly situated on major international platforms.

Scientific visualizations were contributed to the three part documentary series ***Planet Insect* by Steve Nicholls**, three shots in 4k were contributed to the series: ***THE INCREDIBLE AERONAUTICS OF THE FLY***, a shot of a moth antenna and a fully tomographically scanned butterfly embryo in an egg. The butterfly egg shot became the scientific basis for ***Butterfly}Pieris{Effect* (2022)**, which won a subnet artist residency and a nomination for the **GDAP (Global Digital Arts Prize) 2022 Finalist Exhibition at NTU Singapore**.

The organization of PIXELvienna as in-person event and the chairing of the PIXELvienna Animation Festival jury, a **workshop in Venice** following an invitation by Ruth Mateus-Berr and contributions to professional conferences such as CAGA (Conference of AG Animation) in Lucerne underscored the institutional responsibility that has become part of the practice.

2023 – SYSTEMS, BOUNDARIES, AND COLLABORATION

Two major research-driven initiatives began in 2023. ***ARTverse*, developed in collaboration with VRVis** (Vienna Research Center for Visual



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Universität für Angewandte Wissenschaften

sciencevisualisatorlab
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„Film, Region + Kultur“

Bundesministerium
Kunst, Kultur,
öffentlicher Dienst und Sport

DOORS TO HIDDEN WORLDS

*The Power of Visualization
in Science, Media, and Art*

Edited by Alfred Vendl and Martina R. Fröschl

Computing), received funding from netidee. The *Big-Bug Immersion*, created in collaboration with Michael Bachhofer, was supported through INTRA funding. The question of the “bug” perspective also became central to the **exhibition *Butterfly Perspective***, developed with Michael Bachhofer. In this exhibition format, the human viewpoint is deliberately displaced by that of the butterfly.

Schmiede Hallein participation once again became a laboratory with the *Experimental Science Visualization Lab* titled *Boundaries of Visualization* with Mehrta Shirzadian und Peter Mindek. Here, visualization was not only practiced but critically examined: Where does representation fail? Where are the limits of visualization today? These inquiries are echoed in interdisciplinary discussions at the *Convergence? Interfaces of the Digital and the Living* symposium at the Austrian Academy of Sciences and the *Art Museum in the Digital Age* at belvedere21. *NOISE AQUARIUM* got to the Musée de la civilisation in Québec as part of *Our Time on Earth* traveling exhibition.

Contributions to the crowd effort ***Our Earths VR for Earth Day and at Ars Electronica*** reinforced the planetary future dimension of scientific visualizations. Several panels on art & science, AI and digital futures, as well as the book publication of ***Doors to Hidden Worlds—The Power of Visualization in Science, Media, and Art* (De Gruyter 2023)**, positioned the Lab within expanding academic and public conversations.

At the same time, 2023 was marked by strong discursive engagement. An invited keynote at *Figuring the Invisible* in Lucerne situates the practice within broader theoretical debates about visualization and knowledge production.

SCULPTING SYSTEMS

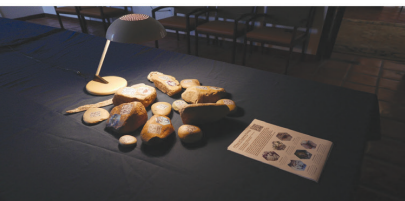
MEANING AND CULTURAL NARRATIVES THROUGH 3D VISUALIZATION AND 3D SCANS

RESEARCH PROJECTS WITH EXTERNAL PARTNERS AT THE SCIENCE VISUALIZATION LAB, DIGITAL ARTS DEPARTMENT

Funding: FFG, netidee

Dr. Martina R. Fröschl

Two research projects from the Science Visualization Lab explore the intersections of data visualization, sustainability, and immersive storytelling through digital art. Together, these works investigate how 3D scans and visualizations can serve as tools for public engagement and critical reflection.



A PIECE OF SYSTEMS ECOLOGY features an animated 3D sculpture created from scanned elements of the landscape in Santa Barbara (USA, CA). Visitors might interact by using QR codes printed on stones and discover connected stories. Additionally, the soundscape reflects fragments of topics of interviews with **NCEAS** (National Center for Ecological Analysis and Synthesis) researchers.



GreenGLAM supports Austrian galleries, libraries, archives, and museums (GLAMs) in aligning their activities with the Sustainable Development Goals (SDGs). Through AI-driven visualizations and augmented reality (AR), new opportunities are created to raise awareness of sustainability and to present cultural content in innovative ways.

Project partners: Modul Technology GmbH, VRVis GmbH, Data Intelligence Offensive (DIO), webLyzard technology GmbH, Universität für angewandte Kunst Wien, OpenGLAM.at



2024 – RESONANCE, RESEARCH AND ECOLOGICAL PERSPECTIVES

An artist residency at the National Center for Ecological Analysis and Synthesis (NCEAS) in Santa Barbara, California marked a pivotal moment. Immersed in a leading research environment for systems ecology, the practice entered direct dialogue with ecological modeling and environmental data science. At the residency I created the installation **A Piece of Systems Ecology** an AR-based work translating complex ecological interdependencies into spatial, embodied encounters. Ecological narratives continue internationally as *NOISE AQUARIUM* travels with *Our Time on Earth* to the Peabody Essex Museum in the United States. At the Angewandte Festival **NOISE AQUARIUM VR** was curated by Sara De Santis for the Digital Arts exhibition by UEBERMORGEN and the exhibition *Sinneswandel, Remarks on Human Perception* revisited the output of the extraordinary teaching course *Sinneswandel—A Hacker's Guide to Perception*: a concept developed with Michael Bachhofer and guest lecturers: Sebastijan Geč, Jeanette Müller, Paul Divjak, Margit Busch and Stefan Resch.

The FFG-funded project **GreenGLAM** starts to support public engagement with the UN Sustainable Development Goals by using GLAM (Galleries, Libraries, Archives and Museums) collections to encourage action on sustainability challenges. It supports this mission by transforming institutional data into interactive virtual data sculptures, augmented reality experiences and AI-supported tools that enhance communication, analysis and public impact. PIXELvienna gained more structural stability through public funding from Vienna Business Agency and WKO. At the international conference *Figuring the Invisible* in Padova, I chaired the panel



Science Visualisation: From Theory to Fiction and Documentary to frame visualization as a space where epistemology, narrative and political responsibility intersect. Further talks and symposia situate science visualization within debates on systemic change and post-growth futures. Teaching takes up much more time, courses such as *Micro Macro Video* and *Immersive Media & Virtual Reality* support a generation of artists capable of navigating scientific data, aesthetic form, technological complexity and political impact.

2025 – CONSOLIDATION AND LIVING LABS

The INTRA project *Big-Bug Immersion* reached its conclusion, demonstrating the scanner as a performer, while interactive works like ***Antenna in the Mud* and *Immersive Mud Bat Mash*** in collaboration with **Mel E. Logan** activated visitors in the newly established Immersive Lab. *A Piece of Systems Ecology—Sequential* extends previous AR and immersive installation work, translating ecological processes into an experimental film. Institutional and public engagement became dense and multifaceted. Autumn starts with a ***HOX Zodiac dinner performance honoring the snake hosted by Victoria Vesna and me*** at the Digital Arts department.

PIXELvienna and **IEEE Vis VISAP (Vis Arts Program) exhibition chairing** highlighted my intense engagement in festival and exhibition curation. Jury and peer-review roles, including subnetAIR, Salzburg Media Art Grant, and VINCI 2025, reinforced international networks and collaborative exchange. Teaching remained integral, with courses in *Immersive Media* and *Green Computing* combining artistic experimentation with ecological and computational inquiry. International visibility contin-

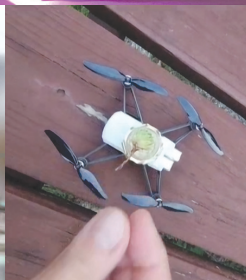
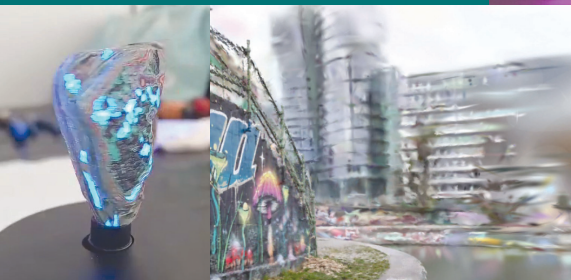
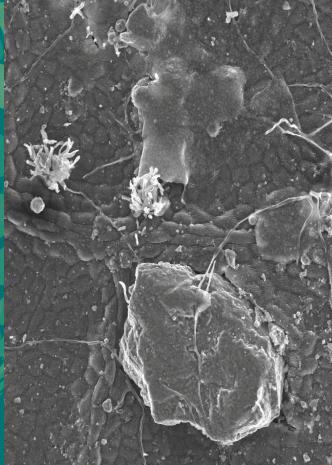
Julia Bentz
Jelena Ristić Trajković *Editors*

Imagining, Designing and Teaching Regenerative Futures: Art-Science Approaches and Inspirations From Around the World



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ued through fewer but selected invited talks such as newly established living lab project presentation *Kanal Opal* at *TABOO–Transgression–Transcendence* in Ljubljana and a chapter contribution to the **Springer book publication *Imagining, Designing and Teaching Regenerative Futures: Art-Science Approaches and Inspirations From Around the World* titled *The Inner Beauty of Art–Science Installations*.**

2026 – ANNIVERSARY AND OUTLOOK

The year 2026 marks an anniversary, accompanied by newly launched projects such as ***Kanal Opal*, developed with Marta Anghelone, who contributes scientific images from the Angewandte Conservation Institute and Michael Hacker, who adds artistic perspectives.** Another new project is ***PerVertical Garden*, created in collaboration with Mel E. Logan.** Both projects consolidate earlier questions about urbanity, ecology, plant-life, sounds, scales, drones and materiality into new work. Sebastian Pichelhofer from Media Center of BOKU Vienna and Sebastian Postl from Postl Film will bring their immersive documentary *Der letzte Urwald (The Last Primary Forest)* about the UNESCO World Natural Heritage site Rothwald in Lower Austria as a possible starting point for collaborative efforts into the courses *Immersive Media & Virtual Realities* and *Scientific Visualization*. Collaborations on Biomes with Florian Panhölzl and Stefan Pommer might start in summer.

2026 looks back and opens up to an open terrain for possible future projects and experiments at the Science Visualization Lab of the University of Applied Arts Vienna.

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