

Introducing the (A) in STEM Processes



ABOUT THE PUBLICATION

With the support of the Erasmus+ programme of the European Union. The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Follow the link to read this publication online:

[STEAMPROCESS.XAMK.FI](https://steamprocess.xamk.fi)

Read more about the STEAMprocess project:

[XAMK.FI/STEAM](https://xamk.fi/steam)

Publisher: South-Eastern Finland University of Applied Sciences
Xamk Inspire 40
Kouvola 2022

© Authors and South-Eastern Finland University of Applied Sciences
ISBN: 978-952-344-431-7 (online)
ISBN: 978-952-344-432-4 (PDF)
ISSN: 2489-6764 (online)
julkaisut@xamk.fi

AUTHORS

EDITORS

Silja Suntola

Minna Porvari

Henna Suortti

LAYOUT AND GRAPHIC DESIGN

Henna Suortti

CASE DATA

Alessia Tripaldi, Sineglossa, Italy

Anna Pinotti Blanch, Conexiones improbables, Spain

Germana Girelli, Materahub, Italy

Francesca Olivier, Changemaker AB, Sweden

Henna Suortti, Xamk, Finland

Minna Porvari, Xamk, Finland

Per Myrén, Changemaker AB, Sweden

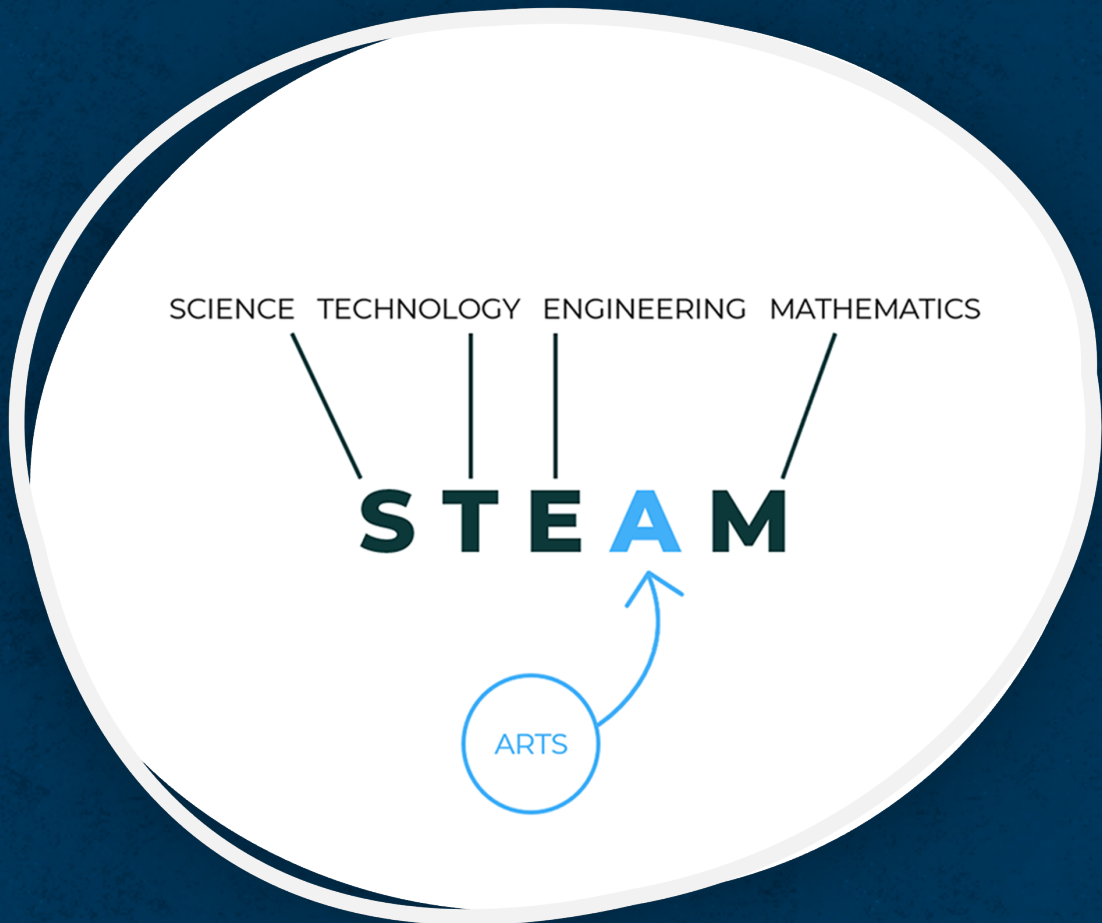
Roberto Gómez de la Iglesia, Conexiones improbables, Spain

What can science learn from the arts, and vice versa?

What is, or could be, the role of arts in education?

How can we bring practices and processes from arts and science to help us examine and understand the world?

How can the arts and science feed innovation and discovery?



WHAT IS STEAM?

Art and Science both “aim to understand the world”

In the past, art and science were considered complementary ways of understanding and describing the world around us.

Art was considered to reflect the same universal laws as the nature around us. Understanding and mastering these principles was the biggest achievement of humankind, that enabled us to rise as a species above many others.

Art communicates directly with our senses enabling bodily experiences, through which we become aware.

Becoming aware enables us to analyze and find commonalities, and hence draw theories from single phenomenon to underlying universal principles.



Henna Suortti 2021

“Study the science of art.

Study the art of science.

Develop your senses –

Especially learn how to see.

Realize that everything connects to everything else.”

— Leonardo Da Vinci

**TO MAKE THIS IDEA
ACCESSIBLE,**

**HERE ARE MULTIPLE
WAYS TO APPROACH
STEAM CONTENT**

ART IS AS OLD AS HUMANITY

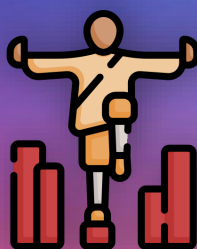


- **Communicating with the unknown:** Gods, spirits and "the other side".
- **Creating symbols and images** to portray and communicate meanings, values and beliefs.
- **Acknowledging something** is important and meaningful and should be paid special attention.

-
- **Gathering information** through our all senses.
 - **Seeing the forest for the trees,** understanding what is meaningful in the whole.

"All our knowledge has its origins in our perceptions."

-Leonardo Da Vinci



WHAT DOES IT MEAN **TODAY**

Acknowledging through reflection. Using bodily, sensory and intuitive knowledge, that we know through being human.

Understanding and learning through experience. Attempting to do (practicing) in order to understand.

Mastering to identify and communicate meanings, values, beliefs, ethics and aesthetics of what is important now.



Henna Suortti 2021

"The soul never thinks

without a picture."

— Aristotle

CREATIVE SOFT SKILLS

Soft skills are our needed personal attributes at work.

They are a combination of people skills, social skills, communication skills, character or personality traits, attitudes, career attributes, social intelligence, and emotional intelligence quotients.

These skills enable employees to:

- navigate their environment
- work well with others
- perform well
- achieve their goals

It is important to recognize soft skills and facilitate the connection between people and the labor market.

Soft skills concern everyone at the early stage of their career. Regarding art and science this phenomenon is very relevant.



EXAMPLES OF SOFT SKILLS

- Cognitive flexibility
- Communication
- Complex Problem Solving
- Coordinating with others
- Emotional intelligence
- Ethics
- Integrity
- Judgement and decision-making
- Motivation to development
- Negotiation
- Networking
- Passion and self-motivation
- People management
- Personality
- Persuasion
- Respect
- Self-awareness
- Service orientation
- Trustworthiness

CREATIVITY AND THE BRAIN

Our brain provides an interesting way to understand **the nature of creativity**. Although the functions of the two hemispheres can't be defined this clearly, it provides an interesting basis for thinking.

The theory is that people are either left-brained or right-brained, meaning that one side of your brain is dominant. If you're mostly analytical and methodical in your thinking, you're said to be left-brained. If you tend to be more creative or artistic, you're thought to be right-brained.

This theory is based on the fact that the brain's two hemispheres function differently. This first came to light in the 1960s, thanks to the research of psychobiologist and Nobel Prize winner Roger W. Sperry.

Source: Healthline. 2017. Left Brain vs. Right Brain: What's the Difference?. [online] Available at: <https://www.healthline.com/health/left-brain-vs-right-brain> [Accessed 28 March 2022].



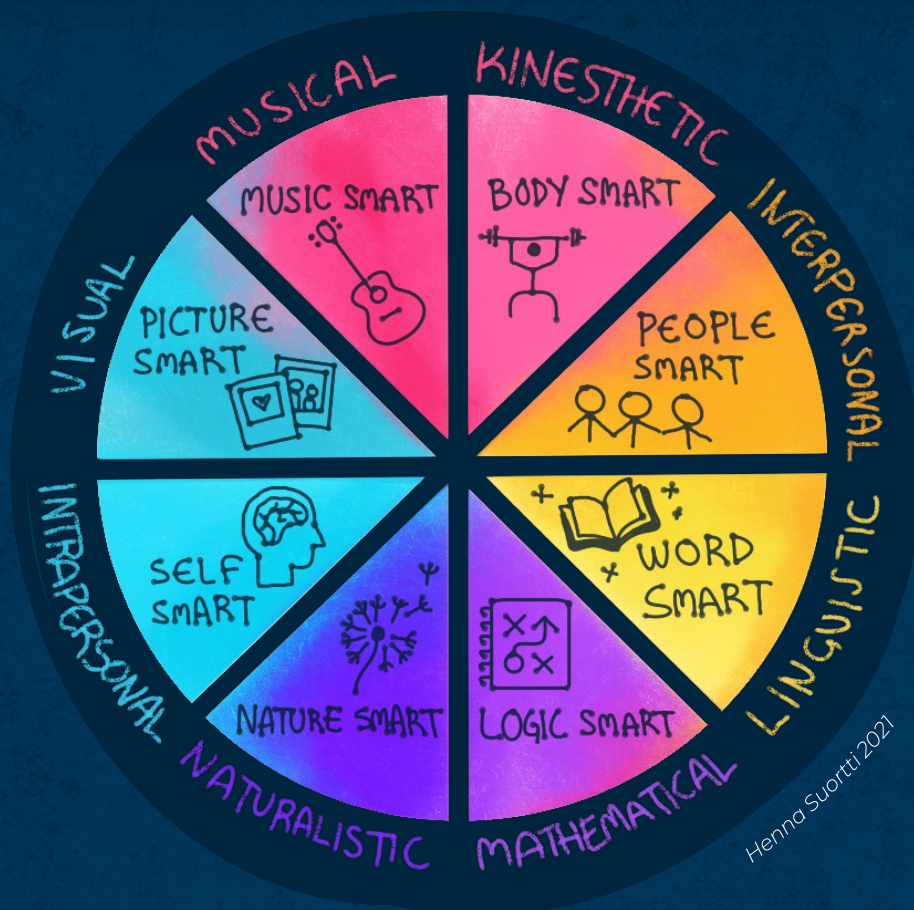
MULTIPLE INTELLIGENCES

In *Frames of Mind: The Theory of Multiple Intelligences* (1983) and its sequels, **Howard Gardner proposed eight abilities that manifest multiple intelligences.**

People do not have just an intellectual capacity, but have many kinds of intelligence, including musical, interpersonal, spatial-visual, and linguistic intelligences.

While a person might be particularly strong in a specific area, they most likely possess a range of abilities. For example, an individual might be strong in verbal, musical, and naturalistic intelligence.

Source: Howard, G., 2022. The Components of MI — MI Oasis. [online] MI Oasis. Available at: <https://www.multipleintelligencesoasis.org/the-components-of-mi> [Accessed 28 March 2022].



Henna Suortti 2021

JUNGIAN ARCHETYPES

Stereotypes that portray characteristics and personas (moving clockwise):

Ruler, Creator, Sage, Innocent, Explorer, Rebel, Hero, Wizard, Jester, Seductress, Lover, Caregiver

- These help us identify who we are; and what characters we bear with us in our lives.
- These help us understand common patterns of behaviors in ourselves and others.
- Awareness of a specific behavior and characteristics is the key to changing them (if they work against us and what we are trying to do).
- Applications/tools: Disc, de Bono's 7 Thinking Hats.

Source: Neill, C., 2018. Understanding Personality: The 12 Jungian Archetypes. [online] Moving People to Action. Available at: <https://conorneill.com/2018/04/21/understanding-personality-the-12-jungian-archetypes/> [Accessed 28 March 2022].



Henna Suortti 2021

A TYPOLOGY OF KNOWLEDGE BASES

ANALYTICAL

- Science based -

Know

WHAT



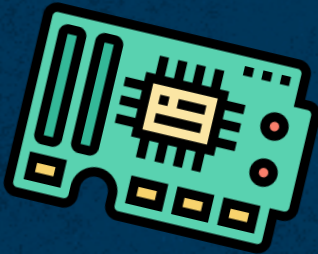
- know **WHY**
- Developing new knowledge by applying scientific laws
- **SCIENTIFIC KNOWLEDGE, MODELS, DEDUCTIVE**
- Cooperation with research units
- **Strongly codified knowledge, universal**
- **MEANING RELATIVELY THE SAME BETWEEN LOCATION**

SYNTHETIC

- Engineering based

Know

HOW



These skills can be practiced by anyone, without mastering a specific artistic discipline.

- Understanding behavior through expression of emotions, values and meanings.
- Visualization of complex systems and abstract ideas.

SYMBOLIC

- Art based -

Know

WHO



- Skills that allow thinking of the whole, while working on particulars.
- Skills that allow grasping the essence in complex and cluttered environments.
- Inspiring awe and aspiring to understand and engage.

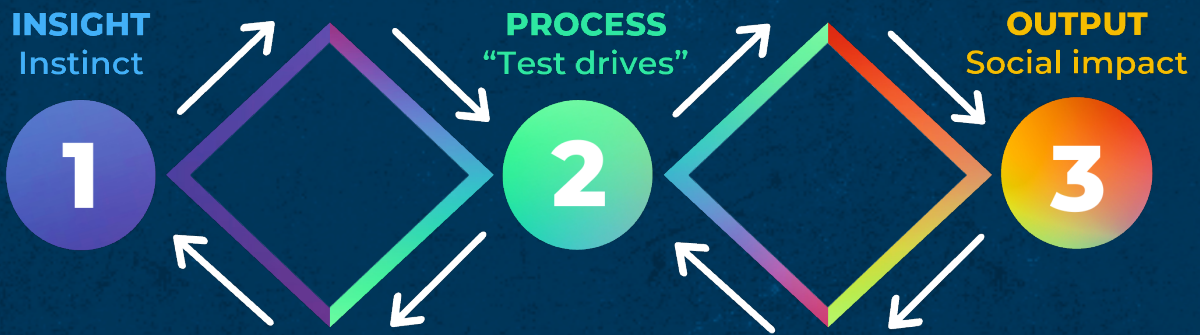


The "A" skills will be identified through interviews with entities that, in different ways, have already experienced a STEAM process (research centers, training institutions, companies).

The first innovation element of the framework is, therefore, a shift of the point of view: artistic skills are not defined through the self-assessment of artists but through the evaluation of those who have introduced Art in their study or research processes.

FIRST HOW WE **ANALYZE** OUR **CASE DATA**





Henna Suortti 2021

Personal skills and competences

- **Self-awareness** → Reflection and mindfulness, awareness of meanings and values through experience and thinking of ethics, aesthetics and philosophy.
- **Learning-to-learn and think** → For example, E. Bono's Seven Thinking Hats, H. Gardner's Multiple Intelligences, personal traits and characteristics and Jungian Archetypes.
- **Novel and critical thinking** → Openness, dealing with uncertainty and critical disruption.

People/social skills

- **Communication** → Bodily and sensory, using symbols, storytelling, awareness of spatial issues and social intelligence.
- **Complex problem solving** → Multi-disciplinary contexts, mastering art and design-based methods, tools and facilitation, facilitative and people skills, and seeing the forest through the trees.
- **Leading creative people and processes** → Network-leadership, communication for purpose and meaning, and seeing the forest through the trees.

Raising awareness and social impact

- **Enable communicating the essence** of human emotions, experiences and revelations related to the meaningful dimensions of our lives.
- **The ability to produce scenarios**, "probable truths" based on incomplete data mixed with bodily or sensory knowledge, and understanding of human behavior and the environment.
- **Raise interest** and inspire awe in phenomena within and around us.

1

INSIGHT
Instinct

CASE YALE

Artwork Can Sharpen Medical Diagnostic Skills

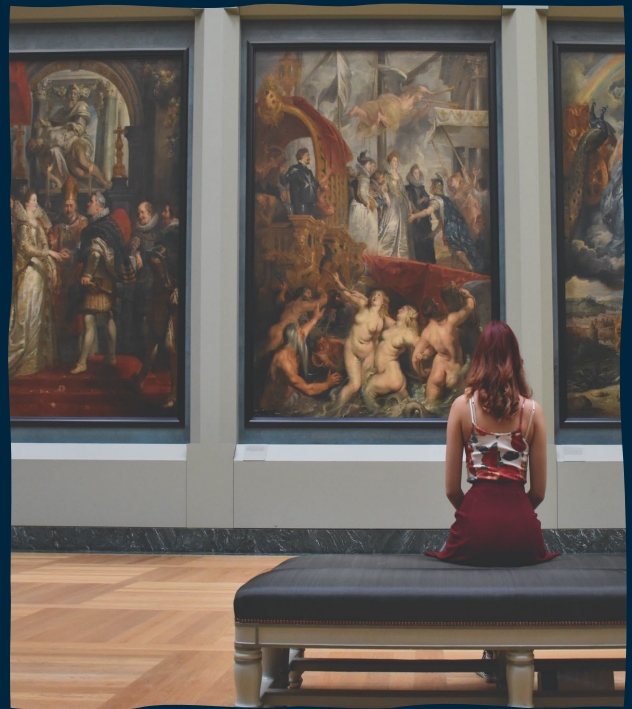
Keywords: medicine, STE(A)M training, art to sharpen observation skills

Who / Professor Emeritus of Dermatology, M.D., Irwin M. Braverman. Yale School of Medicine. The course first started in 1998, the study was published in 2001. Yale School of Medicine.

What / Students are given 15 minutes to observe an assigned painting individually and gather as many details as possible. As a group, they discuss what may be taking place in each painting based on their observations. 18th and 19th century British paintings are perfect for the exercise as many of the them tell a story about a real historical event. But like a patient with unexplained symptoms, they often contain ambiguous or contradictory information. What is most important, is the gathering of details.

Why / In 1998, professor Braverman noticed that dermatology residents were not describing what they saw on patients as thoroughly as they should. They had predefined values of what was important to describe instead of describing everything they saw.

The students replied they had considered themselves to be adequate observers before the workshop.



The observational skills training workshop was developed for first-year medical students. It is an exercise in visual training that gives the students an opportunity to look at something foreign to them early in their medical careers. It can be compared to the examination of a patient: The exhibit hall is the examination room, and the painting become the patient. According to a study published in JAMA: the Journal of the American Medical Association in 2001, the workshop improves students' abilities to pick up on important details by almost 10%.

Results / The course teaches not to automatically interpret but to really observe. A physical diagnosis requires more than a glance. When asked what have they learned about themselves as observers, the students replied they had considered themselves to be adequate observers before the workshop, afterwards they realized they were looking at things superficially. The course had helped them learn to look at the world, and their patients, more in depth.



INSIGHT
Instinct

PROCESS
"Test drives"

CASE

SCIENCE&MUSIC

How to learn science and maths through music?

Keywords: arts to STEM, music and science, arts as a way to communicate

Who / Led by Herbie Hancock and the Herbie Hancock Institute of Jazz. Supported by the US Department of Education and UNESCO. Designed by New York University Music Experience Design Lab. With the contributions in the curricula development of experts affiliated with Harvard University, Massachusetts Institute of Technology (MIT), University of California Berkeley, University of Massachusetts, New York University, San Francisco State University and Johns Hopkins University.

What / This project aims to respond to the need of encouraging students to acquire skills and knowledge in STEM subjects by applying creative thinking. A digital repository that provides free and interactive tools for learning mainly science and mathematics concepts through music-based methods. The initiative has developed play-based games, apps and video interfaces, as well as engaging curricula, developed by professionals from the academia and private sector specialised in scientific, technical, educational and musical disciplines.

While the content is primarily aimed at 4 to 8-year-old children, a stage considered crucial for acquiring this knowledge, other resources can be found both for elementary and higher education students, as well as curricula resources for teachers.



Technology acts as an intermediary interface between musical, mathematical and scientific concepts through a set of interactive games, apps and video tutorials accessible for free and aimed both at students and teachers. All of them promote learning through play, experimentation, practical action and collaboration.

Why / The aim of this project is to apply creative thinking to the learning of scientific and mathematical knowledge among students from elementary, middle and high schools. All concepts (arithmetic, geometry, logarithms, fractions, ratios, etc.) are approached through engaging ways using music-based methods (rhythm, scratches, grooves, beats, sound waves, etc.).

Results / To highlight a few tools: the EcoSonic (Ecology/Sound) Playground project, where children collect and then work with reusable materials to design, build and play large social musical instruments using STEAM-integrated curriculum materials to guide the process of making and playing, or Groove Pizza, a digital tool to create grooves using mathematical concepts such as shapes, angles and patterns.

1

INSIGHT
Instinct

CASE

FUTURE LAB

Event that brings curious minds together

Keywords: future designs, social impact, idea exchange

Who / Ars Electronica Linz GmbH & Co KG - consists of the operational divisions Ars Electronica Festival-Prix-Exhibitions, Ars Electronica Center, Ars Electronica Futurelab, AE Solutions and Corporate Services.

What / The Futurelab is a laboratory and atelier for future systems. As the think-and-do tank of the Ars Electronica, it always places humans at the center of research, considering the social aspects of technological developments such as artificial intelligence, robotics, media architecture, interactive technologies, new aesthetic forms of expression or swarm intelligence and their effects on the future of society. At the interface of art, technology, and society, it creates visions, which are realized for the public, together with partners from fields of business, culture, research, and education.

Why / The Ars Electronica Futurelab networks and discusses the methods of creativity and technology to accompany this development shaping future trends and visions. It develops new concepts for an autonomous future society in an inspiring field of tension between disciplines and transnational cooperation.

Results / With tangible future visions and artistic explorations it is humanizing technologies and novelizing cultural experiences, calling up to social participation and responsible creativity. All concepts and designs for the future are the result of many successful collaborations with art and culture, educational institutions, industries and businesses.



Photo by Guillaume Meurice, Pexels

The first Ars Electronica began in 1979. 20 international artists and scientists gather at this new “Festival for Art, Technology and Society” in Linz to discuss the Digital Revolution and its possible consequences. The Ars Electronica is small, but groundbreaking. The initiative came from Hannes Leopoldseder, director of the Upper Austria regional studio of the Austrian Broadcasting Company (ORF), who is passionate about everything that has to do with the future. Together with electronic musician Hubert Bognermayr, music producer Ulli A. Rützel and cyberneticist and physicist Herbert W. Franke, he lays the foundation for a festival that will become the world’s largest and most important of its kind. The Ars Electronica Futurelab is a laboratory and atelier for future systems.

The network and team of international artists and scientists in the Ars Electronica Futurelab comes from a wide range of disciplines and is concerned with the development and evaluation of technological innovation. Transdisciplinary research is a proven method to create new future approaches, possibilities, and inspirations and has become a multiplier in the process of developing new social and cultural conventions. The Ars Electronica’s laboratory for innovation and sustainable change pushes the boundaries of what is possible day after day, taking a joint step to the future.

1

INSIGHT
Instinct

CASE

SIMETRIA

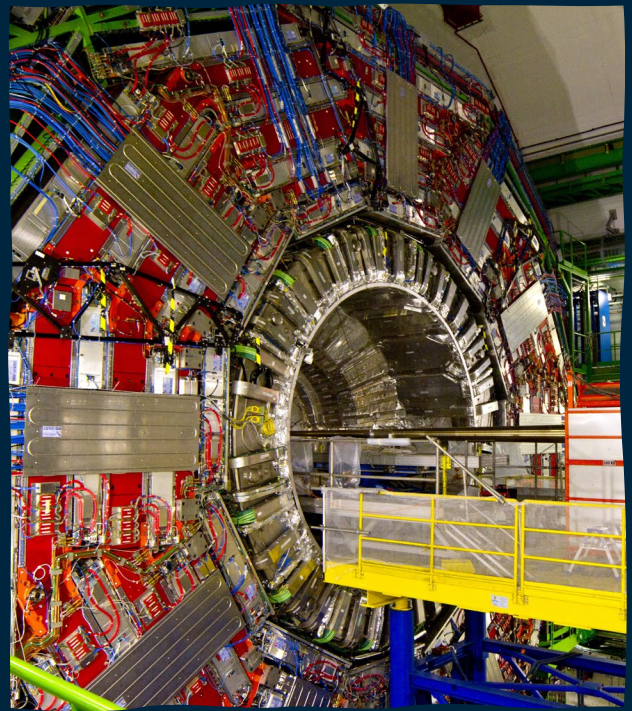
Exploring new ways of expression

Keywords: creative process, idea exchange, arts to STEM

Who / CERN in Geneva - Corporación Chilena de Video y Artes Electrónicas (CChV) in Chile. Artists: Chloé Delarue & Patricia Domínguez

What / This project connects one artist from each of the two countries for a dual residency, to research and explore new expressions in connection with fundamental science. Both Switzerland and Chile are home to some of the most singular scientific instruments in the world, dedicated to understand the origins and the evolution of the universe. During their residencies, the artists will explore the scientific sites, their extraordinary locations and scale, both laboratories and observatories, to explore new expressions in their artistic practices, and to further develop them into art productions. In this unique exploratory residency, the artists will collaborate with and receive support from scientists and engineers, as well as the staff of the host research facilities.

Why / This case explores the diversity of physics and the sciences of the universe and how these fields of research may inspire innovation in the arts. Created in 2019, the goal of Simetría is to foster further developments on the dialogues between science and arts, reflecting about the research at remote locations and at laboratories and observatories.



Born in 1986, Chloé Delarue produces installations (sculpture, video and sound) under the TAFAA acronym, standing for Toward A Fully Automated Appearance, a combination of several installations, which the artist calls “environments”. These environments are elements of the re-composition of a more or less abstract body. Once these elements overlap, they create a sort of spectrum, a material and immaterial flow of information. After a first MAMA degree in 2012 from Ecole Nationale Supérieure d'Art – Villa Arson in Nice, she continued her studies at HEAD-Genève in the Fine Arts Master in 2014.

Patricia Domínguez, born in Chile in 1984, focuses on tracing relationships of work, affection, obligation and emancipation among living species in an increasingly corporate cosmos. Her studies include a Master's degree in Studio Art from Hunter College, New York (2013) and a Certificate in Botanical Illustration and Natural Sciences from the New York Botanical Garden NYBG (2011). She is currently the director of the ethnobotanical platform studying the healing cosmologies of native plants, called Studio Vegetalista.

Results / The main results of the work of the two artists is to see multiple perspectives and explore the field of science and co-create an art production. The collaboration between the two countries helps to understand the origins and the evolution of the universe by the facilitation of scientists and researchers.



INSIGHT
Instinct
OUTPUT
Social impact

CASE

DEFOREST

The consequences of internet browsing

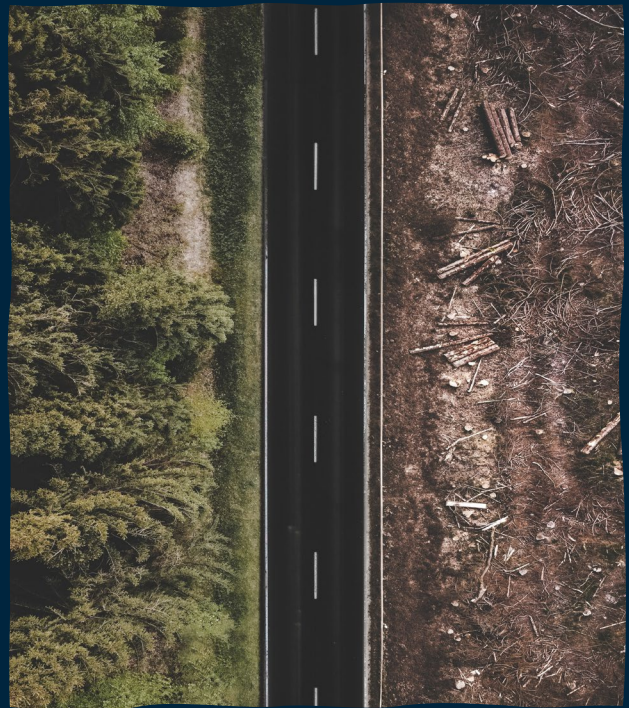
Keywords: social impact, technology, arts as a way to communicate

Who / Joana Moll: artist and researcher who critically explores topics as techno-capitalist narratives, Internet materiality, surveillance, social profiling and interfaces.

The visualizations aim to encourage critical action and thinking.

What / How many trees are needed to absorb the amount of CO₂ generated by visits to google.com every second? Moll answers this question with an artwork that addresses the impact we generate on the environment with our Internet browsing through Google. The artist explores visual strategies that allow making visible the invisible and tries to show the repercussions that our online activity has in a supposedly interconnected world. She interprets complex data and translates it into a graphical visualization that aims to encourage critical action and thinking in an understandable and accessible way for all citizens.

Why / This artwork based on the internet aims to raise awareness of our actions, mainly about the environmental impact of our Internet browsing via Google by interpreting complex data and translating



This project is closely related to CO2GLE: <http://www.janavirgin.com/CO2> another work by the artist in which she makes visible the amount of CO₂ generated every second in global visits to google.com.

it into comprehensive graphical visualization that aims to encourage critical thinking in an understandable and accessible way for all citizens.

Results / Through visual design the artist explores strategies that seek to activate critical reflections and actions on the use we make of digital communication technologies, showing through graphic representations complex cause-effect relationships that are established between human actions and our natural environments and mediated by the digital world.

2

PROCESS
"Test drives"

CASE VÄRMLAND

How can digital game development benefit from the cultural sector

Keywords: multidisciplinary teamwork, concept development, network utilization

Who / The Great Journey project started in 2015 in Karlstad, Sweden. Since 2020, they involved the Futuregames and offer an education programme in Indie Game Development.

What / The Great Journey focuses on promoting the video games industry in the Värmland region, by creating an environment for everyone who wants to develop games. The Great Journey offers pitch events in the digital game development field and organizes game jams where people from both the game development and the creative/cultural worlds. Artists, graphic designers, storytellers, programmers, game developers participate all together in co-creation moments. The final aim is to create a network, share ideas and develop new games.

Nurturing a game concept is by no means a simple task

Why / The main goal is to create synergies among the creative sector and the digital game developers, who often are programmers and experts in coding.

Results / The final result is the creation of new digital games and new companies in the game development sectors, based on artistic and cultural skills.



Photo by Cottonbro, Pexels

The video game industry is flourishing, which is not only a boon to gamers, but also to those who are interested in a career in developing games. Many years of training and development experience are needed to take a video game from its initial concept to a market-ready product. The work can be challenging, but also exciting and highly rewarding, particularly for those who wish to combine their technical acumen with creative license. Video game development is a field in which STEM students may find ample opportunity for success.

Every game starts with an idea, but nurturing a concept is by no means a simple task. The ideation process can involve brainstorming ideas, creating sketches or prototypes to test those ideas, and evolving or streamlining an idea as needed. Ideation may begin with one person having a "light bulb moment," arriving at what they think is a winning premise. Typically, however, a full team of developers is involved in shepherding a gaming idea through to the next steps. Since 2020 in the Swedish region of Värmland an original project started, giving the possibility to game developers to work together with practitioners coming from other sectors: artists, storytellers, graphic designers and more. "The Great Journey" is a community-based project where Game makers have the possibility to develop new digital games in close cooperation with people coming from diverse creative sectors.

2

PROCESS
"Test drives"

CASE

EARTH/WATER/SKY

An open call for artists from any art form

Keywords: arts to STEM, creative process, arts as a way to communicate

Who / Ca' Foscari University of Venice, the Science Museum of Venice.

Artist: Haseeb Ahmed

<https://wind-residency-venice.com>

What / Often working collaboratively Ahmed Haseeb, a research-based artist from the US, now based in Brussels, who produces objects, site-specific installations, films, and writes, integrates methodologies from the hard sciences into his art production. His recently completed Wind Egg Trilogy blends art and aeronautics, myth and technology, to create new narratives for the present. His work with the wind and science began during his Masters from the MIT Program in Art, Culture, and Technology completed in 2010. He is currently an artist in residence at Science Gallery Venice. The focus of his research is the wind, one of the invisible forces which shapes the city of Venice and its maritime history.

Why / This case teaches individuals to observe the world by observing artwork and how the research can make the process visible by engaging emotions or questions.

Results / About the main results, the artist's research into the wonders of wind, including the dust-laden Sirocco which blows in from the Sahara, is to lead to the creation of an art piece to be showcased during the Venice Biennale in 2022. The final piece will combine sculpture,



Earth Water Sky is Science Gallery Venice's 3-year residency programme for artists interested in the environment and the latest in cutting edge environmental knowledge. Every year there will be an open call for artists from any art form – digital arts, painting, sculpture, dance, performance, music, multimedia, video, film, photography, writing, drawing – to apply for a 2 month fully funded residency in Venice. The winning artist/s will work with leading scientists from Ca' Foscari University and the Veneto region. The main concept of this interesting project is the connection to the history of Earth written in the rocks and sediment in the landscape and which have been used for human culture. From the distinctive white Istrian stone and pink marble used to build the Doges Palace in Venice, to ancient organisms, plants and invertebrates preserved as fossils in sedimentary rock, where rocks are the Earth's timekeepers, their history is the witness and record of all activities on our Planet.

architecture, performance and the people of Venice in an artistic work which will also have a digital life.

2

PROCESS
"Test drives"

CASE

RELIQUARY

Regenerative Reliquary

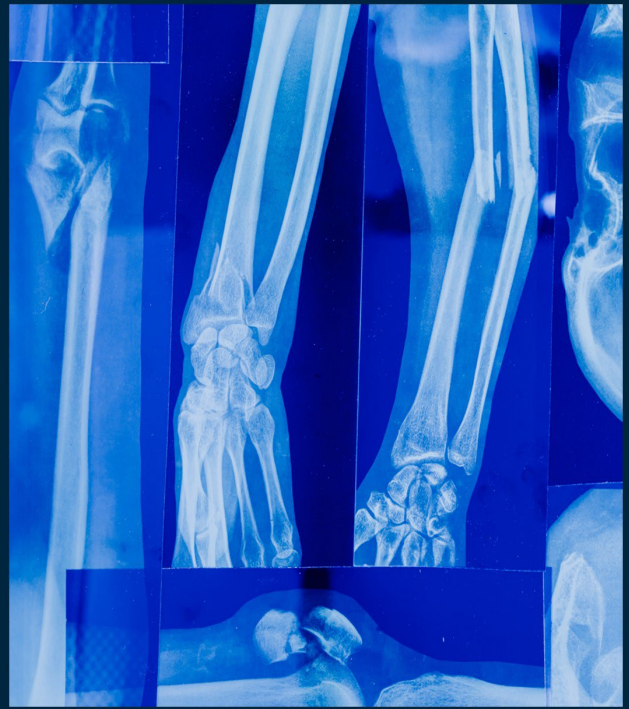
Keywords: arts to STEM, concept development, bio art

Who / Artist: Amy Karle with the support of Autodesk, Autodesk's Pier 9 Artist in Residence (AIR) Program, Bio/Nano Research Team, the Ember 3D Printer Team, Within Medical, Autodesk Software and Evangelists, California Academy of Sciences, Exploratorium: The Museum of Science, Art and Human Perception, and The Bone Room

What / Karle explores what it means to be human through art, design, science and technology. Leveraging the intelligence of human stem cells, she created "Regenerative Reliquary", a bioprinted scaffold in the shape of a human hand, 3D printed in a biodegradable pegda hydrogel that disintegrates over time. The sculpture is in a bioreactor, so that human Mesenchymal stem cells seeded onto the design will eventually grow into tissue and mineralize into bone along the scaffold.

Why / This case encourages envisioning both medical and artistic futuring, fostering innovation and education. This may serve as a foundation for further exploration and research opening conversation about transhumanism, synthetic biology, the future of medicine and implants and speculative design.

Results / This piece was the largest 3D printed scaffold for stem cell growth. This bioart established a new field in the art world, expanding opportunities for biomedical applications. This piece was intended as an artwork outside of the body, but the potential healthcare benefit



Regenerative Reliquary focuses on the dynamic organ and tissue in our bodies that is constantly remodeling and changing shape to adapt to the daily forces placed upon it: bone.

Bone is the structure and foundation that supports our bodies. It seems solid, but bone is very much alive and constantly changing. Bones are a material of life as well as a material that is left after death; historically, used to make tools, accessories, art and objects. Throughout history, there has been a spiritual, macabre, and even miraculous agency associated with bones. Bones have been enshrined into reliquaries to serve as memorials, guidance, protection, objects of fear, superstition and devotion.

Referencing the traditional presentation of relics in their reliquaries, this piece is a finely detailed skeleton sculpture encased in a glass bioreactor. Instead of enshrining the inanimate remains left after death as a memorial to the life that was once there, Regenerative Reliquary presents the opposite, depicting the possibility of life from an inanimate object.

of this approach could be that a patient's own stem cells could be obtained and used for a personalized bone graft designed to be an exact fit and implanted with low risk of rejection since it is made of a person's own DNA avoiding complications of foreign implantation.

2

PROCESS
"Test drives"

CASE

SUPRASPECTIVES

Human universe colonization

Keywords: social impact, space,
arts as a way to communicate

Who / Artists: "Quadrature" made up by Juliane Götz and Sebastian Neitsch, whose research focuses on data and physical experiments. In collaboration with Silvia Bonoli and Raul Angulo, astrophysicists from the Donostia International Physics Center, and the support of local community science groups. Installation developed in Tabakalera MediaLab (Donostia, Spain), with the collaboration of Ars Electronica.

What / This audiovisual installation, created through tracking and gathering the data generated by 590 former spy satellites. Supraspectives follows and calculates satellite trajectories in real time, reconstructing the images captured through an artistic process of speculative reinterpretation. The installation is generated by remixing images with the data from these satellites and from other ones passing close to the exhibition venue. The installation incorporates on screen data relating to the satellites with which it connects live, such as their country of origin and the year of launch. A motorized antenna was built and placed on the roof of Tabakalera to transform live radio signals into sounds that were incorporated into the piece.



Photo by SpaceX, Pexels

Why / The research carried out is based on data interpretation and physical experimentation, exploring our planet and the cosmos, and analysing military space activity and how and how a large number of these satellites can be considered space junk, despite the fact that they continue to fly overhead. Supraspectives raise awareness of phenomena that are hardly accessible and interpretable by most people.

Results / The resulting audiovisual installation addresses, through an artistic interpretation of scientific data, questions related to the unexplored aspects of human life and the universe. The artwork shows the contrast between stunning earth images taken from outer space as it raises critical awareness about human universe colonization, often related to military and surveillance purposes. The creation process incorporated citizen science actions carried out together with the astronomy group of Tabakalera's MediaLab and the local amateur radio community.

2

PROCESS
"Test drives"

CASE SIMPLIFICATION

Communicating something with a few words or lines ...

Keywords: simplifying larger content, observation skills, advanced awareness

Who / Artist Al Hirschfeld. Best remembered for black-and-white drawings of celebrities and show-business stars, Hirschfeld was one of the few artists commissioned to provide art for U.S. postal stamps. His work can be found in museums around the country today, including the Metropolitan Museum of Art and the Museum of Modern Art, both in New York City.

Hirschfeld was also a master of camouflage

What / Hirschfeld created recognizable images of anyone or anything. His art and his creative technique itself is the key point of this Steam case. Visualizing even the most complicated of things in a simple yet clever way. The case teaches how we can communicate ideas to one another.

Why / To make communication easier and simpler. The point lies in finding and simplifying the essence, sharpening the main point of an idea. The following method trains us to realize and communicate specific details in our surroundings.

Bomber pilots in training would use the illustrations as a means to improve their detection skills



In 1924, Hirschfeld traveled to Paris and London, where he studied painting, drawing and sculpture. When he returned to the United States, a friend, fabled Broadway press agent Richard Maney, showed one of Hirschfeld's drawings to an editor at the New York Herald Tribune, which got Hirschfeld commissions for that newspaper and then, later, The New York Times. Hirschfeld is considered to be one of the most important figures in contemporary drawing and caricature, having influenced countless artists, illustrators, and cartoonists.

Results / Despite the sharpness of his lines and the clarity of his work, Hirschfeld was also a master of camouflage. Each week, droves of his fans would spend their Sunday's searching for the word 'NINA' in his drawings. What started out as an innocent little gesture to celebrate the birth of his daughter turned into a weekend pastime for millions of readers.

Hirschfeld's 'NINA's' became so popular that they were even adopted as a training exercise by the U.S. Army (much to Hirschfeld's annoyance). Bomber pilots in training would use the illustrations as a means to improve their detection skills. If they were able to find the 'NINA's' in each illustration, then they were sure to be able to detect hidden targets.



PROCESS
"Test drives"

OUTPUT
Social impact

CASE

8th PASSENGER

How can complex data be represented?

Keywords: arts to STEM, social impact
arts as a way to communicate

Who / Mo Y, a collective comprising artists Katerina Chryssantopoulou and Benoît Durandin, who carry out cross-practices in the fields of art, architecture and science. A collaborative process with GTD System and Software Engineering, one of the most important European companies in sectors such as space, aeronautics, energy or science.

What / A collaborative and multidisciplinary process for knowledge exchange and creation of innovation processes between creatives, artists and organizations, developed in the framework of Disonancias (2008-2009), a program where fourteen research projects were developed jointly by international artists and organizations from Catalonia and the Basque Country (Spain).

The Eighth Passenger aimed to develop a reliable source of knowledge to assist space crews. To this end, experimental research was carried out, starting with the question: how can complex data be represented and at what scale? In response, a series of tools were devised to create alternatives or improvements to the graphical interface of decision support systems for users handling large amounts of complex data in a manned space mission control center.

Why / The Eighth Passenger was an experimental research and prototyping process led by creatives and engineers working together to find a solution to support decision making and decision support systems, modelling of complex data, predictive diagnose and data, among others.



Photo by Mikhail Nilov, Pexels

One of the starting questions of this research process was: How can complex data be represented and at what scale? Mo Y created a holistic image by working from physical laws, chemical signals and biological morphogenesis. As a result, the conceptualization of an assistant based on artificial intelligence and augmented reality techniques capable of guiding astronauts on future manned planetary exploration missions in the interpretation and handling of complex data and materials in which they are not experts such as engineering, medicine or psychology, in the aim of aiding them in critical circumstances, and at the same time suggesting actions to be executed in specific situations.

Results / In 2010 GTD presented the Eighth Passenger, conceived as an assistant based on artificial intelligence and augmented reality techniques capable of guiding astronauts on future manned planetary exploration missions. The ePartner helps interpreting complex data and material with which astronauts are not experts in, such as engineering, medicine or psychology, in the aim of aiding them in critical circumstances, and at the same time suggesting actions to be executed in specific situations.

3

OUTPUT
Social impact

CASE

LIVING LIGHT

Fusing together “nature smart” & “logic smart” & a hip of creativity

Keywords: prototyping, multisensory communication, sustainability

Who / Nova Innova Netherlands

What / Nova Innova is a creative start-up based in Rotterdam that combines nature, science, and design to generate crucial, sustainable breakthroughs. Microbial Fuel Cell (MFC) technology enables us to generate energy from organic waste: from compost to mud, from urine to plants. All organic waste streams are turned into sustainable energy sources thanks to this innovative technology.

Why / There are many interesting things happening in laboratories all over the world, which remain invisible to the general public. The team of Nova Innova aims to bridge the gap between science and everyday life, by developing sustainable applications in the shape of a powerful design.

This case teaches individuals to be more sustainable from influencing the way one observes and become aware of how technology can help to generate energy and contribute to sustainability.

Results / The main result of the case is to make visible what happens in laboratories by developing sustainable applications which can be used in everyday life. This is an innovative approach where science and art can work together and contribute in a sustainable way.



Photo by Singkham, Pexels

Microbial Fuel Cell technology was included in the European Commission's '100 radical innovation breakthroughs for the future' report in 2019, acknowledging the importance of the development of this sustainable technology. Up until now MFC technology has been investigated in laboratories all over the world but attempts to implement this promising technology in the real world have been limited. The Living Light indoor design lamp and the outdoor park modules are the first light applications making use of this technology to provide you with energy. Microbial Fuel Cells for the Living Light collaborate with the naturally occurring microbes in the soil to generate energy. MFC technology is comparable with the solar cell of twenty years ago, standing on the brink of becoming a welcome contribution to the renewable energy mix. The Living Light is there to inspire others to develop this technology to the fullest and to tell the story of MFC technology in a magical way. Before the Living Light project, people were skeptical about the use of this sustainable energy source for practical applications. Now the 'Park of Tomorrow'— the Living Light Park — and our indoor Living Light lamps are the first global example that we can use this promising technology to light up houses and parks.

3

OUTPUT
Social impact

CASE

FUNGI

Mind the fungi

Keywords: arts to STEM, network utilization, sustainability

Who / Departments of Applied and Molecular Microbiology and Bioprocess Engineering of the TU Berlin and the art and research platform Art Laboratory Berlin
Artists: Theresa Schubert & Fara Peluso

What / Mind the Fungi is a project which uses the interdisciplinary concept from STEM to STEAM (Science, Technology, Engineering, Mathematics, Art) to expand scientific research with artistic and design-based research. Work is done with Berlin citizens, artists and designers to develop new ideas and technologies for mushroom and lichen-based materials. "Walk & Talks" are public events and a part of Mind the Fungi, to explore the potential of sustainable biomaterials from fungi. Also, an "Artists in Residence" program brings art and design into this project supporting the aspect of sharing research processes and findings with the public.

Why / All this was to provide citizens with an opportunity for scientific collaboration, to give the public an understanding of the importance of fungal biotechnology for a sustainable future and to establish a research network at the TU Berlin.

Results / The Walk & Talks offered diverse perspectives on the forests and their cultural meaning. Also, during the artist residencies, Schubert studied the effects of sound on fungal growth and Peluso did research on new biomaterials on the symbiotic basis of algae and fungi. The creative works are a result of a close collaboration with both departments of TU Berlin's Institute of Biotechnology. The final exhibition presented new results from the laboratories of the Institute of Biotechnology at TU Berlin.



Photo by Ravi Kant, Pexels

Mushrooms are used in biotechnology as cell factories to produce antibiotics, immunosuppressants, cholesterol-lowering drugs, antimalarials, insulin, prebiotics, pigments, organic acids, enzymes, polyunsaturated fatty acids, vitamins and more. The fungal biotechnology of the 20th century managed to establish itself as an essential platform technology for innumerable branches of industry and thus decisively shapes our daily life and our lifestyle in an invisible way.

At the moment, fungal biotechnology is undergoing a disruptive innovation process, which we want to co-design with citizen scientists in a sustainable manner. Mushrooms, which are produced based on renewable vegetable raw materials in the biotechnological process, are to be converted, with far-reaching consequences, into packaging materials, building materials, and even leather. With the expertise of applied and molecular microbiology in the field of fungal biotechnology (Prof. Meyer), bioprocess development (Prof. Neubauer) and art and science communication (Art Laboratory Berlin) the aim of the project is also to establish a new, innovative and interdisciplinary field of research at the TU Berlin, which dares right from the beginning to build a bridge in the growing Citizen Science Community in order to integrate their expertise at an early stage.

3**OUTPUT**
Social impact

CASE

SOURCEBOOK

The Sourcebook for Teaching Science

Keywords: strategies, instructions, arts as a way to communicate

Who / Authors Norman Herr and James Cunningham, and published by Jossey-Bass, John Wiley & Sons, Inc.

Science is usually seen as an abstract subject

What / The Sourcebook for Teaching Science is designed to complement any secondary school science curriculum. Science teachers will find ready-to-use demonstrations, experiments, illustrations, games, puzzles, analogies, lessons, activities, and strategies, as well as explanations of how to adapt these for English learners and diverse student populations. All topics are accompanied by extensive background material, providing teachers with the scientific, organizational, and pedagogical principles necessary for successful classroom implementation.

Why / Science is usually seen as an abstract subject. Using games, analogies and illustrations give the pupils the possibility to touch and play with science.

The possibility to play with science

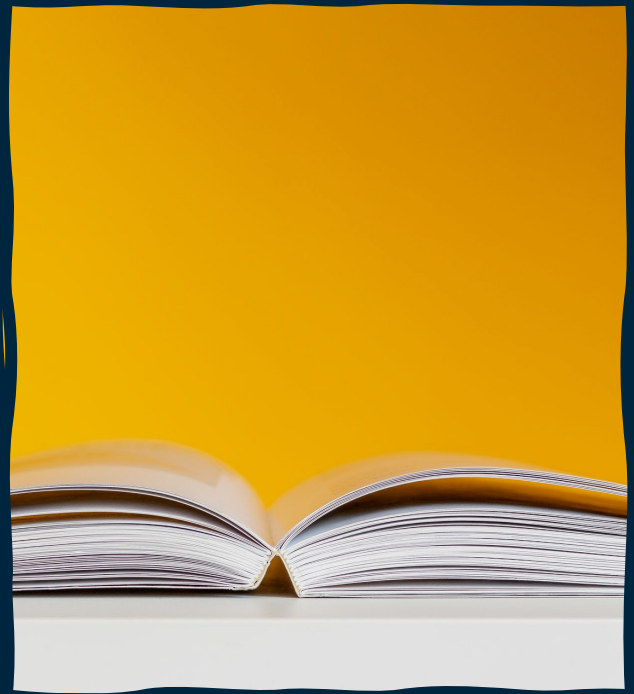


Photo by Stas Knop, Pexels

The Sourcebook for Teaching Science was released in 2006 by Jossey-Bass, John Wiley & Sons, Inc. and written by Norman Herr and James Cunningham. It was first published as a tool for teachers in secondary school, enabling them to present sciences in a more applied way, using serious games, puzzles, experiments, illustrations, and strategies.

The contents of the book are now available on the Internet:
<http://www.csun.edu/science/books/sourcebook/chapters/13-games/index.html>

A series of games are presented, and there are many other resources simplifying scientific concepts using videos, visualization, mind maps and so on.

Results / This project gives the pupils in secondary school the possibility to play with science. It is scientifically proof that Serious Games offer considerable potential for facilitating both formal and informal learning experiences. Games combine different aspects coming from the arts skills, such as graphic design and storytelling, and technological skills such as programming, logic, math.



OUTPUT
Social impact

CASE

ALMA

Collaboration between arts and science affect humans' everyday life

Keywords: prototyping, everyday life, future designs

Who / STARTS Lighthouse Re-FREAM
Artist and designer: Giulia Tomasello
The co-creation process has been hosted by Fraunhofer IZM

What / ALMA is a collaboration between a variety of professionals (material scientists, medical anthropologists, interaction designers, clothing designers, fashion designers). The project team organized workshops and a survey for women to participate in the conversation and thus gaining permission to collect data on stigma and taboos regarding intimate health. The artistic identity of the project was refined through co-creation with 11 international fashion designers.

Why / ALMA opened a space of innovation, where females can become aware of their own bodies by becoming empowered through technology. The aim is to provoke societal changes by rethinking fashion and technology together.

Results / The team developed four working prototypes of inclusive underwear that have an embedded, wearable biosensor for the non-invasive diagnosis of bacterial vaginosis. Alma will continue to build on the results demonstrated by its first pH sensing prototype and co-creation. The prototypes are also proof that collaboration has true value when designing wearable technology for female's healthcare.



The project delved further into the physiological aspects of the female body, conducting a lot of remote research to understand which under-served health conditions experienced by women, Alma could address and add value to. During the physical co-creation process in Berlin (Fraunhofer IZM), they successfully built a modular design where the technology is embedded in the gusset of the underwear, where the pH sensor is located, and the data is conducted through some conductive wires to a small case where the electronics are kept. The prototype even has wireless communication that can potentially allow a woman to access her own information, to know better her body and feel encouraged to seek help when needed.

With Silke, a clothing designer, they investigated the inclusivity of clothing and how the garment itself can be a tool to let women be empowered and feel comfortable with a technology that comes very close to their body. They managed to produce four pairs of underwear with two different styles: a 50s style and a basic style.

3

OUTPUT
Social impact

CASE

ASTROPHOTO

Aspire awe of what we don't yet understand

Keywords: astrophotography, social impact, arts as a way to communicate

Who / Astrophotographer Jukka-Pekka Metsävainio, Oulu, Finland. His photos have been published by, e.g. National Geographic, the Smithsonian Institute and museum, NASA and Wired.

What / Metsävainio's panoramic photo of the Milky Way consists of hundreds of photos, shows over 20 million stars and covers 125 degrees of the sky cover. The photos were taken over 12 years. It is currently, the largest scale photo of the Milky Way. The photo is also a piece of art. Metsävainio is an artist by education, but self-taught in astrophotography and he has developed new techniques to get better photos. The colors in his photos are based on the colors that elements emanate. But his goal is still to capture beauty.

Why / Metsävainio's photos are a way of making people more aware of what it is like in space. The point lies in the ways we can raise interest in specific fields. The blind eye cannot even imagine the true appearance of the milky way, but Metsävainio has been able to prove and capture this beauty with photographic skills.

Results / Astrophotographer Jukka-Pekka Metsävainio's photographs of the Milky Way and the space have gained international fame. The photos are incredibly detailed and high-resolution. This case has awoken engaging questions about the unexplored sides of the universe. This case is one of the greatest examples of how much power visuality has on our comprehension especially on large scale phenomenon.



Metsävainio is a visual artist, not an astronomer. He didn't wait 12 years for this work to be finished. He published independent samples as their own work, and gradually filmed the gap between these samples. He had planned the final result beforehand; The angles and composition had to be considered well in advance because they cannot be changed afterwards.

Technology is just an artist's tool. Taking long exposure times requires equipment that makes the camera follow the stars. Metsävainio has assembled his own equipment. "It's a terrible-looking tune up," said Metsävainio. The axis of the German-made pedestal is parallel to the Earth's axis. Basically, it's a backward-rotating clock that keeps the camera pointing closely at the same spot in the constellation.

SOURCES (1/2)

CASE YALE

Peart, K., 2001. Artwork Can Sharpen Medical Diagnostic Skills, Yale Researchers Report. [online] YaleNews. Available at: <https://news.yale.edu/2001/09/04/artwork-can-sharpen-medical-diagnostic-skills-yale-researchers-report> [Accessed 25 March 2022].

Yale School of Medicine. 2014. How looking at paintings became a required course in medical school. [online] Available at: <https://medicine.yale.edu/news/yale-medicine-magazine/article/how-looking-at-paintings-became-a-required-course/> [Accessed 25 March 2022].

CASE SCIENCE & MUSIC

Hancock Institute of Jazz. 2021. Math Science and Music. [online] Available at: <https://hancockinstitute.org/education-program/math-science-music/> [Accessed 25 March 2022].

MathMusicScience. 2016. MathScienceMusic. [online] Available at: <https://mathsciencemusic.org/#/> [Accessed 25 March 2022].

CASE FUTURE LAB

Ars Electronica Futurelab. 2021. About Ars Electronica Futurelab. [online] Available at: <https://ars.electronica.art/futurelab/en/about/> [Accessed 25 March 2022].

CASE SIMETRIA

Corporación Chilena de Video y Artes Electrónicas. 2021. Las artistas Patricia Domínguez (Chile) y Chloé Delarue (Suiza) son seleccionadas para participar en la segunda edición de Simetría | Corporación Chilena de Video. [online] Available at: <https://cchv.cl/las-artistas-patricia-dominguez-chile-y-chloe-delarue-suiza-son-seleccionadas-para-participar-de-la-segunda-edicion-de-simetria/> [Accessed 25 March 2022].

CASE DEFOREST

Moll, J., 2016. About DEFOOOOOOOOOOOOOOOOOOOOOREST. [online] Janavirgin.com. Available at: http://www.janavirgin.com/CO2/DEFOOOOOOOOOOOOOOOOOOOOOREST_about.html [Accessed 25 March 2022].

Moll, J., 2016. DEFOOOOOOOOOOOOOOOOOOOOOREST. [online] Janavirgin.com. Available at: <http://www.janavirgin.com/CO2/DEFOOOOOOOOOOOOOOOOOOOOOREST.html> [Accessed 25 March 2022].

CASE VÄRMLAND

About The Great Journey. 2022. The Great Journey. [online] Available at: <https://www.thegreatjourney.se/aboutus> [Accessed 25 March 2022].

CASE EARTH/WATER/SKY

CafoscariNEWS. 2020. Haseeb Ahmed is the winner of the 2nd Earth Water Sky residency programme. [online] Available at: https://www.unive.it/pag/16584/?tx_news_pi1%5Bnews%5D=8749&cHash=23c20a779ef3c0a16f98da261233f255 [Accessed 18 March 2022].

Ahmed, H., 2022. Earth Water Sky Residency, Science Gallery Venice. [online] Wind-residency-venice.com. Available at: <https://wind-residency-venice.com/> [Accessed 31 March 2022].

Ahmed, H., 2022. www.haseebahmed.com. [online] Haseebahmed.com. Available at: <https://haseebahmed.com/> [Accessed 18 March 2022].

CASE RELIQUARY

Karle, A., 2016. Regenerative Reliquary. [online] Amykarle.com. Available at: <https://www.amykarle.com/project/regenerative-reliquary/> [Accessed 18 March 2022].

SOURCES (2/2)

CASE SUPRASPECTIVES

Götz, J. and Neitsch, S., 2020. Supraspectives. [online] Quadrature.co. Available at: <https://quadrature.co/work/supraspectives/> [Accessed 18 March 2022].

CASE SIMPLIFICATION

Al Hirschfeld Foundation. 2022. alhirschfeldfoundation.org. [online] Available at: <https://www.alhirschfeldfoundation.org/> [Accessed 18 March 2022].

McCall, B. and Stern, E., 2021. Always Leave Them Smiling: The Art of Al Hirschfeld. [online] Nytimes.com. Available at: <https://www.nytimes.com/2021/07/08/books/review/hirschfeld-the-biography-ellen-stern.html> [Accessed 18 March 2022].

CASE 8th PASSENGER

Gtd.eu. 2010. GTD presents the "Eight Passenger" concept for astronaut crew in future space missions. | GTD Blog. [online] Available at: <https://www.gtd.eu/en/news-and-events/gtd-presents-eight-passenger-concept-astronaut-crew-future-space-missions> [Accessed 25 March 2022].

Zabeli, E. and Chryssanthopoulou, K., 2022. Moy Studio. [online] Moystudio.gr. Available at: <https://moystudio.gr/en> [Accessed 18 March 2022].

CASE LIVING LIGHT

STARTS PRIZE. 2021. The Living Light. [online] Available at: <https://starts-prize.aec.at/de/the-living-light/> [Accessed 18 March 2022].

Livinglight.info. 2022. Living Light. Nova Innova. [online] Available at: <https://livinglight.info/> [Accessed 18 March 2022].

CASE FUNGI

Art Laboratory Berlin. 2020. Mind the Fungi. [online] Available at: <https://artlaboratory-berlin.org/publications/mind-the-fungi-book/> [Accessed 18 March 2022].

Meyer, V. and Rapp, R. (Ed.), 2020. Mind the fungi. Berlin: TU Berlin University Press. Available at: <https://artlaboratory-berlin.org/publications/mind-the-fungi-book/> [Accessed 18 March 2022].

CASE SOURCEBOOK

Herr, N., 2007. The Sourcebook for Teaching Science. [online] Csun.edu. Available at: <http://www.csun.edu/science/index.htm> [Accessed 18 March 2022].

CASE ALMA

Tomasello, G., 2020. ALMA. [online] Re-fream.eu. Available at: <https://re-fream.eu/alma/> [Accessed 18 March 2022].

Tomasello, G., Busolo, T., Farina, I. and Mizuta, R., n.d. ALMA. [online] Al-ma.org. Available at: <https://al-ma.org/Smart-Underwear> [Accessed 18 March 2022].

CASE ASTROPHOTO

Metsävainio, J., 2022. Astro Anarchy. [online] Astroanarchy.blogspot.com. Available at: <https://astroanarchy.blogspot.com/> [Accessed 18 March 2022].

Metsävainio, J., 2022. Astro Anarchy. [online] Astro Anarchy. Available at: <https://astroanarchy.zenfolio.com/> [Accessed 18 March 2022].

Paukku, T., 2021. Oululaisen tähtikuvaajan tarkka otos Linnunradasta ihastuttaa ympäri maailmaa: "Haluan näyttää, kuinka upea maailmamme todella on". [online] Helsingin Sanomat. Available at: <https://www.hs.fi/tiede/art-2000007899693.html> [Accessed 18 March 2022].