International Institute for Applied Systems Analysis
IIASA www.iiasa.ac.at

# SCIENCE AND ART FOR LIFE'S SAKE

## How partnerships between artists and scientists can support the transformation toward sustainability

International Institute for Applied Systems Analysis
IIASA www.iiasa.ac.at

**International Institute for Applied Systems Analysis**
Schlossplatz 1, A-2361 Laxenburg, Austria

The International Institute for Applied Systems Analysis (IIASA) is an independent, international research institute with National Member Organizations in Africa, the Americas, Asia, and Europe. Through its research programs and initiatives, the Institute conducts policy-oriented research into issues that are too large or complex to be solved by a single country or academic discipline. This includes pressing concerns that affect the future of all of humanity, such as climate change, energy security, population aging, and sustainable development. The results of IIASA research and the expertise of its researchers are made available to policymakers in countries around the world to help them produce effective, science-based policies that will enable them to face challenges such as these.


**Available at: pure.iiasa.ac.at/16638**

---



---

Cover image: Cast during the Premiere of *Dancing with the Future* © Jason Nemirow

# SCIENCE AND ART FOR LIFE'S SAKE

## How partnerships between artists and scientists can support the transformation toward sustainability




(R-L) Merlijn Twaalfhoven, Gloria Benedikt and Mimmo Miccolis in *Courage* © Guillaume Gimenez

# FOREWORD
## BY BAN KI-MOON
### EIGHTH SECRETARY GENERAL OF THE UNITED NATIONS

Over forty years have passed since the first conference on climate change was organized by the United Nations World Meteorological Organization. And thirty years have passed since the first Assessment Report of the Intergovernmental Panel on Climate Change, authored by scientists from around the world, was published. Yet over the past decades, the international community has seen that overwhelming scientific evidence, international political commitment and technological progress alone do not result in sufficient action to address climate change. A paradigm shift is needed to transform our relationship with planet Earth, and inspire a transition toward sustainability.

Five years have passed since the 2030 Agenda and the related Sustainable Development Goals (SDGs), were adopted by the United Nations. As a politically negotiated agreement to which all nations commit, the 2030 Agenda is a breakthrough in our quest for sustainability. But we still face the same challenge: how to get from agreement to action. Perhaps one of the most underachieved of the Sustainable Development Goals is SDG 17: Partnerships for the Goals. The SDGs can only be achieved with strong global partnerships and cooperation. However, in the past five years, we have seen a decline rather than an increase in the political culture of global cooperation.

On the other hand, a powerful new partnership has emerged: a partnership between art and science. The pioneering work reflected in this report shows how scientists and artists working together can contribute to cultural and behaviour change, which will be crucial if we are to succeed in translating knowledge into action on our path toward sustainability.



Laxenburg Castle, IIASA's headquaters since 1972 © Dreamstime

# SETTING THE SCENE

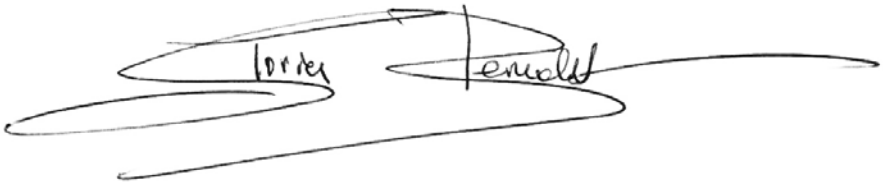
Upon entering Laxenburg Castle for the first time on January 15, 2015, I could not help thinking how ideally positioned IIASA was in hosting a Science & Art project. For hundreds of years, the history of science and art, two human pursuits we have come to see as separate, or even opposite, has been closely intertwined with European courts. Now, Laxenburg Castle, which was acquired by Empress Maria Theresia during the Enlightenment and naturally has a built-in theater, was becoming the place for a 21st-century reunion. Beyond this symbolism, IIASA's founding story as an institute dedicated to building bridges across Cold War divides, and the nature of its research, provided an environment for potentially fruitful collaboration between artists and scientists. Systems analysis has always been interdisciplinary, encompassing multiple branches of the natural and social sciences, but up until now, the humanities have not been included. "The convergence between these two great branches of learning will matter hugely when enough people have thought its potential through," the biologist Edward O. Wilson observed in 2014, referring to the coming together of science and the humanities.[1]

IIASA became a unique place where I could explore what the various interlocking systems that make today's art world often do not see: how to engage with "real world" problems and contribute to solving them. Support for this idea came from Wilson a few years later when, in 2017, he wrote: "To link the humanities through the creative arts to science is a difficult enterprise. Why should we even try? The creative arts are among both the most intellectually advanced and most ephemeral of human endeavors." Combined with knowledge originating in science, they stand to fulfill their potential. "Otherwise," he continues, "the creative arts will continue to grow like trees sprouted outside the forest, less than a part of the living world ecosystem."[2]

This need for convergence goes both ways. Science can depict the world as it is and as it could be in the future. But by nature, it cannot imagine what the human experience in that modeled future would be like. Depicting the human experience is the domain of the arts. So, science and art, brought together, could have transformative power. A true collaboration between these two fields could generate innovative thinking to usher in a global sustainability transformation. Perhaps it could bring about new solutions to the challenges humankind is facing, such as the urgent need to meet the UN Sustainable Development Goals.

For five years, the IIASA Science & Art project explored how artists could support transformations to sustainability. It has been an invigorating journey of discovery and it confirmed that yes, not only is a true collaboration between science and art possible, but such a collaboration leads to outcomes that are greater than the sum of their parts. The insights we gained, as well as the result of our inquiries and suggestions on where to go from here, are all documented in this report.

I would like to thank IIASA for being the first science institution to host such an innovative project for half a decade and the organizations who partnered and supported it. The discoveries outlined here were made possible thanks to the work of the many scientists and artists who poured their hearts and minds into this endeavor, venturing on new paths with passion and diligence, creativity and determination. May what we have uncovered serve humankind in the crucial decade ahead.



IIASA Science and Art Project Leader

**GLORIA BENEDIKT** trained at the Ballet Academy of the Vienna State Opera, and English National Ballet School, London. She graduated from Harvard University in 2013. Prior to joining IIASA, she choreographed papers in Europe and the United States.

Contact: www.gloriabenedikt.com

A documentary film on the Science & Art project featuring the work described here is available at www.iiasa.ac.at/SciArt-20

# CHAPTER I
# FULFILLING THE DREAM OF THE ENLIGHTENMENT

In 1570, the French king, Charles IX, established the Académie de Poésie et de la Musique, modeled after the famous Renaissance Florentine Platonic Academy. It was based on Neo-Platonic ideals, where music and morality are closely linked, and was designed to explore whether connecting various disciplines might bring about a more structured social order and morality. The Académie thus proposed an "encyclopedic course in the inquiry," as described by the historian Jennifer Homans, that was not limited to music and poetry but also included natural philosophy (later known as science), languages, mathematics, paintings, and the military arts.[3] "Until well into the 17th century," she points out, "distinguished scientists, poets, and writers looked back with admiration on the Académie's experiments."[4]

Throughout the second half of the 17th century, Louis XIV gave disciplines that had traditionally been housed under one umbrella their own separate homes. He founded the Academy of Painting (1648), Academy of Fencing (1656), Academy of Dance (1661), Academy of Science (1666), Academy of Music (1669), and Academy of Architecture (1671). His move was strategic; by encouraging progress through specialization, he aimed to increase France's influence on cultural and intellectual matters across Europe.[5]

During the 17th and 18th centuries, the idea of the Enlightenment ruled the Western intellectual world. As the biologist Edward O. Wilson points out:

> *Scholars appeared on track to explain both the universe and the meaning of humanity by the laws of science, the latter called at the time natural philosophy. Enlightenment thinkers believed that the great branches of learning can be unified by a continuous network of cause and effect. Then, when built from reality and reason alone, cleansed of superstition, all of knowledge might come together to form what Francis Bacon called "the empire of man."*[6]

The quest of the Enlightenment was driven by the idea that human beings could know all there is to know entirely on their own and, through the act of knowing, they could understand, and once they understood, they would gain the power to make better choices. However, by the early 19th century, the dream faltered. According to Wilson,

there were two reasons for this: "First, although scientists were generating discoveries at an exponential pace, they were nowhere close to meeting expectations of the more optimistic Enlightenment thinkers." Second, this shortfall led artists, who rejected the presumptions of the Enlightenment worldview, "to seek meaning in other, more private venues" embodied by the Romantic tradition.[7]

For the following two centuries up to the present day, science and art went their separate ways. Scientific disciplines were divided into specialties at an ever-increasing rate, yielding great progress. The arts, in the meantime, continued to blossom "with brilliant and idiosyncratic expressions of the human imagination," Wilson describes. "Physicists, of course, no less continued to enjoy playing in string quartets and novelists wrote books that marvelled at the wonders uncovered by science." But, by and large, the two cultures, as they were called by the mid-20th century, were considered separate.[8] There was little interest in reviving the quest for unification—or, at the very least, there was not enough interest that translated into a concentrated effort and investment over an extended period of time for scientists and artists to work together.

However, as we have seen over the last decades, reliance on scientific knowledge alone is reaching its limits in some areas. For example, we have known for 40 years that $CO_2$ emissions are causing global average temperatures to rise. Year after year, more details have emerged on the life-threatening consequences our current trajectory will have on humans, animals, and plants. But knowledge has failed to translate into action on the necessary scale. When technology cannot solve a problem, and collective action is needed, knowledge alone does not result in behavior change. In fact, science tells us the prerequisite for action is emotion.[9] To Enlightenment thinkers, this would not come as a surprise as they were aware that science cannot move people the way the arts uniquely can.[10] Given the urgency in addressing our current challenges, has the time come to resume the quest for enlightenment, and are conditions for its success more favorable now than during the onset of the industrial revolution? Four reasons, indicating that this might be the case, are outlined below:

First, thanks to extensive progress in science, today we have a lot more knowledge to make fulfilling the dream of the Enlightenment attainable.[11]

Second, the problems we face today are considerable and require new approaches. The remainder of the century, Wilson points out, "will be a bottleneck of growing human impact on the environment and the diminishment of biodiversity."[12] Addressing these challenges entails taking responsibility for bringing ourselves and all lives into a more sustainable existence.[13]

Third, solutions to many problems we encounter in modern life hinge on the fact that, by itself, science cannot take into account the various ambiguities of moral reasoning and

worldviews that lead people to receive and react differently to the same knowledge.[14] The human mind is neither purely wired to act upon reason nor emotion; it employs both.[15] Thus, we ought to find new forms of knowledge transmission that take both into account. Emotion, or intuition, as the social and cultural psychologist Jonathan Haidt terms it,[16] is a prerequisite to behavior shift, which is a prerequisite to the sustainability transformation.

Fourth, science, technology, and new business models alone cannot bring about the sustainability transformation. We need a cultural shift:[17] a shift in perception and attitude that leads to a change in public opinion on a large scale, which results in a change in behavior. A lot of resources have been poured into creating scientific knowledge to understand what is required to enable the sustainability transformation. But hardly any resources have been invested in facilitating a cultural shift. It is thus not surprising that scientific knowledge fails to translate into action. We need non-traditional media to help convey sustainable thought and action. Artists, as we will see below, could be promising candidates to fill this gap by partnering with scientists.

Having established an intellectual foundation for the Science & Art project, the next step was to determine what kind of art would best connect to science, and, given the IIASA context, to sustainability science in particular. A logical approach was to start with the performing arts. As we have seen, they share common roots with science as they were housed together in the 16th century before being relocated to their own specialized academies. More importantly, historic evidence on the role the performing arts have played over the past 500 years shows their potential in connecting them with science. A detailed account of this history could fill an entire book, but the short overview below provides examples of their role in society, and how they engaged with the challenges of their time.

Since the performing arts include theater, dance, and music, it is possible to look through each one of these disciplinary lenses and follow the unfolding story of the arts in society. For the purpose of this report, I am going to focus on classical dance. In Chapter XV, contributing authors will supplement this account by providing their perspective through the lens of classical music and theater.

### *Cultural diplomacy and inspiring awe*

### 16TH CENTURY

During the 16th century, Catherine de Medici, queen of France and mother of Charles IX, who, as mentioned above, founded the Académie de Poésie et de la Musique, introduced elegant Italian social dances called "*balli*" (*ballare* means dancing in Italian) at court. The

French called them "ballet."[18] These theatrical events were hardly mere entertainment; rather, they were seen as a matter of state, easing tensions and pacifying warring parties. These early ideas of cultural diplomacy would recur on a much larger scale in the 20th century.

Out of the research conducted at the Académie de Poésie et de la Musique, emerged the idea that "movements of the body, disciplined with poetic rhythm and meter, and brought into accord with musical and mathematical principles, could tune man into celestial harmonies."[19] In 1581, this idea found its embodiment in the *Ballet Comique de la Reine,* which marked the birth of classical dance as an art form. The ballet was presented at the wedding of the queen's sister, Marguerite de Vaudemont. The tale included contemporary relevant themes: passion subjugated by reason and faith, a king and queen subduing their enemies, discord resolved and the triumph of reconciliation and peace. "After many unsettling events" (e.g., only nine years had passed since St. Bartholomew's Day massacre), the ballet's choreographer, Balthasar de Beaujoyeulx, wrote in the preface to the piece, "the ballet will stand as a mark of the strength and solidity of your kingdom."[20] The dances, Homans reports, "traced perfectly formed figures across the floor in tightly measured steps: circles, squares, and triangles, each demonstrating the ways that number, geometry and reason ordered the universe and men's souls."[21] "So dexterously did each dancer keep her place and mark the cadence," Beaujoyeulx observed, "that the beholders thought that Archimedes himself had not a better understanding of geometrical proportions." He hoped that the audience watching would be "filled with awe."[22]

### *Social ambition: Extending influence through progress in social and intellectual matters*

### 17TH CENTURY

King Louis XIV based his reign on three pillars: strengthening the internal hierarchy and social order, fostering progress in art and science to increase the kingdom's cultural influence, and maintaining a well-drilled army to expand the French territory. He understood that maintaining internal social order was key to his reign. Therefore, court life was filled with rituals, including elaborate dances, which were both performative and participative to capture the hearts and minds of his people and strengthen hierarchy and social cohesion. To embody the hierarchy, until 1669 he frequently performed in the leading role. After that, professional dancers took over, developing what we now know as classical ballet.[23] Louis XIV also understood that progress in science and art would increase his cultural influence across Europe, and so founded and funded the various academies mentioned earlier.[24] His logic is still valid to this day and, as will be seen below, was particularly helpful during the culture wars of the 20th century. Finally, the king invested in an exceptionally well-drilled standing army, the most famed in Europe at the time.[25]

*Enlightenment: Expressing essential human truths with a moral force that words simply cannot convey*

## 18TH CENTURY

Because classical dance was so closely linked to the court, the Enlightenment challenged the art form's foundations. In his *Lettres sur la danse et sur les ballets*, the influential ballet master and reformer, Jean-Georges Noverre, suggested "moving the art form away from the trivial, pleasure-seeking aristocracy, and to turn it toward tragedy, moral dilemmas and the study of humankind." He complained that it was not enough "to perform beautiful movements, in beautiful costumes, against lavish sets that pleased the eye. Dancers must also 'speak' to the soul and bring audiences to tears. Ballet must become 'a portrait of humanity,' using humankind and truth as its subject."[26] Similar understandings occurred across the arts. For example, the dramatist Gotthold E. Lessing proclaimed: "If pomp and etiquette make machines out of men, it is the task of the poet to make men again out of these machines."[27]

*Embodying crumbling hierarchical structures and groundbreaking scientific discoveries*

## TURN OF THE CENTURY

By the turn of the 20th century, the confident positivism of the mid-19th century was experiencing a disturbing series of shocks. Appearance was no longer seen as a reliable guide to reality. The discovery of X-rays and radioactivity, very real but invisible, undermined the then immutable laws of nature. Einstein and other physicists discovered completely unexpected linkages between space and time, and weird properties of light and matter. Both the theory of relativity and quantum theory were incompatible with the classical framework familiar since Newton's time. The foundations of mathematics displayed strange paradoxes. Freud's theories of the unconscious started to take shape.[28]

In Vienna, at the time, Freud's contemporary, the expressionist Egon Schiele, was breaking the rules of classical painting, creating physically expressive, tormented, not very aesthetic, yet erotic self-portraits. For his part, the Russian dancer, Vaslav Nijinsky, was pushing the boundaries of classical dance technique in a similar fashion in Paris, shifting away from static poses toward movement. *L'après-midi d'un faune,* which premiered in Paris in 1912, with a score by Claude Debussy, embodied introversion, the animalistic instinct, and self-absorption.[29] The following year, the premiere of *Le Sacre du Printemps* caused one of the biggest riots in theater history. The grim and intense celebration of the collective will, which signaled the death of the individual, was composed by Igor Stravinsky and choreographed by Nijinsky. Ballet had always had an underlying nobility; in contrast, the choreography of *Sacre* "was a coldly rational depiction of a primitive and irrationally-charged world."[30] When first rehearsing the score, musicians found it impossible to play and dancers impossible to count.[31] As for the audience, those who hated it saw a "threatening depiction of a diminished

humanity" and those who loved it saw a manifestation of the most fundamental developments of the time.[32]

*Inspiring hope*

## DURING WORLD WAR II

In the early 1940s, Soviet dancers performed for the Soviet troops as well as in hospitals and factories. Their impact must not be underestimated. As an example, Galina Ulanova, a superstar of the Kirov Ballet, received thank you letters from soldiers who said they took strength from her White Swan.[33] In Britain, by 1943, demand for dance performances was so high that tickets needed to be rationed, like other essential goods. Long lines for tickets formed up to ten hours before seats would be released.[34] Meanwhile, in the United States, the performing arts had finally ceased to be private or commercial ventures and had become matters of state. In 1943, New York's Mayor, Fiorello La Guardia, who wanted the city to have a theater for the performing arts to match great European cities, established the *City Center for Music and Drama*. Tickets were priced to be accessible to working class people, and performances were presented early in the evening to suit their schedules.[35]

*Binding people together across a divided world*

## COLD WAR

In the second half of the 20th century, the Cold War's cultural, scientific, and technological races deeply influenced the role of the arts. In the 1950s, in the United States, the Congress for Cultural Freedom was founded to counter Soviet cultural organizations and demonstrate the superiority of the West in literature and art. To win the cultural Cold War abroad, it seemed imperative to emulate the Soviets and fund culture at home. Public and private sectors thus invested unprecedented resources into education and the arts. In the following decades, as will be seen below, what had started as a cultural war evolved into cultural diplomacy.

Cultural diplomacy was also practiced by other countries. For example, in 1956, as part of a rapprochement between Britain and the USSR, the Bolshoi Ballet visited London with its 1940 production of *Romeo and Juliet.* Britain's Royal Ballet was scheduled to reciprocate later that year, but the trip was abruptly canceled due to the Soviet invasion of Hungary and the Suez Crisis. Yet, as Homans points out, "when the curtain went up on *Romeo and Juliet,* Cold War hostilities momentarily ceased." The British, many of whom had lined up for three days before the box office opened, "were overwhelmed by the scale and magnitude of the production, and by the emotional depth" of Galina Ulanova's portrayal of Juliet. The performance drew 13 curtain calls.[36]

In 1962, New York City Ballet (NYCB) arrived in Moscow for an eight-week tour of the Soviet Union. Even during crucial days on the tour, when a nuclear war nearly erupted, the company kept dancing to cheering audiences in sold-out theaters. The Russian people assured them that they were safe: "You are artists. We don't associate you with your government."[37] The American government had paid for this tour, as it was considered an act of cultural diplomacy. No one could have foreseen that the Cuban Missile Crisis would coincide with NYCB's tour in Russia. Right then and there, it was evident that the arts had the ability to unite people by appealing to universal values.[38] Ten years later, following an agreement between US President Lyndon B. Johnson and Soviet Premier Alexei Kosigyn, IIASA was founded with the goal of promoting science diplomacy—it became a unique place where scientists from the East and West could work together.

Scientists and classically trained artists both receive rigorous training. In both cases, this training has been painstakingly developed over the past 500 years and has led to a professional practice that is pretty much uniform across countries. Scientists seek to uncover and understand what is, and extend this understanding to what may be in the future, using the scientific method. Yet, they know that 100% certainty does not exist. Artists strive to perfect technique, knowing that 100% perfection does not exist. The point of art, as the cellist Yo-Yo Ma explains, is to "transcend technique. That's when we get to meaning."[39]

How can art join science in the defining quest of the 21st century—the transformation to a sustainable way of life? The brief historical overview presented here shows the various roles the performing arts have played in society that are particularly relevant to the sustainability transformation: inspiring awe, transcending politics by fostering empathy, expressing essential human truths with a force that words alone cannot convey, embodying fundamental scientific developments, inspiring hope, and binding people together across divides. How can we harness this potential now? And are there new roles the performing arts can play, when paired with science, that have not been discovered yet?

The following chapters show how music, theater, and dance have partnered with science over the past five years, tackling a vast range of topics from resource depletion to biodiversity loss, from game theory to climate change, and from mechanisms of cooperation to migration. The process of creating these works has yielded a framework and methodology for artists and scientists to work together.



Gloria Benedikt and Hussein Khaddour during the premiere of *InDignity* at European Forum Alpbach, 2015 © Philipp Naderer

# CHAPTER II
# InDIGNITY

The Sustainable Development Goals, extensively informed by science, provide a direction for the world, with the ultimate aim of ensuring "life in dignity for every person on the planet." But what does life in dignity actually mean? Before engaging with science directly, the first Science & Art project, developed in 2015, sought to contribute to the sustainability agenda-in-the-making by examining the meaning of dignity.

*InDignity* premiered at the Political Symposium of the European Forum Alpbach on September 1, 2015, and subsequently toured to China.

## 1. MOTIVATION

The Sustainable Development Goal (SDG) agenda was initially known as the "Road to Dignity by 2030." In the early spring of 2015, while drafts of the agenda were still being negotiated, I embarked on a search to better understand the meaning of dignity. There are concepts that cannot be expressed in words, typically because they are closely connected to emotion. Could art fill this gap? Through an artistic process involving Hussein Khaddour, a dancer living in war-torn Damascus, Syria, I hoped to gain insights into what life in dignity actually means.

## 2. PROCESS

### *A. Identifying the topic*

While reading the synthesis report "The Road to Dignity by 2030," published on December 4, 2014, I noticed how the goals addressed basic human needs such as eradicating poverty and providing universal access to clean water, healthcare, and education, but didn't address what dignity actually meant. This was not surprising. As mentioned above,


Benedikt and Khaddour comparing notes in rehearsal (still from the trailer).

there are concepts that cannot be expressed in words. At the time, Khaddour was living in Damascus, in conditions that made him better equipped than anyone living in the Global North, whose basic needs are already met, to provide insights into this topic. Together, we agreed to embark on a quest to express the meaning of dignity in 2015.

### *B. Preliminary research and discussion*

While I covered the academic research—in particular Michael Rosen's book, *Dignity,* and Donna Hicks' *Dignity: Its Essential Role in Resolving Conflict,* provided inspiration—Khaddour did research on the ground, asking people around him what dignity meant to them. This was a complicated process because during the Arab Spring in 2011, Syrians had taken to the streets demanding a dignified life. Ever since, discussing the concept of dignity has polarized the population.

### *C. Rehearsal period 1*

In April 2015, Khaddour traveled to Austria for a two-week rehearsal. Only hours after he landed in Vienna, more than 800 refugees drowned in the Mediterranean Sea. On this sad note, we, European and Syrian, started to work on our piece about dignity. This was also the day media coverage of the refugee crisis started to dominate the news. We worked for 12 days to choreograph the 20-minute piece. Khaddour has a background in breakdancing, which is very different from my own classical training, but we both have also trained in contemporary dance, and that's where we found common ground. Breaks were spent talking about politics, the refugee crisis, and the role of the UN. A trailer for the piece was shot and a journalist covered Khaddour's story.

**Over these 12 days, we developed the narrative for the piece.**

**SCENE 1:** Article 1 of the Universal Declaration of Human Rights, "All humans are born free and equal in dignity and rights," is projected on a screen. The two dancers try to move, but invisible barriers restrict their movements. They protest against the force that stops them from moving freely, but eventually give up. The scene ends with a projected quote from Immanuel Kant: "In the kingdom of ends, everything has either a price or dignity."

**SCENE 2:** The dancers share playful movement phrases as a metaphor for people communicating with each other on a daily basis. The game, however, becomes competitive and ends up in conflict. She strips him of his T-shirt, steps on it, and starts cleaning the floor with it—a clear violation of his dignity. He tries to get the T-shirt back but does not succeed. She leaves with it.

**SCENE 3:** The man is alone, trying to come to terms with his loss of dignity.

**SCENE 4:** A quote from a woman Khaddour interviewed in Damascus is projected: "If dignity is torn, it cannot be healed." One of the dancers returns with a frantic solo, blue color pigment appears all over her body to hint at psychological pain (in contrast to red, the color of blood).

**SCENE 5:** On the screen is a quote from a conflict resolution expert: "If indignity tears us apart, dignity can put us back together again."[40] Both dancers find ways to give each other back their dignity. The piece concludes with a call to action from UN Secretary General Ban Ki-Moon.

### *D. Research period 2*

During the second research period, we reviewed our material (a filmed run-through of the first draft of the piece) and discussed changes over Skype, while being frequently interrupted by power outages in Syria. The text for the video installation and press release was written and the trailer edited.

### *E. Rehearsal period 2*

The second rehearsal period consisted of 10 more days in the studio, adding new parts, and fine-tuning. We were interviewed by newspapers and radio stations. One of the new parts Khaddour added in Scene 3 was a one-minute solo performed over Harold Pinter's Dead Body Poem, which asks questions such as: "Where was the dead body found? How was the dead body found? Who found the dead body?" On the last rehearsal day, 71 refugees were found dead in the back of a truck in Austria. I remember shaking after


Final scene of *InDignity* © Philipp Naderer

hearing the news and realizing how close to reality our work had become. The truck incident was later considered a tipping point, prompting Austrian and German leaders to open their borders.

## 3. OUTCOMES AND DISSEMINATION

*InDignity* premiered at the Political Symposium of the European Forum Alpbach on September 1, 2015 under the auspices of the Alpbach-Laxenburg group and was also live-streamed—Syrian artists, in particular, watched the live-stream with great interest. High-level decision-makers from the UN and the European Commission were present. That day, hundreds of refugees arrived in Austria, and thousands followed over the following weeks. The audience was very moved; many of them shed tears, and some observed that the performance set the tone for a more honest and critical debate for the remainder of the symposium.

After the performance, we took part in a panel discussion where we explained how our findings were relevant to the SDG agenda. We pointed out how people in war-torn regions need more than food and medicine; they also need "food for the soul" to endure the hard-

ships of daily life. We noted that this kind of essential nourishment, which art can provide, was not explicitly covered in the SDG agenda.

*InDignity* received coverage from multiple newspapers and radio stations, and a short summary video was posted on social media. Six weeks after the premiere, we traveled to China on the invitation of the Austrian Ambassador to China, Irene Giner-Reichl. We performed *InDignity* and led workshops on the topic in various locations including at Tsinghua University.

> *“Gloria Benedikt and Hussein Khaddour realized what is seldom achieved: To express concrete philosophical and political insights through a very strong, deeply moving and impressive dance performance.*
>
> **Stephan Contious, member of the Alpbach-Laxenburg group 2015**

Detail from the poster

## HOW MIGHT THIS WORK SUPPORT THE GLOBAL TRANSFORMATION TO SUSTAINABILITY?

Involving an artist from a war-torn region provided insights from a community whose voice would not have been heard otherwise. Art acted as a medium to connect Syrian civil society with high-level decision-makers—who typically see the conflict through facts and figures—and the general public—who generally learns about the conflict from mainstream media. In addition, the performance offered a different perspective on the SDG agenda. *InDignity* shows how artists might support the global transformation to sustainability through a creative process that generates understanding across cultures, employing the universal language of art, connecting people whose lives are seemingly worlds apart, yet interconnected, and expressing what cannot be expressed in words alone.

## CONNECTING SCIENCE & ART
## PROCESS IN PROGRESS

Chapter I established why collaborations between science and art are worth exploring, and why performing artists are promising partners for scientists working on the sustainability transformation. However, there is no knowledge (framework, model, handbook) on how scientists and artists can best collaborate. The next project, *Courage*, was set up to explore what artists and scientists have in common, where their approaches differ, how they can bridge these differences, and what they can learn from each other. Based on discussions and exchanges with scientists, I took four observations as starting points to develop the project:

1. Science and art are vastly different. Science shows what is and why, it describes technical consequences but does not explain their human dimension. Art is concerned with meaning—humans understanding their place in the world. However, both are creative processes that engage the same parts of the brain.

2. Scientists go through rigorous training in order to gain competence in the scientific method, a universal language that enables scientists from all over the world to work together. Similarly, in classical music and classical dance, artists go through rigorous training for six to eight years to become proficient with the classical technique, a universal language that enables musicians and dancers from all over the world to work together. Through this rigorous training, both practitioners have learned to pay attention to detail.

3. The language of a scientist must at all times be supported by demonstrable facts and the reproducibility of their experiments. The opposite is true for artists. For them, metaphors are everything. They strive to communicate in a way that requires the audience to participate in creating meaning.

4. Once a scientist publishes her work, she knows exactly, down to the last comma, what the article or book will look like. Performing artists, on the other hand, have little control over their final product. No matter how well-rehearsed they are, there are so many moving parts and people involved in the creation and presentation of a performance that any moment, something can go wrong. They have to trust that everyone involved on and off stage will do their part so what they envisioned can come together. The goal of the project *Courage*, which culminated in a dance-science performance debate, was to explore how to bridge these two cultures to truly fulfill the potential of creative thought.



Mimmo Miccolis and Gloria Benedikt during the premiere of *Courage* at European Forum Alpbach, 2015 © Maria Noisternig

# CHAPTER III
# COURAGE

**How can we appeal to both cognition and emotion in debate?**

*Courage* premiered at the Political Symposium of the European Forum Alpbach on August 30, 2016, and was subsequently invited to be presented at the European Commission's Joint Research Center, Ispra, the Stockholm Act, and the Euro Science Open Forum, Toulouse.

## 1. MOTIVATION

"Democracy thrives on civil debate, but we're shamefully out of practice," the political philosopher Michael Sandel observed in 2010.[41] The need to revive and improve the current culture and format of debate in order to rejuvenate democracy is itself increasingly "debated." *Courage* was an experiment to identify relevant questions, analyze problems, research solutions, and engage audiences through an artistic process involving scientists and resulting in a performance debate.

## 2. PROCESS

### *A. The quest for a good question*

In the summer of 2016, I worked with a group of IIASA scientists to develop *Courage*. They were asked to read two books: *Flourishing within Limits* and *Lilith and the Daemons of Capital*. The co-authors of both books, IIASA research scholar Brian Fath and journalist Oliver Tanzer, were part of the project. The group discussed what it perceived as the most pressing global challenges at the intersection of economics and ecosystems, the role of science in addressing them, and what impeded progress. Six questions emerged and one was picked as the basis of the performance debate.

### *B. Writing the text for the video*

The scientists wrote a text analyzing our chosen question, which was to set the stage for the

(L-R) JoAnne Bayer, Vilma Sandström, Nazli Koeseoglu, Anneke Brand, Julia Puaschunder, Gloria Benedikt, Fabian Heidegger, Oliver Tanzer, and Brian Fath © Patrick Zadrobilek

debate. Their challenge was to "translate" scientific jargon into common speech in order to make the concepts accessible to a general audience, and to create something that all scientists involved, regardless of their discipline, agreed on and were able to deliver convincingly on camera.

### *C. Shooting the video*

The scientists were coached by a former television journalist on how to deliver content convincingly on camera. The video was then shot against a black screen to add a theatrical frame to the delivery of their message. During the editing process, special effects and music were added.

### *D. Writing the narration for recording*

To provide context for the video and for the debate question, a narrative text about the relationship between people and nature, describing humankind's dual role as "conqueror and gardener of planet Earth," was written and recorded.

### *E. Developing the script and rehearsing*

The Italian dancer and choreographer Mimmo Miccolis, known for his work on social issues, such as human rights, for which he won a BCC award, joined me for a ten day re-

hearsal period. We divided the script for the entire performance into five parts and then choreographed the dance sequences.

**PART 1:** The artistic introduction begins with the ticking of a clock, suggesting "the race against time," followed by movement sequences that are inspired by the texts to come.

**PART 2:** The narration is amplified by the dancers' movements. They are predominantly sitting on chairs, like panel members, but use their arms, head, and upper body to physically translate the text.

**PART 3:** The video featuring the scientists is projected on a large screen, framed by the dancers. This sequence ends with one of the dancers posing the question for the debate: "How can scientists and artists create an enlightened sense of shared responsibility so that people and their governments act in ways that enable sustainable development?"

**PART 4:** The debate cast members enter the stage one by one, each delivering a short monologue that reflects on the question posed before debating it.

**PART 5:** Notes from the audience are read out loud by the debate cast while the artists join them on stage in order for performance and debate to come together as one. The event concludes with an audience engagement segment.

Most of the time when debates about global challenges take place, people listen, perhaps find the conversation interesting or even learn something new, but they ultimately feel that the issues do not concern them, or that they are too big to address. Yet, a sustainable future is only possible if we internalize sustainable thinking and change our behavior. Two components were added to the performance to encourage the audience to shift from passive to active listening. First, people were asked to write notes during the debate, which were collected and read out loud by the debaters in Part 5. And then, toward the end of the performance, composer Merlijn Twaalfhoven invited the audience to hum with him in order to create a sense of engagement and community—a feeling that we are "all in this together."

### *F. Choosing and briefing the debate cast*

The debate cast was chosen from members of the Alpbach-Laxenburg Group, a high-level retreat of the Political Symposium of the European Forum Alpbach. The cast was briefed and asked to prepare a short statement reflecting on the debate question. Two days before the premiere, the debate cast members attended rehearsals and were given directions on their entries.

(Top Left) Oliver Tanzer coaching Fabian Heidegger during the shooting of the video © Patrick Zadrobilek; The debate cast: (Top Right) H.E. Tarja Halonen former President of Finland © Andrei Pungovschi; (Bottom Left) Jonathan Rose, Venture Capitalist © Maria Noisternig; (Bottom Right) Merlijn Twaalfhoven engaging with the audience © Maria Noisternig

> *"Taking part in project* Courage *during the Young Scientists Summer Program (YSSP) at IIASA was a unique experience. As an interdisciplinary international team of scientists, journalists, and dancers, we were confronted with our different working styles when writing the screenplay. While scientists are used to producing precise facts, on stage creativity and spontaneity are needed. It allowed us to ask questions in an unconventional way and embark on a process that provided more freedom than we are used to.*
>
> **Fabian Heidegger, Young Scientists Summer Program participant**

## 3. OUTCOMES AND DISSEMINATION

*Courage* premiered at the Political Symposium of the European Forum Alpbach on August 30, 2016 and was live-streamed.

### *Audience response*

After the performance, audience members remarked that the debate provided a window into both art and science, and allowed them to understand the discourse on sustainability better.

> *“There is a fundamental need to recognize, nurture, and re-energize a symbiotic relationship between science and art. Great science, like great art, comes through a mix of inspiration, hard work, precision, thoughtful/mindful focus, and diligence. Both can and must inspire, infuse, energize, and give form to the other. Great scientific breakthroughs often come via conceptual and abstract inspiration. Gloria Benedikt’s inspiring performance captured these concepts, weaving them into a conceptual dream that gave new meaning and focus to some of the biggest systemic challenges of our time.*
>
> **Daniel McMurray, audience member**

*Impact of the debate format*

The following year, there was increased interest in shifting away from the classic debate format throughout the entire symposium. This is an example of the artistic mindset, applied to the need to improve public debate, delivering new approaches. These kinds of collaborations may provide the new solutions we need. As Einstein observed and as it was also mentioned during the debate: “You can’t solve a problem with the same mind that created it.”

A summary of the performance debate was distributed via social and other digital media. *Courage* was also featured as a highlight in the European Forum Alpbach Impact Report. Subsequently, *Courage* was invited to the European Commission’s Joint Research Center in Ispra in 2016; the Stockholm Act, a cultural festival initiated by the Stockholm Resilience Center, in 2017; and the ESOF, Toulouse, in 2018.

## HOW MIGHT THIS WORK SUPPORT THE GLOBAL TRANSFORMATION TO SUSTAINABILITY?

*Courage* shows how addressing delicate issues through art combined with science has the potential to support the sustainability transformation. The coupling of the two fields allows people to look at topics from different perspectives, and to question their beliefs, whereas being presented with data and rational analyses alone would not.

> *Participating in project* Courage *was an immensely satisfying experience. Part of the pleasure was watching the production unfold from an inchoate and novel concept regarding a discussion of two books to the final performance involving dance, video, dialogue, debate, and music. The preparatory discussion among the scientists forced us to think deeply about the key ideas we wanted to communicate to the audience and how to distill them into visual cues. I have used the video in my classes several times and the students were captivated. It really is a striking way to merge art and scientific discourse.*
>
> **Brian D. Fath, Professor of Biological Sciences, Towson University; IIASA research scholar; coauthor of the book *Flourishing Within Limits to Growth***

Curtain call at the European Forum Alpbach, 2016. (L-R) IIASA Director General and CEO Professor Dr. Pavel Kabat; Venture Capitalist Jonathan Rose; Former President of Finland Tarja Halonen; Gloria Benedikt; Choreographer Mimmo Micolis; Composer Merlijn Twaalfhoven © Andrei Pungovschi

# WHEN SCIENCE MEETS ART
## THE BIRTH OF A NEW MINDSET

*A reflection by Merlijn Twaalfhoven following the* Courage *performance debate at the EuroScience Open Forum 2018*

### AN URGENT NEED FOR BETTER QUESTIONS

There I was, an artist invited to the largest conference on science and innovation in Europe, the EuroScience Open Forum, commonly referred to as ESOF. Amid showcases and lectures about robotics, space exploration, and gene technology, I could share my ideas about the connection between art and science.

This topic can easily become lost in abstractions or generalities. It is true that science and art are both about creativity and research, but is there a concrete way for them to find each other? Is there urgency to bridge these two worlds? The answer to both these questions is a resounding yes.

### DIFFERENT EYES

Art and science are like children who used to love to play together. Both worlds are filled with curiosity, venture into the unknown, and embrace uncertainty and adventure. Both are not satisfied with the answers that are provided, and keep asking questions—obsessed with what is below the surface, beyond the horizon, and beneath the solid ground of our convictions.

These two children have much in common, yet they have different eyes—they see things differently. While observing the same world, they pose different questions.

One would ask: "What is this?" "How did it become this way?" and "Why is this the way it is?" And the other would ask: "What might this also be?" "How can we see this differently?" and "What will this be if…?"

Art and science have always learned and grown together, but over the last few centuries, they have started to grow more and more apart. We might say they have grown up. They each developed their own curiosity and creativity into diligent practices and professional attitudes, and started to work within strict disciplinary boundaries. The playfulness and free experimenting sadly transformed into competition and a fixation on what they call "excellence."

### WHO IS ASKING THE QUESTIONS?

Today, while global warming, inequality, digitalization, and migration bring instability and change to our societies and global mindsets, there is an urgent need for answers, reliability, and guidance.


Engaging with the audience at ESOF 2018 Toulouse, (L-R) Debate Cast: Lidia Brito, UNESCO Regional Director of Science for Latin America and the Caribbean; Dame Anne Glover, President of the Royal Society of Edinburgh; Valentina Montalto, Researcher at the European Commission's Joint Research Centre; Merlijn Twaalfhoven, Composer © Guillaume Gimenez

Leaders of all kinds, including artists who might influence the way we feel, and scientists who might direct the way we reason, are pressed to give such answers. We all add our answers to platforms and channels disseminating news, opinion, soundbites, and statements. It is a cacophony. A flood without structure.

But do we actually know who is asking the questions? Is it the entertainers, talk show hosts, and commercial news media? Will we let the most dominant voices define the big questions of our time? Or can we bring to the surface better questions based on the observations, insights, and intuition of artists and scientists?

## SHOW, DON'T TALK

We know what the big challenges in society are, and the urgent steps needed to prevent catastrophic global warming, societal polarization, and mass migration are well defined. But how do we, as curious, experienced, and highly trained artists, scientists, researchers, and explorers join forces to make the urgent and engaging questions become not just loud and clear, but part of everybody's daily reality? Rather than just writing or talking about warnings and concerns, can we formulate questions that ask for a vision that is attractive and beautiful—a way forward that we can experience directly and that makes all of us want to make the world great again?

## BEAUTY

A first step is to find beauty in the world around us. Instead of asking, "Why are these people poor?" we can ask, "What makes you proud?" Instead of asking, "How do we stop people from buying cars?" we can ask, "How can I relieve you from the burden of owning (cleaning, insuring, repairing) a car?" Instead of asking, "Why are people unhealthy?" we can ask, "When do you feel free of stress?"

## IMAGINATION

A second step is to design ways to express this beauty and to imagine new possibilities. How can we show others the pride you feel? What is the value you get when you do not own a car? What does a stress-free moment sound like?

## PLAY

A third step is to connect people to a changing and evolving reality in playful and challenging ways. What makes your pride contagious? How do we practice freedom from possessions? How do we build stress-free moments into our routines?

These are only a few examples of how art can highlight the beauty hidden in urgent research topics, create forms of expression to give new ideas presence, and build living and changing structures where a new scientific/artistic mindset may flourish.

What will be the laboratories in which we develop and explore new questions? When will these grown-ups—science and art—decide to approach each other again, remember their playful childhood, and fall in love all over again? It might be a fruitful affair and give birth to a new mindset that can help us face today's challenges.

**MERLIJN TWAALFHOVEN** is a Dutch composer and founder of The Turn Club, a lab for arts in society. He has received a UNESCO award and collaborated with the Kronos Quartet and the New York Philharmonic. He has also worked in refugee camps and across dividing lines in Cyprus, Palestine, and Syria, involving children, local communities, and professional musicians. He is a graduate of the Conservatorium van Amsterdam and THNK School of Creative Leadership.

## CONNECTING SCIENCE & ART
## PROCESS IN PROGRESS

Insights on how artists and scientists can work together effectively:

### 1. Precision and Intuition

Through the research process, the artists were exposed to the precision scientists are accustomed to when formulating questions and writing texts. Through the artistic creative process, scientists were challenged to focus not only on substance but also on the delivery of their message.

### 2. Trust

Given that the result was a live performance, scientists had to trust that the artists, as well as the debate cast, would convey their work accurately. A total of 14 people from several disciplines came together for this production, and although everyone was prepared and committed, the only way to succeed was to trust each other and, for those on stage, to be alert and responsive to each other.

### 3. Language

As a result of ever-increasing specialization, neither artists nor scientists are trained to communicate well with a general audience. Both assume that their complex way of thinking, and highly specialized vocabulary, will be understood when often they are not. Neither scientific data nor artistic language devoid of context is immediately accessible to people outside of those fields. Through the process of creating *Courage*, scientists and artists were challenged to share their expertise in a way in which they could meaningfully connect and make their knowledge and skills accessible to others.

The process also revealed the potential for artists to learn from scientists to follow their intuition in a more systematic manner, and to be more articulate. The artists chose to use text to underlie their movement when they realized that movement and music alone could not deliver the message they wanted to convey accurately enough. At the same time, scientists learned to pay attention to their delivery, as opposed to focusing exclusively on content. They learned from the artists to be comfortable with an element of uncertainty, grounded in trust.

Mimmo Miccolis and Gloria Benedikt during the premiere at the European Forum Alpbach © Maria Noisternig

# CHAPTER IV
# (POST) TRUTH?

## HOW CAN WE INCREASE TRUST IN SCIENCE?

*Courage*, the quest to invent a new process to identify debate questions, and a new approach to present and discuss them, took place in 2016 against the backdrop of rising populism. The resulting loss of confidence in science increased the need for a new language that could reach people with widely different ideologies. A short film, *Post Truth? The Paradox of Progress*, first screened at the Viennese Science Ball and then distributed through various media channels, was produced to further investigate and respond to this new political and cultural reality.

The causes of the rise of populism, frequently called the "post-truth phenomenon," were increasingly the subject of public discourse throughout that year. However, information overload and the explosion of digital news that didn't meet the same quality standards as traditional journalism seemingly led people to create their own realities or strengthened their confirmation bias. But through the lens of art and science, the phenomenon didn't seem so new or unique.

For scientists and artists, the term "post-truth" is a paradox. It suggests that there was such a thing as truth in the past. Responsible scientists and artists are—and always have been—on a lifelong journey to discover what is not immediately apparent. One group specializes in reason, the other in emotion; they are both searching for insights to help society make better-informed decisions, knowing that they are only a small part of a truth-searching expedition that will continue indefinitely. For both groups, the journey must be the goal. For decades, this understanding was a foundation on which society could build. The danger of post-truth is that it puts forward simple black-and-white solutions based on gut reaction even though the problems we face have become more complex and interconnected. More than ever, we need science-based solutions. Yet, simplistic solutions have been successful in challenging the nature of science, which is based on ranges and probabilities.

What, then, can the reasons for the shift toward post-truth be? Is there a new divide between "rational progressives" and "emotional regressives?" Between those who focus inward and

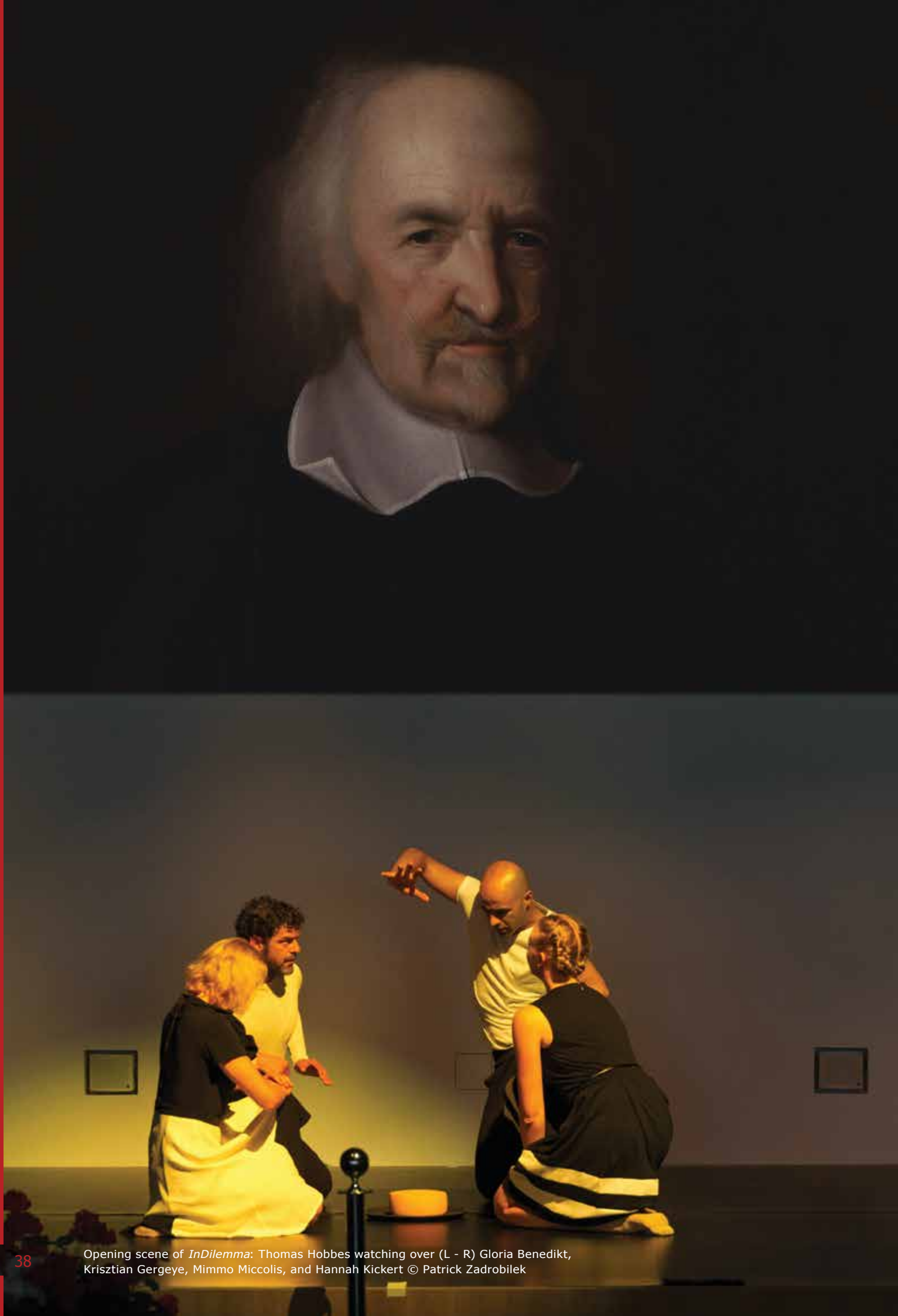
A still from the short film Post-Truth with Gloria Benedikt and Christian Felber ©Patrick Zadrobilek

backward, attempting to reject forces of globalization, and those who focus outward and forward, embracing the forces of globalization? Between those who are overwhelmed by interconnectedness, seeking simple short-term solutions, and those willing to work on long-term sustainable solutions? Between those who employ fear and hatred as tactics versus those who advocate complex but hopeful solutions? If so, how can we bridge this divide? Perhaps the answer to reconciling these conflicting worldviews lies in shifting our traditional focus on knowledge production to instead focus on developing compelling narratives, and conveying positive, hopeful solutions that enable people to envision a sustainable future with heart and mind—and overcome their fear along the way.

Scientists generate abstract data and artists reveal the meaning hidden behind this data: that's how the two groups can come together and combine their strengths. The short film shown at the Science Ball was a small step toward that goal. It developed out of an artistic urge to respond to the current discourse, which only seemed to brush the surface of a deeper problem. To shed light on these depths and attempt to find new insights, scientists contributed their views on the phenomenon of post-truth. However, there are things one cannot fully express with words, so this is where non-verbal communication comes in. Here the medium was dance. "Dance is one of the most beautiful forms of cooperation. Verbal language is an inefficient, incomplete form of communication that is prone to misunderstandings. Completing it by the physical, sensual, emotional, intuitive, and spiritual spheres provides a more holistic form of communication," the economist and dancer Christian Felber observed. He thus was a perfect partner to realize this project.

## CONNECTING SCIENCE & ART
## PROCESS IN PROGRESS

Based on the insights gained through *Courage*, the next step in connecting science and art to fulfill the human potential was to explore how collaboration could be strengthened. Up until then, the artistic process had followed the research process—once the artists started to translate ideas into a theatrical production, scientists were no longer involved. A rehearsal space was built at IIASA so scientists could be fully integrated into the artistic process. In *InDilemma*, scientists were part of the rehearsal process for the first time.



Opening scene of *InDilemma*: Thomas Hobbes watching over (L - R) Gloria Benedikt, Krisztian Gergeye, Mimmo Miccolis, and Hannah Kickert © Patrick Zadrobilek

# CHAPTER V
# INDILEMMA

**Can a scientific theory be performed? If so, can this performance support better decision-making when coupled with an interactive stage game?**

*InDilemma* premiered at the Political Symposium of the European Forum Alpbach on August 29, 2017, and was subsequently performed at the OSCE Ministerial Council Meeting at the Hofburg Palace in Vienna.

## 1. MOTIVATION

The anticipated US defection from the Paris Climate Agreement, Brexit, and North Korea's nuclear program were among the topics dominating current affairs in 2017. Could these issues—and the options available to deal with them—be better understood if the science of conflict and cooperation, namely, game theory, was more widely known? And could a fusion of the science of conflict and cooperation, and the art of movement and cooperation, support that understanding? In short, could dance breathe life into an abstract theory? And could the theory become accessible to a greater number of people as a result? If so, could it help them make better-informed decisions about current issues? These were some of the questions that led me to embark on a new project: *InDilemma*.

## 2. PROCESS

### *A. Setting the goal*

#### Innovation

Game theorists devote their lives to studying the dynamics of conflict resolution and cooperation. Meanwhile, dancers devote their lives to generating movement through cooperation. Could these two seemingly different worlds complement each other in a meaningful way and give unprecedented expression to game theory? If so, what impact could this new alliance have?

## Impact

What would it take for audience members to walk away from a performance with new insights that enabled them to make better-informed decisions about the "real world?" With this in mind, a game was designed to engage an audience in applying newly gained insights to the issue of global resource inequality.

### *B. Identifying the topic and structure*

For two months a scientific committee* at IIASA met on a weekly basis to discuss current affairs through the lens of game theory, and to eventually select the topic for the performance piece: global resource inequality. Along the way, a first draft of the structure of the performance was developed.

**The committee consisted of JoAnne Bayer, Acting Director, Risk & Resilience Program; Ulf Dieckman, Director, Evolution and Ecology Program; Piotr Magnuszewski, Research Scholar, Risk and Resilience Program; Elena Rovenskaya, Director, Advanced Systems Analysis Program; and Karl Sigmund, Senior Research Scholar, Evolution and Ecology Program.*

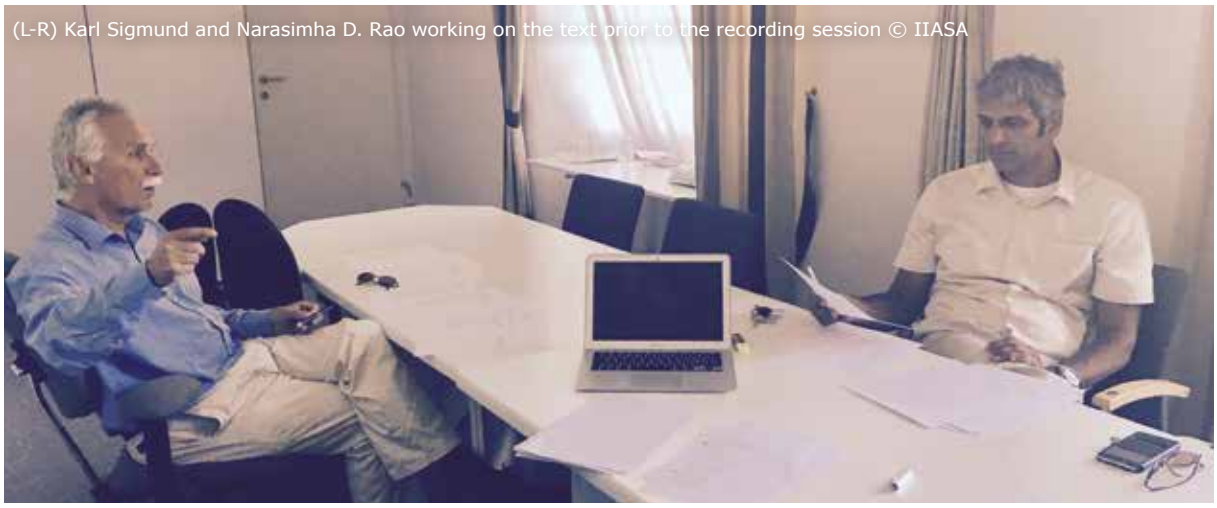
### *C. Writing the text*

**Lead:** Karl Sigmund
**Input:** Gloria Benedikt, Piotr Magnuszewski

Karl Sigmund wrote the first draft of the text that was to introduce the mechanisms of game theory. I commented on how the text might be translated into choreography, while Piotr Magnuszewski looked at how the same text might be linked to an actual game.


First draft of the text by Karl Sigmund

Next, Magnuszewski and his team developed the first sketches of a game that would challenge the audience to take a stance on the dilemma presented. It became clear that the game activity for the performance needed to go beyond game theory and include a broader building block of game design. Meanwhile, I organized the recording of the text on which the dancers were to choreograph, with Narasimha Rao, then Leader of IIASA's Decent Living Energy Program. I also confirmed and briefed the artistic cast on the progress of the creation process thus far and selected the music.


(L-R) Karl Sigmund and Narasimha D. Rao working on the text prior to the recording session © IIASA

> *Whenever I introduce myself as a "game theorist" at a party, people's faces light up, and I rarely have the heart to disappoint them by explaining that the term "game" for a mathematician is just shorthand for "conflicts of interest" and involves lots of linear algebra. In general terms, of course, "game" covers an amazingly diverse range of behaviors (games of luck, games of skill, parlor games, etc.). So, from time to time, I try to escape from the narrow confines of mathematical theory and give free rein to the* Homo ludens *in me. This was why I eagerly joined the production of* InDilemma*; I had never done anything like that before. Little did I know that I would be in for a mind-opening experience in cooperation. The public was moved by the outcome, but not nearly as much as I was, enjoying the tortuous path which led to it, through countless discussions, rehearsals, and* in vivo *examples of conflict resolution.*
>
> **-Prof. Karl Sigmund**

### *D. Developing the game*

**Lead:** Piotr Magnuszewski
**Input:** Gloria Benedikt, Krisztian Gergye, Hannah Kickert, Mimmo Miccolis, Vladyslav Zoloto

The development of the interactive game component of *InDilemma* was an ambitious task, as it was far from obvious how to meaningfully involve an audience of a few hundred people in the experience, how to frame the decisions they would make, and how to provide them with feedback on the consequences of those decisions. An additional challenge was to design the activity to generate the desired meanings and emotions in a very short time: instead of the few hours often given for a "serious" game—i.e., a game

Cast of *InDilemma* setting up for the serious game © Patrick Zadrobilek:

designed for a primary purpose other than pure entertainment—here, the interactive part had to be under 10 minutes.

Magnuszewski and his team at the Centre for Systems Solutions (CRS) purposely started with a complex concept that involved more choice options for the audience. The design goal was to create an experience where the audience would make the decisions and the dancers would illustrate those decisions and their consequences. Then, through a series of tests conducted by the CRS team, with consultations with the IIASA team of artists and scientists, the concept was evaluated and stripped of superfluous elements.

During the tests, the need for additional illustrations of the impact of the players' decisions on the natural environment emerged. This led to the creation of an interactive projected animation. Our main concern, then, was to make certain that the audience engaged in the activity. This was ensured by simplifying the number of actions required from the audience and making the rules of the game very clear. Overall, the design goals—to create an activity that channels sophisticated ideas through a highly emotional, easy-to-comprehend, artistic experience—were met. Further integration of the gaming elements within *InDilemma* took place during the rehearsals with the artistic cast, Karl Sigmund, and other IIASA staff.

### *E. Rehearsal period*

**Lead:** Gloria Benedikt, Krisztian Gergye, Hannah Kickert, Piotr Magnuszewski, Mimmo Miccolis
**Input:** Wei Liu, Elena Rovenskaya, Karl Sigmund

The artistic cast, which included the Hungarian choreographer and theater maker Krisztian Gergeye, the former dancer of the Vienna State Opera and student of political sciences Hannah Kickert, as well as Mimmo Miccolis, joined me at IIASA for two days to discuss how the text could be turned into choreography. The main challenges were to not only translate the text into movement word-for-word, but to find visual symbols and metaphors

that would make the text's meaning more apparent. For instance, how could we show through movement the sequence about uncertainty?

*The outcome is uncertain.*
*It depends not on next year's harvest*
*Or tomorrow's currency rates.*
*It depends on what your co-players invest.*
*And that, you do not know.*

After bouncing around multiple ideas, we agreed to proceed with Gergye's idea to use blindfolds and develop movement phrases where the characters were trying to find out whether they could trust their co-players, even though they could not see them.

Music, projected images, and videos were chosen, the text recorded, and the sound and visual files finalized.

The artistic cast convened at IIASA to rehearse for ten days. For the first time, scientists were part of the artistic creation process.

Sigmund periodically attended rehearsals to answer the artists' questions about the text and assist with the choreographic process. Magnuszewski was cast as Master of Ceremony. Together with the dancers, he developed a semi-structured improvisation for the game at the beginning and the end of the piece, where the audience was involved. Elena Rovenskaya and Wei Liu attended run-throughs as a test audience to provide feedback on the effectiveness of the artistic performance and the interactive game.

A trailer was shot and shared on social media.

In rehearsal (back to front): Piotr Magnuszewski, Hannah Kickert, Mimmo Miccolis, Krisztian Gergeye; Rehearsing uncertainty: Gloria Benedikt © Patrick Zadrobilek

## 3. OUTCOMES AND DISSEMINATION

*InDilemma* premiered at the Political Symposium of the European Forum Alpbach on August 29, 2017 and was live-streamed. The audience, comprised of approximately 350 people, consisted of senior decision-makers, students, and forum participants. We divided them into four groups—the ultra rich; the well off, but working for a living; poor people in industrialized countries; poor people in developing countries—and asked if they needed more "life space," i.e., both the physical and metaphorical space needed to live a decent life, or if they had enough. The dancers, each representing one of the groups, then translated the group's decision through movement on stage. While disadvantaged groups gained more "life space," their decisions created negative environmental impacts.

The cast of *InDilemma* during the performance, embodying unequally distributed "life space" between the four groups
© Patrick Zadrobilek

About five minutes into the game, half of the earth was symbolically destroyed, and inequality remained unresolved. Magnuszewski, acting as the Master of Ceremony, then suggested looking at game theory. After the 15-minute performance introducing game theory, which focused on the tragedy of the commons, the audience was asked to make decisions again, this time with the added option of sharing resources.

As no one could predict how the audience would react and how the piece would end, the dancers were prepared for different responses. When the game was played again with new parameters, the whole audience got up to share. A wave of emotion swept through the room. At the end, the environment was restored and inequality vanished.

Footage from the live-stream was edited into a 10-minute summary of the project, which was shared on social media.

Three weeks after the premiere, *InDilemma* was presented to a group of students and researchers at Harvard University. The discussion that followed focused on what kind of audiences the performance could have the greatest impact on.

The cast of *InDilemma* during the performance, adjusting "life space" depending on the audience's decision © Patrick Zadrobilek

In October 2017, *InDilemma* was presented at Stiftung Genshagen near Berlin as a best-practice example of how artists can support democracy-building and participation.

In December 2017, *InDilemma* was performed on the occasion of the OSCE Ministerial Council Meeting at the Hofburg Palace in Vienna.

## HOW MIGHT THIS WORK SUPPORT THE GLOBAL TRANSFORMATION TOWARD SUSTAINABILITY?

*InDilemma* shows how artistic and scientific processes can complement each other to generate a better understanding of complex problems and encourage more informed decision-making. By developing a multimedia performance around an abstract theory, using music, dance, visuals, and narrated text to create and communicate meaning, the theory acquired a new form, appealing to both reason and emotion. The Alpbach-Laxenburg Group, which met during the Political Symposium, noted "bridging emotional and cognitive competences as a key competence of sustainability." *InDilemma* shows the potential of fusing artistic and scientific processes to strengthen this competence. It also shows how actively engaging audiences can lead to better understanding of current issues and support of complex decision-making.

Premiere of *InDilemma* (L-R) Franz Fischler, President of European Forum Alpbach; Heidi Fischler; H.E. Heinz Fischer, former President of Austria; Margit Fischer; Pavel Kabat; and Anneke Kabat © Luzia Puiu

The cast performing the principles of game theory © Patrick Zadrobilek

The cast performing the principles of game theory © Patrick Zadrobilek

# CHAPTER VI
# THE ART OF SYSTEMS ANALYSIS

**How does art fit in systems analysis, and how does Science & Art fit in the art system?**

Two-and-a-half years into the Science & Art project, a first account of how artists can support the global transformation to sustainability was published. It was co-authored with the Canadian playwright Chantal Bilodeau, founder of The Arctic Cycle, and the Dutch composer Merlijn Twaalfhoven. The publication sought to position this new type of artistic work within the art system, defining it as constructive art. We analyzed how constructive art would fit into the framework of systems analysis and provided concrete examples of artistic work fulfilling this potential.

## A. CREATING A NICHE BETWEEN 'HIGH' AND 'ACTIVIST' ART

Only a select group of mostly highly educated and older patrons enjoy traditional Western "high art." High art has become a comfortable and pleasant pastime, which provides opportunities to reflect on life, evoking familiar emotions and engaging audiences in playful intellectual exercises. It has its value and occupies a stable place in society, often affirming belief systems already in place. Art has also found its place in society as a healing practice, for instance in the form of music or dance therapy. But what about the scary and the unknown? Today, a growing number of artists are challenging art forms and moving away from traditional spaces and audiences to better engage with complex global challenges. As engaged citizens, they are eager to take on the burning questions of our time, like, for instance, how we, as a global community, might make a transformation to a sustainable lifestyle. This has led to what the authors defined as *constructive art*. Constructive art does not just illustrate a topic, reflect on a problem or, in the case of activist art, advocate for a particular point of view.

- It poses original questions that open up avenues for inquiry and aim to create changes in perception, breaking negative patterns of behavior, and promoting new ways of relating to humans, other species, and ecosystems.

• It engages with real-life problems through the artistic process. It breaks the old dichotomy between autonomous and applied art to make room for a novel approach where artists create autonomous spaces within the context of current global challenges.

• It tends to be disruptive and unconventional, but it is always strongly connected to contemporary society and concerned with making a positive change.

While the methodologies used in constructive art vary, the authors identified two main approaches:

**Research-based art that engages with science to contribute to the discourse on global challenges and to envision practical solutions.**

**Research-based art that engages with communities, experts, and other professionals to derive new insights into societal issues.**

Within these two approaches, five hallmarks define constructive art: social relevance, investigation, process, constructive output, media engagement, and sustainable post-production.

## THE FIVE HALLMARKS OF CONSTRUCTIVE ART

### *1. Social relevance*

Similar to constructive journalism, constructive art engages with social, economic, and environmental issues that are urgent, complex, and global in scope. Artworks explore problems that affect not only individuals but entire societies, and have the potential to shape the lives of generations to come.

### *2. Investigation*

Like science, constructive art begins with a research process. This process typically involves consulting with relevant stakeholders, such as communities or experts from other fields, who can contribute first-hand knowledge about a given issue. This knowledge goes beyond rational and physical phenomena and uncovers emotional, subjective, and experiential insights that can lead to a greater understanding of barriers to change.

### *3. Process*

Unlike traditional art, constructive art is not exclusively performance- or product-oriented; the creation process is equally important. Artists engage stakeholders and create spaces for imagination and play, embracing complexity and nonlinear thinking to see the world with fresh eyes. The creation process bridges the fields of art and science, welcoming experiential knowledge (for example, the traditional knowledge of Indigenous people), and generating new insights for everyone.

### *4. Constructive output*

The resulting output, whether it is a performance or another form of artistic presentation, is constructive. It goes beyond art as illustration, or art as a communication tool. But unlike activism, which proposes very practical solutions, constructive art opens up avenues for exploration to lay the groundwork for constructive solutions.

### *5. Media engagement and sustainable post-production*

Media coverage goes beyond traditional media communication on arts, which is typically limited to press releases, performance reviews, and—at best—interviews. The nature of the creative research process opens up new possibilities for journalists and stakeholders to engage with artists on a collaborative level. Where such collaborations are not yet in place, artists disseminate their work through non-traditional channels. They may share artworks or performances on social media, partner with non-arts organizations to reach non-traditional audiences, or create educational campaigns to extend the reach of their work.

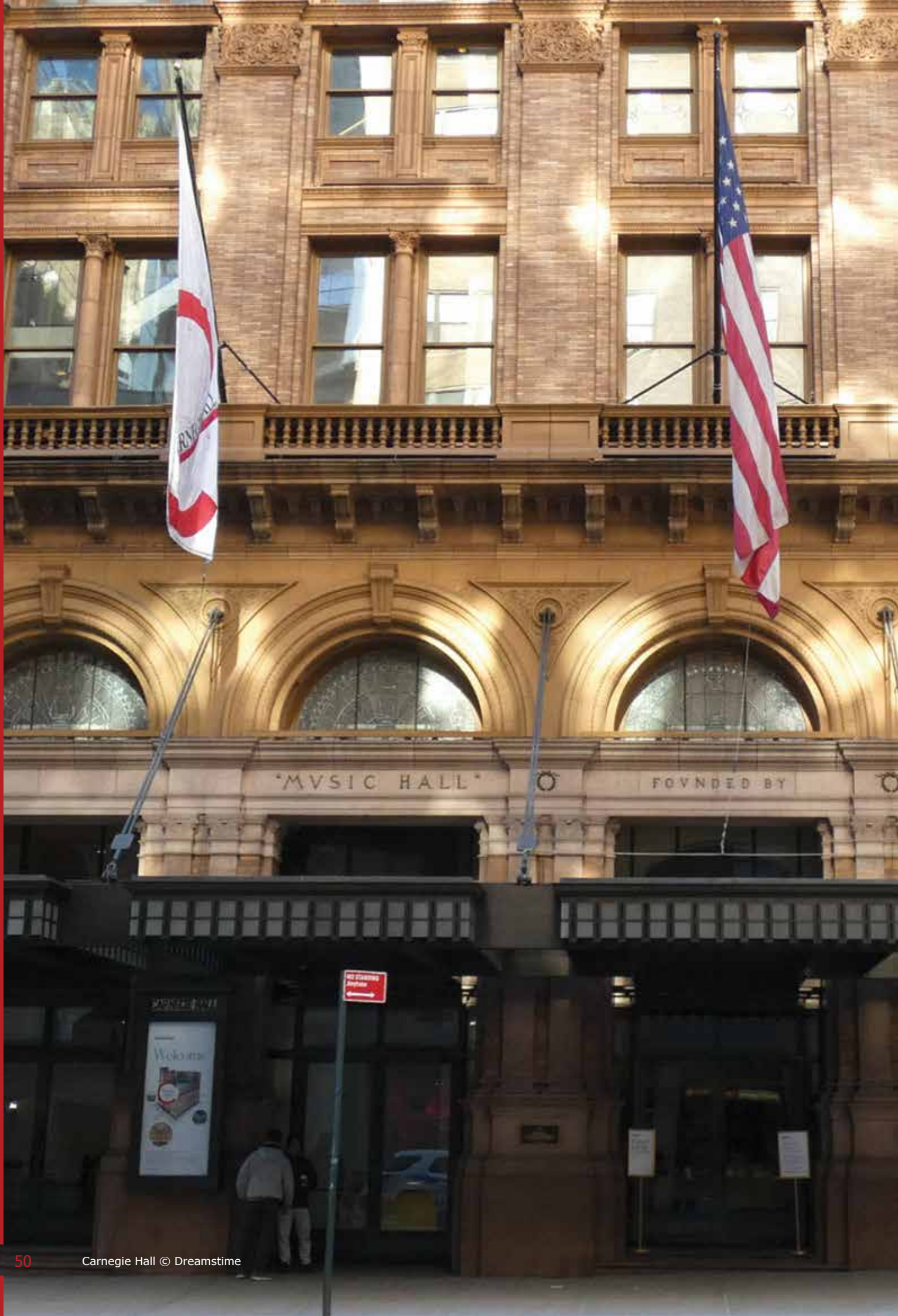
## B. INTEGRATING ART AND SCIENCE AT IIASA: A UNIQUE APPROACH

Systems analysis—the hallmark of IIASA's approach—is a problem-solving process that seeks to understand individual elements and how they might interact, while accounting for the system as a whole. This necessitates the participation of people from many walks of life and, traditionally, this has meant scientists from different disciplines as well as stakeholders and decision-makers. Has the time come to also include artists?

There is strong evidence from the social sciences that between the brain's two processing systems—the experiential processing system, which controls survival behavior and is the source of emotions and instincts, and the analytical processing system, which controls analysis of scientific information—the experiential processing system is the stronger motivator for action. Things that touch us emotionally, like stories, images, and music, are more likely to ignite the kind of passion needed to propel us into action than rational exposés. Facts are not enough to shake us out of complacency; we need to be rattled by our emotions.[42]

To successfully address complex global challenges, we also need to align our cultures—which is to say our beliefs and values—with the reality of our changing world. This deep, often challenging, internal work must be supported through individual and collective processes that embrace subjectivity, while being accountable to scientific facts. Constructive art is uniquely positioned to do that.

One project that exemplifies constructive art, *Four Drifting Seasons,* aimed to provide an experience of abstract data on temperature rise through music in order to convey the urgency of global warming without resorting to simplification or propaganda. It is described in the following chapter.






Carnegie Hall © Dreamstime

# CHAPTER VII
# CONCERT FOR A SUSTAINABLE PLANET

On the eve of the 72nd UN General Assembly, the United Nations Sustainable Development Solutions Network (UN SDSN) and IIASA hosted the "Concert for a Sustainable Planet" at Carnegie Hall in New York City. We hoped that the concert would inspire people worldwide to make positive changes in society and heal the planet. Special guest cellist Yo-Yo Ma, and artists from around the world, shared their gift, alongside Jeffrey Sachs, then Director of the Earth Institute at Columbia University, Amina Mohammed, Deputy Secretary-General of the United Nations, and Pavel Kabat, then Director General and CEO of IIASA.

I co-curated the concert and choreographed a series of short responses to questions relating to the Sustainable Development Goals presented throughout the evening. These culminated with two contributions, described below, which fall into the category of constructive art: *Four Drifting Seasons* and *Contextual Matters*.

Jeffrey Sachs, UN SDSN President; Amina Mohammed, Deputy Secretary-General of the United Nations; Pavel Kabat, Director General and CEO of IIASA; and special guest Yo-Yo Ma © Mena Brunette

# FOUR DRIFTING SEASONS

By Merlijn Twaalfhoven

## CAN WE FEEL THE TEMPERATURE RISING?

### 1. MOTIVATION

The increase of the Earth's global average temperature since 1880 is dramatic. However, it is hard for an individual to notice this change. One might observe more extreme weather, or the early arrival of migratory birds, but it is difficult to grasp the extent of long-term, gradual, and irregular changes. Global warming over a century remains abstract: it is impossible to feel the changes. Or is it?

In the project *Four Drifting Seasons*, I asked two questions:

1. How can we create an immediate, physical experience out of abstract data?

2. How might we convey the urgency of global warming in an emotional way, without resorting to simplification or propaganda?

Together with composers, music technologists, and programmers, Jan Driessen, Killian Elbers, and Marco Alkema, I also explored a third question:

How will the nature of the information change when scientific data is converted to music?


Test performance at an Earth Hour event in Rotterdam, March 2017 © Merlijn Twaalfhoven

*Four Drifting Seasons* searched for a fresh and inventive way to tell the story hidden in the data, bypassing the politicized and polarized tone of debates on this topic.

## 2. PROCESS

### *A. Collecting data*

We focused on two sets of data: temperature data from NASA starting in 1880, and occurrences of storms and hurricanes. The data used was limited to the Northern Hemisphere. The piece can be updated every three months when new data is available.

### *B. Defining a relationship between creation and observation*

We had to create parameters to protect the objectivity of the data.

Measures taken included:

1. The four seasons were divided among four voices. Since the goal was to create music for singers, four seasons fitted well with the structure of a mixed choir: winter/bass, spring/tenor, summer/soprano, and autumn/alto.

2. The time span of the whole piece was 1880 to 2017.

3. To make the progression of global warming audible, the goal was for the piece to last four minutes. Every year lasts roughly 1.5 seconds. After a series of tests, the artists set the tempo at 72 beats per minute.

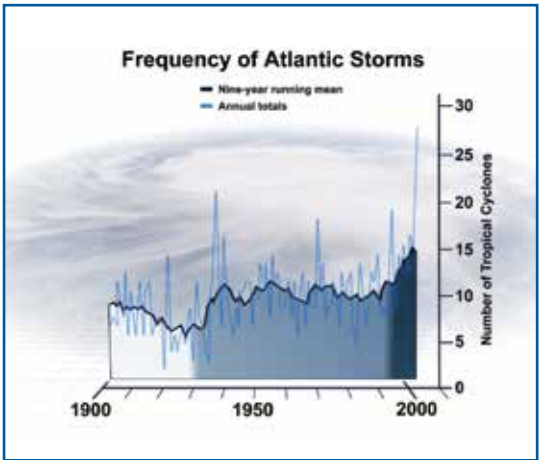
4. Given the limitations of the human voice, each 0.105°C equaled a single semitone difference in pitch. This number may change in future iterations with new temperature data.

5. Only the most extreme storms were used as an extra musical effect in the years they occurred.

6. The yearly average temperatures in the Northern Hemisphere were divided into four levels. The composer attached a certain dynamic (loudness) and expression (articulation) to the tones within these levels to make the temperature rise audible.

### *C. Developing new tools*

Since the music does not follow the regular patterns of a traditional melody, it is hard for performers to judge their accuracy. To make the piece accessible to young performers and




The annual average number of observed hurricanes and tropical storms in the North Atlantic has risen from 6 in the first part of the 20th century (white), to 10 after 1931 (mid blue), to 15 after 1995 (dark blue). The dark blue line is the nine-year running mean. © Steve Deyo, UCAR

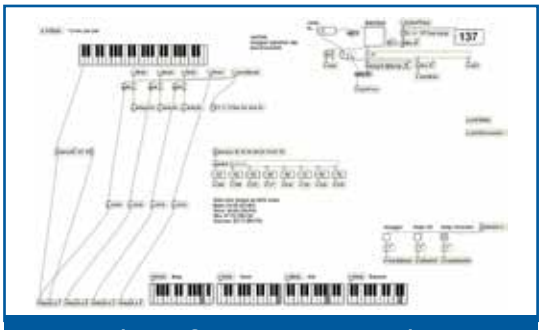
other non-professionals, we developed an app called *Conductless* that each singer uses with headphones to get the right pitches before singing them. Conventional music notation is shown on a screen. A centralized computer steers the process, synchronizing the different devices and making sure the piece runs at the right moment. The app has been tested with both (semi-)professional and amateur singers, and supports singers of all levels.

### *D. Testing, sensing, and searching for the music*

Tension between dissonant and consonant, chord progression, and rhythm creates a unique language. The challenge was to stay true to the data while making a musical statement. We programmed software to generate multiple versions, using different pitches as starting points for each voice, while retaining the scaling for each subsequent year. For each year, the change in pitch reflects the change in temperature, but the starting point is a matter of choice.

The scaling of 0.105°C per semitone was derived by scaling the difference between winter's highest and lowest temperatures (2.52°C difference between both extremes occurring between 1880 and 2016) to a professional singer's vocal register of 24 semitones.

The musical score and app were tested several times. In addition to the technical challenges, there was the question of musical experience and reception from the audience. After a trial with singers, the concept had to be simplified to make the relationship between data and music audible. Earlier ideas, which, for example, incorporated the relative speed of rising or falling temperatures, were abandoned for the sake of clarity. Instead of dividing trends in temperature rise into seasons, a new layer that connected the yearly averages was introduced to create a unified trend. Furthermore, the chromatic approach to translating the data into pitches was replaced by a symmetrical approach, using whole tones instead of semitones.



Screenshot of an experimental set up, translating data from temperature to text that is readable by music notation software © Jan Driessen

Every Voice Concert Choir © Mena Brunette

## 3. OUTCOMES AND DISSEMINATION

The first performance took place on September 18, 2017 at Carnegie Hall in New York City as part of the "Concert for a Sustainable Planet." The piece was subsequently performed at the launch event for Green Culture-Magazine O, Wonder! in The Netherlands in March 2018, and became the basis for a new project in The Netherlands by the VU-Chamber Choir: *Visions from 2068*, performed several times in winter 2018 and spring 2019. A video recording was produced with subtitles indicating the years and rising temperatures.

## HOW MIGHT THIS WORK SUPPORT THE GLOBAL TRANSFORMATION TO SUSTAINABILITY?

*Four Drifting Seasons* seems fairly abstract so it does not generate "warm" emotion around "cold" data. But this changes dramatically when the score is sung by a children's choir. The children sing through data history, but they will be alive long enough to see and experience the future trajectory of temperature rise. The project also raises new questions: Can we perceive more when we translate scientific data into music? Are our senses a reliable source of information? What do we gain by combining disciplines? Is there beauty in music generated by scientific observation rather than by human imagination?

This project shows a way for musicians and scientists to experiment with a new language that is both musical and scientific. Such a new language can enrich the art of exploration and storytelling that is the domain of both artists and scientists. Using the technology and techniques developed in this project, musicians can develop, create, and perform sets of data and bring them to diverse audiences. In this way, they become ambassadors and storytellers of the findings generated by science.

## CONTEXTUAL MATTERS

### WHAT KIND OF COOPERATION WILL IT TAKE TO IMPLEMENT THE 17 SUSTAINABLE DEVELOPMENT GOALS?

#### 1. MOTIVATION

No scientific assessment to date has established the feasibility of implementing all 17 Goals—ranging from ending poverty to protecting ecosystems—adopted by the 193 UN Member States in 2015. I decided to explore whether IIASA's research on the complexity inherent to the integrated implementation of the SDGs could be a compelling theme for artistic investigation within the framework of the "Concert for a Sustainable Planet." In the absence of scientific data, one aspect seemed clear: humanity can only succeed in implementing the Goals through global cooperation. Could artists contribute to making global collaboration possible? And if so, how?

To succeed in their chosen discipline, artists must cooperate at all times. Musicians need to listen to each other, not play too soft or too loud, too fast or too slow, and always pay attention to the conductor. Meanwhile, dancers must not only precisely execute the choreography, but also respond to each other, constantly adapting to—and balancing out—the mistakes

SDG 5: Gender Equality (L-R) Cesare Zanfini (violin); Revital Hachamoff (piano); Gloria Benedikt; Mimmo Miccolis; Tali Kravitz (viola); and Maya Belitzman (cello) © Mena Brunette

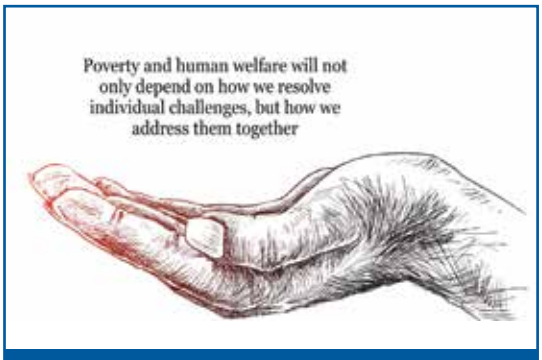
that inevitably arise. The parallel between the macrocosm of global cooperation needed to implement the SDGs and the microcosm of artistic collaboration required for a flawless performance resulted in the piece *Contextual Matters*.

## 2. PROCESS

### *A. Developing the plot*

I consulted with IIASA scientists, in particular, Pavel Kabat, Director General and CEO; Brian Fath, Research Scholar; and Frank Sperling, Senior Project Manager. Based on research conducted at the institute, we developed a plot for the piece. It would start with 17 unusual and beautiful melodies played by live musicians, representing the 17 Goals, embodied by two dancers and supported by projected images. Next, the musicians would try to play the melodies but all at the same time, resulting in cacophony—since they do not listen to each other, some play too soft, others too loud, some too fast, and others too slow. Meanwhile, the dancers mix up all the motifs they executed so beautifully earlier, and fall on their faces as they attempt to dance to all the melodies at the same time.

At the height of the chaos, a narration about the complexity of integrated SDG implementation is played. The dancers slowly start to embody the different SDG motifs in an integrated way. At the end of the narration, the dancers meet as the musicians begin to play in concert again. In the last part, the artists depict what it takes for the world to succeed in implementing the SDGs in an integrated way. All 17 SDG melodies are carefully incorporated while choreographically, the dancers embark on an eight-minute duet during which they never lose connection. It is a delicate balancing act between skill, adaptation, and trust that becomes ever more complex. At the end, to build active connections between the performers and the audience, and to convey the feeling that "we, human beings, are all in this together," the audience is invited by the composer Merlijn Twaalfhoven to hum with the choir.




Still from the video installation for the choreographed question on poverty © Mimmo Miccolis

### *B. Composing music, text, and visuals*

Once the plot was established, Twaalfhoven proceeded to compose the score for the piece, and Fath and Sperling began writing the text, which was then narrated and recorded by another scientist, Marcus Thomson. Mimmo Miccolis designed the projected images.

### *C. Rehearsal period*

Putting all the components together, I then tackled the choreography with Miccolis during a ten-day rehearsal period at IIASA. Our challenge was to create movement that would adequately reflect integrated SDG implementation through cooperation. Inspiration for these movement sequences came from personal interpretations of the SDGs and how they connect human wellbeing and natural systems. Fath and Sperling observed the process and offered feedback and ideas. Three days before the concert, Miccolis and I convened in person for the first time with the composer and musicians in New York in order to rehearse together.

Composer Merlijn Twaalfhoven working on the score with musicians (L-R) Gilad Hildesheim (violin); Cesare Zanfini (violin); Tali Kravitz (viola); Maya Belitzman (cello); and Alexander Osipenko (double bass)

## 3. OUTCOMES AND DISSEMINATION

*Contextual Matters* premiered at the "Concert for a Sustainable Planet," on September 18, 2017 at Carnegie Hall in New York City, on the eve of the 72nd UN General Assembly. It was also live-streamed. To increase our reach, a video of the performance was shared on social media and made available for teaching purposes.

Technical rehearsal at Carnegie Hall © Private

*“The interesting thing about working on projects at the intersection of science and art is the trust that is needed. The process is open, without a clear endpoint until much discussion and effort is invested, similar to a very open-ended exploratory research project. In some ways, the process mirrors the production, from chaos to coordination, but it somehow works out, and works out beautifully in unexpected ways. That is the power of the creative process. As the current framework for promoting sustainable development worldwide, the SDGs are an important part of the educational curriculum. In the United States, very few people are familiar with the SDGs, and even less are working toward implementing them. I therefore made a point of introducing this material to students in my classes at Towson University. This production is an effective way of engaging them and showing them how the topic goes beyond scientific borders.*

**-Brian D. Fath, Professor of Biological Sciences, Towson University; IIASA Research Scholar**

'Complex Systems' (L-R) Gloria Benedikt; Mimmo Miccolis; Maya Belsitzman; and Alexander Osipenko © Mena Brunette

## CONNECTING SCIENCE & ART
## PROCESS IN PROGRESS

*InDilemma* and *Contextual Matters* deepened the collaboration between scientists and artists by integrating scientists into the artistic process. *InDilemma* even integrated a scientist into the performance: Magnuszewski served as Master of Ceremony in the dance part of the performance and also designed and directed an interactive game at the beginning and the end of the session to offer participants the experience of making decisions before and after being exposed to new information. The subsequent projects, *Migraspectives* and *Dancing with the Future,* further explored how interactive games could be combined with artistic performances, and whether such a format was an effective approach in bridging the knowledge-to-action gap. They also explored whether the process of writing text for the performance could be optimized. Up until then, the texts had been written by scientists. Turning text into a script for performance had at times been very challenging because the writing wasn't necessarily taking the requirements of live performance into consideration. The next two projects thus examined if the writing of the text could be done in collaboration with the performing artists, with their input provided early on, so the translation from text to physical performance could be smoother.

'Testing the limits' (L-R) Revital Hachamoff (piano); Mimmo Miccolis; Gloria Benedikt; Tali Kravitz (viola) © Mena Brunette

# CHAPTER VIII
# MIGRASPECTIVES

**A boat full of people who have fled their homes is not given permission to dock. We know that more boats with similar passengers will come. What do we do?**

In what ways can artists and scientists explore this real-world dilemma together and come up with a new approach to guide the audience through a solution-finding process?

## 1. MOTIVATION

In 2018, IIASA and the European Commission's Joint Research Centre (JRC) brought together researchers and policymakers to explore how to optimize the use of scientific evidence in policymaking. The theme of the 2018 event, held under the auspices of the Austrian Presidency of the Council of the European Union, was "migration and demography"—or, more specifically, the role of population dynamics and migration in sustainable development in the European Neighborhood. This event, coupled with the increasingly urgent need to address migration challenges, provided the inspiration for a new research project. Artists and scientists decided to explore the current debate around migration through the lens of diverse, and often conflicting, worldviews while involving participants in a new approach to solution-finding.

## 2. PROCESS

### *A. Setting the goal*

### Innovation

There are deeply rooted differences in the current debate on migration. The cultural theory of risk, which takes people's widely different worldviews into account, proposes that sustainable solutions must also contend with these worldviews.[43] This raises the question of whether insights from the cultural theory of risk could become more tangible if the theory was communicated through a physical theater play.

## Impact

Would participants be able to engage with, and discuss, a complex topic such as migration in a constructive way? Would the solution-finding process, based on insights gained from looking at the current migration debate through the lens of different worldviews, lead to a proposal for a resilient solution?

### *B. Preparation: Identifying the topic and structure*

**Lead:** Gloria Benedikt, Piotr Magnuszewski

Piotr Magnuszewski and I met to discuss the preliminary shape of the piece. We decided that the first part would convey the current debate on migration through different worldviews. This required a playwright to write the text and create three characters to embody the three main worldviews (egalitarian, hierarchical, and individualist). The aim was to present a real-world dilemma related to migration. The second part would require the audience to propose a solution, which the artists would then enact to see whether it worked. While searching for a performance location on site at IIASA, I realized that the Paradise Garden happened to have the perfect proportions for what we had in mind and could be converted into an open air stage.

I then assembled the artistic cast. Nour Barakeh—a Syrian immigrant with a background in art and science—was cast as the "egalitarian" government representative; Hannah Kickert played the role of the "hierarchist" representative; and I embodied the "individualist" representative. Krisztian Gergye, played the role of Leader of the Migrants. Chantal Bilodeau, who is well-known for her theater plays on climate change, took on the role of playwright.

I also discussed the piece with researchers Wei Liu from the Risk and Resilience Program and Guillaume Marois from the World Population Program. They prepared presentations for the kick-off workshop.

Paradise Garden of Laxenburg Castle
© Private

### *C. Kick-off workshop*

**Lead:** Gloria Benedikt, Piotr Magnuszewski
**Input:** All

The full cast and advisors assembled for the first time for the kick-off workshop. Fittingly, all eight individuals were or had at some point been migrants themselves and hailed from six

different countries: Austria, Canada, China, Hungary, Poland, and Syria. As a means of introduction, they told their stories about migration and attempted to summarize the stance of their respective countries on the subject. Next, everybody was asked to share recent media clippings. The purpose of this exercise was twofold: to get to know each other and to discover the various situations in which the term "migration" is used.

Kick-off workshop at IIASA (L-R) Wei Liu, Piotr Magnuszewski, Guillaume Marois, Gloria Benedikt, Nour Barakeh, Hannah Kickert, Krisztian Gergye, and Chantal Bilodeau (via video conference) © IIASA

It was particularly interesting to see that all of the artists, independently of each other, emphasized the human dimension of the issue—that is, that the migrant is commonly depicted as a faceless shadow rather than a person—and their hope to give this abstract figure a human form. In contrast, the scientists focused more on long-term trajectories, looking at the movement of people from one place to another with the intention to permanently or temporarily settle in a new location. The team explored ways in which they could combine these two viewpoints—the scientific and the humanistic—and go deeper than current media coverage, which tends to focus on singular events, emphasizing symptoms rather than root causes. Finally, the team considered ways to better engage the audience in pursuit of a sustainable solution that takes into account the humanitarian, economic, and social aspects of migration.

Guillaume Marois, from the World Population Program, provided an overview of the latest migration data and Wei Liu explained the different worldviews according to cultural theory. Based on this knowledge and a real-world scenario (a refugee boat being given permission to dock), the group brainstormed how the situation would be perceived and proposed potential solutions based on each worldview. Chantal Bilodeau, who joined the meeting from the US via Skype, took notes in order to write a first draft of the script.

### *D. Rehearsal period*

**Lead:** Nour Barakeh, Gloria Benedikt, Krisztian Gergeye, Hannah Kickert
**Input:** Piotr Magnuszewski

In this phase of the project, the team focused on the development of the choreography. For the opening scene, the artists started by exploring different ways of moving in order to portray the different forms of migration.

For example, they examined how to depict people migrating out of curiosity versus people migrating out of fear. With Bilodeau's script, the artists then developed the opening scene, which gives a brief overview of human migration throughout history and then transitions into a choreographed dialogue representing the three worldviews. The cast and playwright adjusted the script based on choreographic and scenic needs to ensure that all parts fit together. Unlike all other productions to date, *Migraspectives* didn't have any recorded text. The dancers had to train themselves to move and speak at the same time. In the art world, dancing and acting are usually considered separate and independent skills. To meet the needs of the production, these barriers had to be broken down.

A migrant, commonly depicted as a faceless shadow, is used as a stage prop in the performance © IIASA

An additional challenge the artists experienced was that they could not fully prepare, as the audience would influence the second part of the performance through their decisions. They could therefore only prepare by anticipating different scenarios based on how the audience could react.

Throughout the rehearsal period, it became clear that a group of extras (actors who appear typically in the background, in non-speaking roles) would be needed to portray the migrants on the boat. These extras were recruited from among IIASA scientists, and were briefed on their role prior to the performance.

### *E. Developing the game*

**Lead:** Piotr Magnuszewski
**Input:** Nour Barakeh, Gloria Benedikt, Krisztian Gergeye, Hannah Kicktert, Marta Magnuszewska

#### The challenge

The interactive "gaming" part of the piece starts with a challenge—a ship full of migrants (played by extras led by one of the artists) is trying to get to Europe. The government of a European country—represented by three other artists—needs to decide what to do. In other words, the government representatives have to decide which solution to adopt. The audience is asked to suggest possible solutions to address this challenge; not just one-time solutions in response to a crisis, but sustainable courses of action that take into consid-

The cast in rehearsal © IIASA

eration the fact that more ships will be arriving in the future. It was critical to present a concrete and specific challenge to the audience in order to elicit an emotional response and avoid abstract and general discussions.

## Forming uniform groups

During the performance, the Master of Ceremony (MC) asks the audience to move to one of three spots, corresponding to one of the three worldviews presented earlier, that is closest to their way of thinking/feeling. Next, the MC gives participants five minutes to form small groups with other like-minded participants and discuss potential solutions. In each of these smaller breakout groups, there is at least one participant with email access on their smartphone. Participants submit their solutions by sending their ideas to an email address created for the performance.

## Solution-seeking in uniform groups

During the small-group discussion, facilitators distribute newspaper clippings with conflicting, and sometimes radical, opinions on immigrants. The Leader of the Migrants then additionally engages participants based on these news. The MC selects one solution from each perspective (worldview) and these are sequentially enacted by the artists. The solutions directly affect the migrants; for example, based on proposed criteria, some migrants are sent home, while oth-

ers are invited to stay. Since all of the solutions proposed stem from specific worldviews, the government representatives, portrayed by the artists, cannot agree on any of them—there is always at least one of them who strongly disagrees. In this way, it becomes clear that another approach is needed.

### Solution-seeking in mixed groups

Next, the MC asks the audience to form small mixed groups with all three perspectives represented in each group. These new groups search for compromise solutions. Their new ideas are submitted again via email, and one "best inclusive solution" containing elements from all three worldviews is announced by the MC. Similar to the first round of discussions, newspaper clippings with conflicting opinions on immigrants are distributed to participants, and the Leader of the Migrants engages them based on these news. The final solution is enacted by the government representatives leading to some friction between them. Ultimately, however, they manage to find a compromise solution that all of them can agree on.

> *"Data cannot be the only tool used to reach people to encourage change.* Migraspectives *was a journey for all of us to find out how we can bridge the gap between researchers, policymakers, and society.*
>
> **Nour Barakeh, cast member**

Three government representatives embodying the three worldviews, (L-R) Gloria Benedikt (Individualist), Nour Barakeh (Egalitarian), Hannah Kickert (Hierarchist), watch Krisztian Gergeye (Leader of the Migrants) engage with the boat

IIASA scientists portraying a group of refugees seeking help © IIASA

## 3. OUTCOMES AND DISSEMINATION

*Migraspectives* premiered in the Paradise Garden of Laxenburg Castle, where IIASA is housed, on September 5, 2018. In the audience were researchers and policymakers from 40 nations who were participating in a three-day summer school on Evidence and Policymaking. The performance created a unique opportunity for participants to not only observe, but also deeply and meaningfully engage with the migration debate. During the performance, participants followed the steps suggested by the MC. They gathered in small groups, where they engaged in thoughtful and intense discussions. The boundary between the "game world" and real life was blurred. Following a controversial statement in one of the groups, for example, a participant asked: "Are you serious or are you acting?" In another group, one of the participants was so emotionally distraught that "we cannot take them all" that other participants had to reassure her: "Look, it is just a game."

From a social science perspective, it was interesting to observe that all groups acted consistently with their worldviews. When the Leader of the Migrants tried to engage them during discussions, the "individualists" turned their backs on him and did not even notice that migrants were asking for help. The "hierarchists" were looking in the direction of the migrants, but were also ignoring them—in a way, looking "over" them. Finally, the "egalitarians" were the only ones who made eye contact. However, throughout the performance, all of the participants walked through the group of migrants without interacting with them in any

One participant makes direct contact with the migrants © IIASA

way. Only one of more than a hundred participants joined the migrants for some time. This confirmed a consistently observed real-world pattern where policymakers discuss solutions without consulting with the impacted communities.

For the scientists playing migrants, it was a moving experience; despite the audience's best efforts, they felt ignored and neglected. For most of the participants, this provided an opportunity to feel the many pressures involved in making important decisions that can have significant consequences on human lives. Participants kept sending solutions to the email set up for the performance for days afterwards.

All of the participants in the IIASA JRC Summer School were asked to evaluate the different sessions they attended as part of the program. The response rate was 97%. *Migraspectives* was rated one of the top two sessions.[44]

| **Dance theatre – MIGRASPECTIVES** (Benedict et al.) | Participants' Evaluation |
|---|---|
| Extremely well perceived by the participants. Almost 2/3 of participants found it excellent. Participants appreciated the unusual, but effective manner to convey a message. It was an unexpected and thoughtful way to get everyone thinking about the issues. It was an impressive collaboration between science and art and it added exceptional variety to the program. It also served as an icebreaker in bringing participants together in smaller groups to discuss how to handle the migrants in the boat.<br>Suggestions for improvement: Make a clearer distinction between "migrant" and "refugee". | 89%<br>11%<br>0% |

> *The artistic performance connected to the participatory exercise was a very nice way to help total strangers engage with and discuss an extremely complex topic in a constructive way in a very short amount of time.*
>
> **Laurent Bontoux, Senior Expert, Joint Research Centre, European Commission**

## HOW MIGHT THIS WORK SUPPORT THE GLOBAL TRANSFORMATION TOWARD SUSTAINABILITY?

According to cultural theory, taking into account people's different worldviews is a prerequisite to finding sustainable solutions to global problems. *Migraspectives* showed that using cultural theory as part of a physical theater performance, applying it to current affairs, and connecting it to a participatory exercise, can help experts and non-experts alike understand the complexity of a problem and strive for balanced solutions. The transformation toward sustainability requires a holistic approach that includes the natural and social sciences, the humanities, and the arts. It requires listening to and respecting all perspectives. *Migraspectives* serves as an example of how it can be done.

The summary video is available HERE.

Participants discussing potential solutions © IIASA



Gloria Benedikt during the premiere of *Dancing with the Future* © Jason Nemirow

# CHAPTER IX
# DANCING WITH THE FUTURE

**When findings from a paper are choreographed, can they lead to better decision-making?**

*Dancing with the Future* premiered at Harvard University's Farkas Hall on September 25, 2018. It was subsequently presented at the International Conference on Sustainable Development, organized by the UN SDSN in New York during general assembly week; at the IIASA headquarters; and at the Sustainable Brands Flagship conference in 2019.

## 1. MOTIVATION

Since the 17 SDGs were adopted by UN member countries, scientists and policymakers around the world have been working to figure out how to achieve them by 2030. At the same time, we still know very little about how to cooperate with future generations. The 2014 *Nature* paper titled "Cooperating with the Future" provides evidence that a large majority of people would choose to cooperate with the future if they could jointly decide to do so through a global and binding vote. Translating scientific insight into policy development, however, is never easy, even if published results are considered enormously successful when they are extensively cited. This prompts the question of whether art could be a vehicle to transmit scientific findings to society.

## 2. PROCESS

### *A. Setting the goal*

#### Innovation

Understanding the ways in which humans cooperate is becoming crucial as cooperation is a prerequisite for successful problem-solving in an increasingly interconnected world. Most people think in stories rather than in theories and numbers. Could dance, music, words, and imag-

es woven together provide a human dimension to the theoretical mechanisms of cooperation and make them tangible to a broad and diverse audience?

### Impact

Interactive games were included as integral parts of the performance (as will be seen below, in scene 2 and 4, instead of being placed at the beginning and/or at the end of it). To determine how effective they were at engaging different stakeholders, we tested them on general audiences, policymakers, and on the business community.

### *B. Preliminary work / Identifying the topic and structure*

**Lead:** Gloria Benedikt, Martin Nowak

Building on the 2017 production of *InDilemma*, which fused game theory, dance, and an interactive game to engage the audience in addressing resource inequality, the 2018 production of *Dancing with the Future* investigated a question that is at the heart of sustainability, yet remains elusive. It has a moral dimension that is very hard to embrace through modeling alone, namely, "What will be the state of the planet left behind for future generations?" As future generations are unable to give back (either directly or indirectly) to the current generation, traditional game theory cannot solve this dilemma. However, strong evidence provided by Martin Nowak, Professor of Mathematics and Biology at Harvard University, and his team, shows that a global democratic, binding, voting process would result in humans being willing to leave enough resources behind for future generations.[45] In addition, research suggests that there is an altruistic majority of people who care about the future.[46] On this basis, Nowak and I started to conceive the new production, which was to combine dance, game theory, evolutionary dynamics, and an interactive game.

### *C. Writing the script*

**Lead:** Martin Nowak
**Input:** Gloria Benedikt, Piotr Magnuszewski

Martin Nowak, Piotr Magnuszewski, and I discussed the structure of the piece. We agreed on five scenes, where scenes 1, 3, and 5 would gradually build the mechanisms of cooperation, while scenes 2 and 4 would be devoted to turning the paper's findings (which were based on lab experiments) into an interactive game. Nowak wrote the text for scenes 1, 3, and 5.

### *D. Rehearsal period 1*

**Lead:** Gloria Benedikt, Mimmo Miccolis
**Input:** Martin Nowak

Filming the trailer for the piece © Martin Nowak

Mimmo Miccolis and I spent one week at Harvard University's Dance Center, trying to figure out how to translate the script into a story that could be told through movement. Together with Nowak, we created a storyboard for each scene. Working together ensured that the story was compatible with the science and that it would be possible to choreograph it. Miccolis and I then choreographed parts of the scenes.

Specific challenges included creating a sound file where music and text could be timed perfectly to fit with the choreography. This involved a back and forth process of breaking up the text into smaller chunks when more time was needed for movement and re-syncing it with the music.

Working with two other dancers, Henoch Spinola and Sophia Isidore, Miccolis and I tested some of the choreographic ideas that required more dancers and spent a day filming material to use in a trailer to promote the production.

Jeffrey Gerold, one of Nowak's graduate students, showed talent for voiceover work. After getting some coaching so he could act as the narrator, the text for scenes 1, 3, and 5 was recorded.

### *E. Developing the game*

**Lead:** Piotr Magnuszewski
**Input:** Gloria Benedikt, Bartosz Naprawa, Martin Nowak

Gloria Benedikt and Jeffery Gerold preparing to record the text © Private

Magnuszewski designed an interactive game based on the *Nature* research article and the text written by Nowak. Since game theory usually involves more abstract games, and the original game designed by Nowak and his collaborators was meant to be run under experimental conditions, it needed to be adapted for our purpose. This provided two big challenges. First, the strictly controlled experimental settings of the

original game had to be adapted to accommodate theater conditions where a large number of participants are restricted by the time allocated for the performance, and have limited options to communicate their decisions to the game facilitator. The game also needed to follow the flow of the performance with only minimal time available for explanations. Second, since we were planning to involve a broad audience including policymakers, it was desirable to embed an abstract game-theoretical representation in a more realistic setting. In this setting, participants would be influenced by specific worldviews shared among members of small groups formed as part of the game, and the coalitions that they were assigned to. Instead of using an abstract representation of resources, a more tangible view of a city dependent on extracted resources and constrained by serious issues of inequality and pollution was used.

We expected that if participants were pushed to solve pressing current issues, they would neglect to think about the wellbeing of future generations. We prepared four specific roles (the "Optimistic Economist," "Worried Egalitarian," "Radical Environmentalist," and "Tribal Nationalist") that participants were asked to take on and provided descriptions for these roles that emphasized certain values. Similar to Nowak's original game, the decisions that participants would have to make in the first part of the game (scene 2 in the performance), were designed to be made unilaterally. We planned to provide strong incentives for participants to ignore the future, which would lead to them ending this part with overall unsustainable outcomes.

The second part of the game (scene 4), which was designed to build on new knowledge about the mechanisms of cooperation, started with participants being asked to interpret the roles they had been assigned more freely and reestablish cooperation. Using the newly-learned collective mechanism of decision-making and a binding vote, more sustainable results could be reached. Although far from perfect, this was a significant step forward.

The game was designed to smoothly integrate with the dance sequences and to, in effect, make the audience a co-creator of the performance, thus making the whole experience engaging and memorable, resulting in a deeper learning experience.


Projected illustration of a city dependent on extracted resources © Bartosz Naprawa

Projected illustration of a future resource-depleted city © Bartosz Naprawa

### *F. Reaching out to media, briefing the artistic cast, finalizing sound and visual files*

**Lead:** Gloria Benedikt
**Input:** Mimmo Miccolis, Martin Nowak

The artistic cast included four additional dancers. Mimmo Miccolis and Hannah Kickert had both worked with IIASA before, while Jessie Jeanne Stinnett and Henoch Spinola had extensive experience and an affinity for connecting art with science. All four were briefed on the research process and given the script so they could start thinking about how to translate it into choreography.

The project was promoted through a press release and a video trailer.

The production meeting took place at Harvard University's Farkas Hall. Technical requirements were kept to a minimum since setup time for the New York performance, scheduled to take place two days after the Harvard premiere, was only two hours.

Sound and images were saved together as one file, and light cues were designed to be as simple as possible. The only technical complication was switching video operators. In Farkas Hall, what appeared on screen was controlled by a sound technician backstage. In New York, Magnuszewski controlled the game from his laptop while on stage and adjusted it based on the audience's responses.

Editing the trailer © Private

Images were chosen to provide a backdrop for the performance, and to supplement text and choreography when those alone could not convey the message. The final version of sound and visual files were edited.

Cast of *Dancing with the Future* rehearsing "fruits of cooperation" © Olivia Falcigno

## *G. Rehearsal period 2*

***Lead:*** Gloria Benedikt, Hannah Kickert, Mimmo Miccolis, Henoch Spinola, Jessie Jeanne Stinnett
***Input:*** Piotr Magnuszewski, Martin Nowak

Cooperation was not only a theme for the piece; it was also a necessity among the creators in order to bring the project from preparatory stage to premiere in only 10 days. Day One started with a kick-off meeting, where the entire artistic and scientific cast worked through the storyboard and discussed and resolved questions so everyone could be on the same page when rehearsals began.

The next four days were spent in the studio completing the choreography for the mechanisms of cooperation (scenes 1, 3, and 5). Creating a narrative around these mechanisms without going off script proved to be a challenge. Here is an example of the section about defection at the end of scene 1:

*While humans strive for goodness*
*there is temptation to defect.*
*Cooperation invites exploitation.*

*Is never stable.*
*Waxes and wanes.*
*Comes and goes.*
*Reverts to selfishness.*
*Cooperation is lost and has to be reinvented.*
*It does not come for free.*
*It is not easy to maintain.*
*The opportunity is slippery.*
*The moment is fleeting.*
*The future is uncertain.*

We brainstormed symbols of defection and settled on walls. One naturally thinks of physical walls, and the decision had been made in the first rehearsal phase to project images of walls on the screen. But how could we enact what is described in the text on stage? Discussions led to the observation that humans do not just build physical walls, they also create human walls by deciding who belongs to a group and who does not. These human walls are more fluid than the physical ones. Someone inside the group today may be excluded tomorrow and someone outside the group may suddenly be invited in. The future among defectors is uncertain. So we built a human chain that moved forward, backward, and sideways while the person who was excluded tried to take one person out to take his or her place. Eventually, the chain breaks and everyone fights with everyone.

Humans and (projected) physical wall (L - R) Gloria Benedikt, Henoch Spinola, and Hannah Kickert © Daniel Kruganov

On Day Six, sound and light cues were created and delivered to the theater. Days Seven and Eight were devoted to staging the games (scenes 2 and 4). Day Nine was spent in the theater for the technical and dress rehearsals. We premiered the production on Day Ten.

## 3. OUTCOMES AND DISSEMINATION

*Dancing with the Future* premiered at Harvard University's Farkas Hall on September 25, 2018. It was presented at the International Conference on Sustainable Development two days later, on September 27, 2018, during the United Nations General Assembly week in New York City, both times to standing ovations.

Participants remarked that the science presented in the performance was made more tangible and helped them understand how it could be applied to real world problems. Furthermore, many participants pointed out that having flesh and blood artists embody the future generation on stage—a future generation whose fate they were asked to vote on—altered their perception. The commonly used phrase "future generation" was no longer perceived as an abstract concept but as a reality that demanded responsible action now.

The cast embodying the mechanisms of cooperation Top © Jason Nemirow; Bottom Right © Daniel Kruganov; Left: Piotr Magnuszewski (future generation in the back) © Daniel Kruganov

> *What an experience tonight was. I thought it was aesthetically beautiful, emotionally gripping, and intellectually stimulating. I think the whole world should be required to see this.*
>
> **Majorie North, Communication Expert, Harvard University**

Both performances were recorded and a summary video was posted on social media. In June 2019, *Dancing with the Future* was invited to the Sustainable Brands Flagship Conference and was presented at IIASA's headquarters in Laxenburg.

## HOW MIGHT THIS WORK SUPPORT THE GLOBAL TRANSFORMATION TOWARD SUSTAINABILITY?

Humans think in stories. By themselves, facts, theories, numbers, and equations do not create meaning. This project showed how narratives can be created to imbue scientific concepts, in this case the mechanisms of cooperation, with life. This collaboration between art and science forms the basis for a new language that speaks both to the brain and to the heart.

Informing society about scientific findings is not enough. Collectively, we need to internalize scientific knowledge so we are compelled to act. Cross-disciplinary approaches combining different scientific and artistic languages are the key.

The audience is asked to vote © Daniel Kruganov

# WHEN SCIENCE MEETS ART
## A GRACEFUL PARTNERSHIP FOR CHANGE

*A reflection by* Dancing with the Future *cast member Jessie Jeanne Stinnett*

What can I do to contribute to global efforts to create sustainable practices that might yield cooperation with the future? Why do I dance and what kind of impact does my dancing have on my environment and on myself? As a co-artistic director, entrepreneur, choreographer, and performing artist with the young and fast-growing contemporary dance company Boston Dance Theater (BDT), I am turning to projects that live in the innovative cross-section of arts, technology, and other disciplines. I turn to these projects because of their potential to have a transformative impact on the creative team, the audience, and beyond. I am searching for practices and partnerships that yield pathways for collective problem solving, or "super-cooperation." As mathematician Martin Nowak notes in his book *SuperCooperators: Altruism, Evolution, and Why We Need Each Other to Succeed,* "[evolutionarily speaking] this is what humans are."

Being part of the *Dancing with the Future* project has revealed to me that scientists, dancers, and policymakers can successfully sit at the same table (or in the same theater or conference hall), tackle the same issues, and productively collaborate toward unearthing sustainable solutions.

All of us involved in the project had to be open to compromises—this is not an easy task in a room full of expert-leaders. I created a mantra for myself to remember that we were creating something completely new. Each time my choreographer-dancer brain sent up a red flag, I had to decide whether it was useful, in that moment, to share my opinion with the group. I elected to practice the Buddhist teachings of Shunryu Suzuki, captured poetically in *Zen Mind, Beginner's Mind: Informal Talks on Zen Meditation and Practice:* "In the beginner's mind there are many possibilities, but in the expert's there are few." This choice opened others and myself up to creative and peaceful solutions that I otherwise wouldn't have seen.

Conversely, I was able to offer constructive solutions at moments when working with the scientific material seemed to overwhelm the studio process—for example, by dividing the existing text and music into segments and giving each of those segments a specific choreographic task that related to the content of the scientific text. This was a very simple concept that had to do with pacing and sculpting time. Once we counted out the music, it was easy for us to construct the movement score and see the overall arc of the piece.

I learned to not be afraid to use my voice and also to listen deeply. It was, at first, very intimidating to be seated across from experts in fields outside my own. I learned that sci-

Performing indirect reciprocity (L-R) Henoch Spinola, Gloria Benedikt, Mimmo Miccolis, Hannah Kicktert, and Jessie Jeanne Stinnett © Daniel Kruganov

entists and policymakers can understand, respect, and respond to the decisions I make through a process of peaceful negotiation, even when we speak different languages, were born on different continents, and may have varying political opinions. My fear was ultimately unnecessary because the very nature of this project appealed to our common humanity.

This form of cross-disciplinary collaboration allowed us to see our own work in a new light and to discover new languages that are exciting because we have co-authored them. For the work to be successful, the dance, science, and debate components of the piece had to have equal weight and value otherwise the movement and its choreographic structure would have simply been visual representations of the science. When that happens, the magic of innovative collaboration falls flat.

During the rehearsal process, we often referred to this Chinese proverb: "Tell me, and I'll forget. Show me, and I'll remember. Involve me, and I'll understand." Dancers understand this concept in a concrete and visceral way. For scientists, policymakers, and audiences to understand too, they must be as involved as possible in the creative process. If we cannot, for practical reasons, have them with us in the studio, then we must bring them into the process another way. It is only by involving them as collaborators that we can generate large-scale, super-cooperation.

Sometimes it feels like my dancer colleagues and I exist in a vacuum: we rehearse within the confines of the studio and traditionally perform on stages that position us as "other" in relation to our audiences. Western, Euro-derived concert dance has been criticized for being an inaccessible art form and, according to the 2016 report from The Boston Foun-

dation, it is the most underfunded of Boston's performing arts. Contemporary dance, in particular, can be challenging for audience members to understand because its language and conceptual frameworks are not always obvious. In addition, dancers are not typically trained to speak about their own work—many choreographers feel creatively stifled when asked to explain their work in words and wonder why the work can't speak for itself.

I have come to realize that these problems are not unique to dance. Scientists work in labs, use scientific and mathematical languages, and often feel challenged when asked to communicate their research findings to a larger audience. Scientists may use metaphors in order to more directly connect scientific knowledge with the human experience. Dancers undergo a similar process. We use bodily languages, music, lighting, costumes, voice and spoken word, and other theatrical devices to express ideas, which we share with our audience through the performative event. The key difference is, as Ann Cooper Albright suggests in *Choreographing Difference: The Body and Identity in Contemporary Dance:* "Dance, although it has a visual component, is a fundamentally kinesthetic art whose apperception is grounded in not just the eye but in the entire body." The experience of the dancer and the experience of the audience member become linked through a shared empathetic, kinesthetic experience unfolding in real time. The onlooker receives a sympathetic response in their own musculature, which does not necessarily happen when a scientist gives a lecture. The dancing body expresses meaning differently than most other forms of communication.

After our premiere of *Dancing with the Future* at Harvard University, scientists who were in the audience thanked me for helping them draw new meaning from the scientific research presented through my performance. Witnessing and "feeling" my artistic choices, such as the fluid movement quality and sense of care I expressed through my body during a partnering section dealing with the idea of indirect reciprocity, gave them an opportunity to experience their data-driven findings from a fresh perspective. They felt the humanity within their own research. Their witnessing of human, dancerly bodies in performance elicited an immediate "metakinesis"—a spectrum of somatic, kinesthetic, aural, visual, and spatial sensations that allowed them to perceive how scientific mechanisms can work in action. This collaboration yielded a tri-fold, reciprocal impact for the artists, the scientists, and the public.

Our work helped to bridge the traditional gap between creative team and audience. In most cases, when an audience member enjoys a concert performance, they leave the venue with a good feeling and a nice memory. But I believe that our art form has the power to do more—to have a greater social impact and to be appreciated as an inherent and necessary aspect of our society and culture.

It is our civic responsibility to continue workshopping solutions that promote global cooperation and cooperation with future generations. *Dancing with the Future* has shown

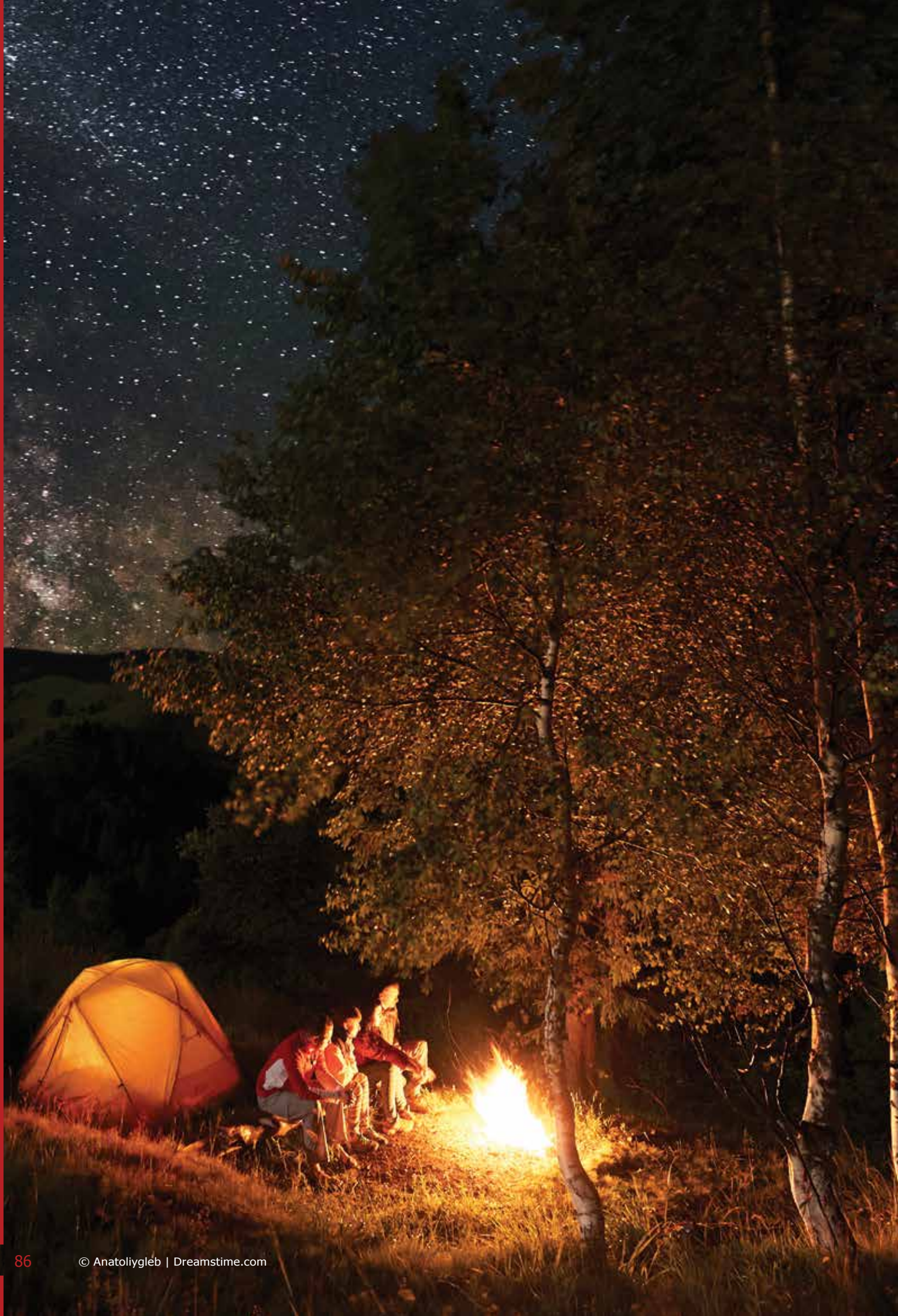
to me, on a micro scale, that this is a reasonable and plausible endeavor. With continued care, attention toward our common goals, compassion, deep listening, and risk-taking, we can understand one another through the process of creation regardless of what language we speak or where we were born. The next steps may be small, but nonetheless crucial. Next season, Boston Dance Theater will commission new works by three international choreographers with the stipulation that the pieces speak to pressing global issues, and that cross-disciplinary collaboration is a cornerstone of that production.

*Dancing with the Future* has revealed to me that partnerships with super-cooperators such as the teams at IIASA, and scientists from Harvard University, have the potential to catalyze change in me as an individual as well as in Boston Dance Theater as an organization, while enabling us to reach our extended communities.

**JESSIE JEANNE STINNETT** is an American choreographer and founder of Boston Dance Theater, a contemporary dance company. Her work has been sustained in part by grants from The Boston Foundation with support from The Barr Foundation, New England Foundation for the Arts, Assets4Artists at MASS MoCA, Boston Center for the Arts, Boston Dance Alliance, and Fidelity Charitable. She is a graduate of the Boston Conservatory and Trinity Laban Conservatoire of Music and Dance, London.

## CONNECTING SCIENCE & ART
## PROCESS IN PROGRESS

The productions described so far have used multimodal communication: narrated text, music, movement, and dialogue. The texts written by the scientists were mostly abstract though the last two productions experimented with different text formats. In *Dancing with the Future*, Nowak chose to write in prose, thus crossing the boundary between science and art himself. Going one step further, *Migraspectives* had a very loose storyline that led to the realistic boat scenario. From there, we decided to move toward narrative-driven performances; there is strong evidence, as the experimental psychologist and neuroscientist Joshua Greene explains, that stories "engage our social emotions, the ones that guide our reactions to real-life cooperators and rogues."[47] Storytelling, thus, became the focus of the next project.



# CHAPTER X
# STORIES FOR THE FUTURE

**How could stories support the sustainability transformation and can scientific papers be turned into theater plays?**

There is extensive literature in the humanities about how stories have evolved over time, and how they have changed the course of history.[48] There is also a growing body of literature in psychology and neuroscience that looks at what happens to the brain when exposed to stories, and how stories shape behavior. However, this knowledge had not yet been applied to gain an understanding of how stories could effectively support the sustainability transformation. The first phase of the *Stories for the Future* project was devoted to academic research. Based on these findings, in the second phase, two Science & Art pilot productions were created in collaboration with two playwrights. In the third phase, a larger scale initiative was set up.

## 1. RESEARCH

Over the last decades, psychologists have been studying the effect of stories on the human mind. "Research findings have been consistent and robust," Jonathan Gottschall, who specializes in literature and evolution, reports. "Story—whether delivered through films, books, or video games—teaches us facts about the world; influences our moral logic and marks us with fears, hopes, and anxieties that alter our behavior, perhaps even more than our personalities."[49] As will be seen below, there is strong evidence that the evolutionary role of stories was to enable a better understanding of cause-and-effect relationships, and to prepare humans for real-life challenges. Stories have the potential to improve, but also negatively influence, social skills.

### The function of stories in relation to sustainability science

Human minds are wired to perceive meaningful patterns, and are averse to uncertainty, randomness, and coincidence. The mind is "addicted to meaning" as Gottschall puts it, and this "hunger for meaningful patterns translates into a hunger for story." Stories provide a

way to create meaning out of random facts.[50] Humans look for patterns to make sense of the world around them. Their brains use pattern recognition to break down complicated and variable situations into simpler relationships, as when solving a complicated mathematical equation. Moreover, people retain about one-fifth of what they read, but four-fifths of the images they form in their minds.[51] Thus, stories are recalled much better than facts because they are remembered as symbols or images.[52] This helps explain why most people have difficulty digesting scientific facts and why the language of science is not, by itself, optimized to have a lasting impact. Not all scientific knowledge is required to be widely understood. But sustainability science is one of the branches of science that need to reach a broad audience because its findings require large-scale behavior change. Stories can be effective tools in facilitating this transmission of knowledge.

What is more, as scholars of world literature have shown, stories are preoccupied with a few master themes that "universally focus on the great predicaments of the human condition," such as love, fear of death, and power. In short, they are about our most significant challenges in life.[53] Fiction, Gottschalll points out, "allows our brains to practice reacting to the kinds of challenges that are—and always have been—most crucial to humans' success as a species."[54] Stories about sustainability could thus be built around the same great predicaments of the human condition, but with an updated context that reflects today's world.

Finally, stories shape human minds. While technological advances have changed how stories are told and disseminated, they continue to fulfill their original function: they bind members of society together by reinforcing common values, thus increasing the ties of common culture.[55] We also know that the sustainability transformation will require a cultural shift.[56] Given the role stories have played throughout the ages, could authors help promote values that support sustainability and bring global society together?

## Harnessing the power of stories to convey principles of sustainability

People's response to fiction has been studied at the neuronal level. When they watch a film, their brain lights up as though what is depicted in the film was happening to them in real life. The neuroscientist Anne Krendl and her team discovered that the emotions conveyed on screen were emulated by the viewers' brains. For example, when the protagonist was angry, the brains of those watching looked angry, and when a sad scene was shown, the viewers' brains were sad as well.[57]

In another study by neuroscientist Mbemba Jabbi and his team, research subjects were placed in an fMRI scanner and first shown a short video clip of "an actor drinking from a cup and then grimacing with disgust." Next, the subjects were asked to imagine that they were "walking down the street, accidentally bumping into a retching drunk, and catching some of the vomit in their own mouths." Finally, research subjects were given a solution to drink that tasted disgust-

ing. Every time, the same brain region, namely the anterior insula—also known as the seat of disgust—was activated.[58] "This means," as one of the study's authors explains, "that whether we see a movie or read a story, the same thing happens: we activate our bodily representation of what it feels like to be disgusted—and that is why reading a book and viewing a movie can both make us feel as if we literally feel what the protagonists are going through."[59]

When creating stories based on sustainability science, it is therefore of utmost importance to be aware of the protagonist's power and to carefully craft his or her role in line with sound scientific findings, rather than, as is often the case in mainstream storytelling, with the author's point-of-view.[60]

Also relevant in relation to creating stories based on sustainability science is the evidence that continuous immersion with fictional problem-solving improves humans' ability to deal with real problems. Psychologists Keith Oatly, Raymond Mar, and colleagues have shown that people who read a lot of fiction "have better social skills—as measured by tests of social and empathic ability—than those who mainly read non-fiction."[61] However, it is important to note that in lab settings, consuming fiction with pro-social themes has led subjects to be more cooperative whereas consuming fiction with violence has led subjects to more aggressive behavior.[62]

Audiences tend to identify with fictional characters and live through the story with them, reducing the distance between "us and them." Narratives also reduce resistance to new ideas because people become absorbed in the story and visualize themselves in it.[63] This is helpful in creating openness, a prerequisite disposition for engaging in meaningful communication, and change. However, when crafting stories about science, authors must be aware of the power of protagonists outlined above. Protagonists can act in ways that bind people together and promote prosocial behavior. But they can also spur empathy within a group that results in more hatred toward (an)other group(s), causing more harm than good.

## 2. PILOT PROJECT: PUBLISHING FOR THE PUBLIC
### Turning scientific publications into theater plays

In the spring of 2019, two playwrights, experienced in writing stories that engage with science, visited IIASA for three weeks to write short theater plays based on scientific publications.

The Chinese-American playwright, Lanxing Fu, co-director of the New York-based eco-theater company Superhero Clubhouse, worked with Fabian Wagner, a senior researcher at IIASA. Wagner had co-authored the PNAS paper "Impact of population growth and population ethics on climate change mitigation policy." Taking the paper's findings as a


starting point, Fu wrote a theater play titled *Piece of Cake,* which grapples with what resource depletion, climate change, and demographic development mean for society.

## PIECE OF CAKE

Past, present, and future exist in one space as four generations of a family, spanning 1950 to 2050, gather around a table to share an absurd, abundant, limitless feast. The play traverses a century of humans' changing relationship to resources and shifting ideas of what it means to have children.

The play begins with the first character entering the scene in 1950, capturing the spirit of the post-World War II era.

*Ahhh. What a day. It's a great day to be alive.*
*It's great luck to be alive.*
*As long as I've been alive, the world's been at war.*
*That's all over now.*
*Well not entirely.*

*There's still rumblings here and there.*
*When wars so big happen there are wounds that open a million little knicks and bruises.*
*Even after you staunch the bleeding, it takes time to heal.*
*It's time to heal.*
*Onwards and upwards.*
*Time to eat cake...*

This first character marries and the couple has two sons. The sons wonder whether resources are limitless. Their mother objects:

*The world will be enough. You don't believe you'll have enough, or be enough, and then you have a child. And suddenly it must be enough. You make it enough. This city used to be a small town. But over the years it had to keep being enough for each new child that was born…*

The older son next has a child. In contrast, the younger son decides against it; he feels there won't be enough resources left for future generations. The grandchild of the older son has a child amidst great concerns. In an emotional monologue set in 2016, the grandchild reflects on her life and on her desire to bring forth another life, framed by a series of hurricanes.

*My grandmother dies. My tribe is small now too. My loneliness is hungry.*
*I roam. I meet someone. I fall in love. I fall into a home.*
*Haiyan.*
*I vote. I vote for the people that say they're going to do something about all this. Put real money behind it.*
*Winston.*
*Well, it could be the next Einstein.*
*Harvey.*
*But this is a first world baby. That's like five babies. That's a wildfire of a baby. That's a Pakistani heatwave baby. That's 310 lives in a Brazilian mudslide baby. That's an island underwater baby. That's your last chance to see a glacier baby. That's eight percent of plants gone baby.*
*Irma.*
*And yet. Because my father wants it so much.*
*Because I want to feel like I belong.*
*Because what is this all for anyway, if not to love?*
*Because I want to be a mother. Because I'm afraid to die alone.*
*Because people will smile at me, at us.*
*Because I bought pants that make me feel like I should be a mother.*
*Because I will be giving life. Because it's the right thing to do.*
*Because I have a lot to teach someone.*
*Because I drink a lot of wine and maybe being a mother will make me stop. Because I want to be adored.*

*Because I want to be needed.*
*Because I watch five hours of TV a day.*
*Because boredom terrifies me more than regret.*
*Because we need more smart people.*
*Because who knows what the future will hold anyway?*
*Maria.*
*My baby is born.*
*Florence. Michael. Yutu.*
*My baby grows.*

The young woman dies early, but the abstract setting allows all family members across generations who sit around the table to continue to have conversations. She speaks with her child in 2050. The child reflects on her life.

*I'll never not want to be alive. But I'm not used to living…*

The play brings up ethical dilemmas. For instance, it describes how many people have just died because they could not protect themselves from the heat.

*That won't happen to me. I'll be okay. But, I don't know.*
*Can I be okay if WE are not okay?*

One more person enters the room—someone who has not been born yet. The six generations sit around the table; all the chairs are taken. The "potential child" imagines how they could fit into a world which does not have a spare chair:

*I might be a child from your body. We'd have to share.*
*I might be a child you adopt from someplace far away. I would bring my own chair. I might be part of a dying species. I wouldn't be here long.*
*I might be a creation of your minds, a being with a consciousness that you can't even imagine.*
*I wouldn't need a chair.*
*I might not be at all, but then you'll never know.*

A cast of courageous IIASA scientists read the piece for a filmed internal premiere at the institute. Post-performance discussions with IIASA colleagues centered around how staging the play in a theater could enhance the performance and help audiences grasp the content. And, depending on where in the world the play was performed, some of the content could be adapted. It would also be interesting to develop a version of the play where the audience has to make the decision for a character and, depending on the decision, the play would have a different ending. When asked about her greatest challenge

The cast for the internal reading of *Piece of Cake* (L-R) Wei Liu, Fabian Wagner, Frank Sperling, Lanxing Fu, Gloria Benedikt, Chantal Bilodeau, and JoAnne Bayer © IIASA

in writing this play, Fu pointed out that offering a constructive ending rather than a tragic one was not easy. In the end, she succeeded by imagining the different ways in which the potential child could come into the world in 2050.

> *"I found it fascinating how a playwright can turn ideas into words. These words are not necessarily descriptive, but they create life and action. As scientists, we always have to describe a concept or a model... we have to explain how the world works. But artists can show how things really are.*
>
> **Fabian Wagner , IIASA Senior Research Scholar**

**LANXING FU** is a Chinese-American writer, director, and performer. She is co-director of Superhero Clubhouse, a New York City based eco-theater company, and is currently working as project director for the Living Stage as artist-in-residence with University Settlement. She has collaborated on and led interdisciplinary projects on globalization and the environment through research in Sri Lanka, Morocco, Turkey, and the United States. She is a graduate of Virginia Tech.

## GOOD NEIGHBOR

*Good Neighbor*, by the Canadian playwright and artistic director of The Arctic Cycle, Chantal Bilodeau, is based on Chapters 3 and 4 of the WWF Living Planet Report 2018. Bilodeau worked with the authors, IIASA research scholars Pierro Visconti and David Leclere. Their discussions focused on the challenges posed by biodiversity loss, its various causes, and possible ways to address it. While writing the play, Bilodeau explored questions such as: How can we show the interconnectedness of species within an ecosystem? How can we visualize the complex domino effect set in motion by our interactions with the natural world? How can we overcome ideological barriers in making these things personal and relevant? To avoid dystopian and apocalyptic scenarios, which are often how artists engage with these topics, and infuse a constructive dimension, she sought to convey the severity of the situation but also the possibility for change scientists have uncovered.

**Scene 1:** The two main characters admire nature. They decide to get married and to live on a farm.

**Scene 2:** The couple host friends for a meal on their farm. They reflect on how the nature of running the farm has changed over time.

*SHE: At first, we only wanted a garden. Tomatoes. Peppers. Zucchinis. Something modest. Just enough to feed ourselves.*

*HE: But then we realized: a tomato garden is not how you succeed in life.*

*FRIEND 1: Unfortunately.*

*HE: We wanted to buy stuff. Own stuff. Like everyone else.*

*FRIEND 2: Be a part of society.*

*HE: Exactly.*

*SHE: Especially with the triplets.*

*HE: Corn seemed like a good idea.*

*SHE: Yes, it seemed like a good idea.*

*HE: Government subsidies.*

*SHE: Pesticides.*

*HE: Increasing demand for biofuel.*

*SHE: Fertilizers.*

*HE: A lot of the forest had to be cut. But we became upwardly mobile.*

Internal reading of Good Neighbor (L to R) Piero Visconti, Wei Liu, Cynthia Festin, David Leclere, Marcus Thompson, and Chantal Bilodeau © IIASA

*SHE: Very upwardly mobile. Then we had the twins.*

*HE: Yes, the twins. More mouths to feed.*

*SHE: Except we don't feed anyone with what we grow. We only feed engines….*

Later the concept of biodiversity loss is conveyed:

*SHE: It's become addictive. First, we killed the trees and everything that lived in and under them. Then we shot the wolves because they were eating the lambs. Next, we killed the soil with our straight rows, which in turn killed the fish because the chemicals we had to feed our dead soil to keep it productive harmed the river. And I suspect the beavers went away. We don't hear them anymore or see their dams. Did you notice there are no songbirds?*

*HE: I hadn't noticed.*

*SHE: We used to be surrounded by them.*

*HE: Did we?*

*SHE: Don't you remember?...*

**Scene 3:** The main character grieves.

*SHE: I miss the forest and the fish and how happy the river used to be. Now it's confused. It doesn't know where to go. Every season, it changes its mind and takes a different path. I miss the birds singing love songs. The only things we see now are locust and they eat everything—the trees, the grass—there's too many of them, they eat everything and leave the land barren. But most of all, I miss the bunny rabbits. And the wolves…*

A friend proposes a solution. After the elk on her property went away, she explains that she had a conversation with them and asked what they needed in order to come back:

*FRIEND 2: Yes. I had a conversation with them. I asked questions. Then I listened. I observed. I tried to guess. Then I listened and observed some more until I got some answers. Some call it science; I call it being a good neighbor.*

*SHE: What did they say?*

*FRIEND 2: They said I had taken away their favorite sleeping place.*

The friend proposes that SHE seek a conversation with the animals who have deserted her farm and the surroundings. Even if she cannot undo all the damage that has been done, she can still try to make amends and save the relationship.

**SCENE 4:** SHE seeks to make amends with a wolf. In a semi-humorous scene, the wolf forces her to play a game of Little Red Riding Hood. In the end, he details why, though under-appreciated, his presence within this ecosystem is so important to the life of all of the species.

Food chain of a complex forext © Lukaves | Dreamstime.com

*SHE: "Oh, grandma, what a… what a big mouth you have."*

*WOLF: "The better to catch prey, my child. The better to catch prey and howl at the moon and play with my cubs. The better to chase deer from the valleys so the grass and trees can grow again and bring back the birds and the beavers and all manners of river animals. The better to hunt coyotes and make room for rabbits and mice, which in turn will attract hawks and weasels and foxes and badgers, which in turn will eat the locust. The better to eat and share the leftovers with ravens and bald eagles and bears. The better to help the soil stabilize within the roots of the newly grown bushes and trees. The better to make the river feel safe and contained within its banks. The better to change the landscape that changes me. To feed the ecosystem that feeds me. To give life to the world that gives life to me. All of this I can do, my child. All of this I can do."*

**SCENE 5:** SHE explains to HE the changes that they need to make.

**SCENE 6:** The friends are back for a visit and reflect on the new changes. The songbirds can be heard once again.

Following the filmed internal premiere, discussions with IIASA colleagues centered around what it would be like to stage the play in a natural environment that reflected the setting of the play. There were also discussions about potentially expanding this 20-minute play into a full-length play in order to convey more of the complexity of the different issues.

> *"For once I did not have to just stick to the facts and leave behind my advocacy role. I'm a human being and I feel strongly about biodiversity. I'm quite passionate about it, but I can't express my values in my papers, I have to stick to the facts and for once I could communicate the intrinsic value of biodiversity and what it means for me and other people.*
>
> **Piero Visconti, IIASA Research Scholar**

**CHANTAL BILODEAU** is a playwright and the Artistic Director of The Arctic Cycle, an organization that uses theatre to foster conversation about our global climate crisis, create an empowering vision of the future, and encourage people to take action. She is writing a series of plays that look at the social and environmental changes taking place in the eight Arctic states and was recently named one of "8 Trailblazers Who Are Changing the Climate Conversation" by Audubon Magazine.

## DO THESE STORIES HAVE THE POTENTIAL TO SUPPORT THE SUSTAINABILITY TRANSFORMATION, AS OUTLINED ABOVE?

*Piece of Cake* and *Good Neighbor*, though based on the Science & Art framework (see Chapter XIII), turned out to be very different plays, aesthetically and stylistically. They offer a glimpse of the range of artistic possibilities when transforming scientific findings into theatrical storytelling.

Scientific facts can be woven into meaningful narratives. For example, *Piece of Cake* shows how the depletion of resources, demographic development, and climate change intersect, and how attitudes toward these issues change over generations. It does not offer a solution, but instead, provides insights that help the audience better understand the moral dilemma confronting humanity. *Good Neighbor* highlights the interconnectedness of all plants, animals, and human beings, and presents a vision for what change could look like if we embraced certain values. The author employs humor and absurdism as strategies to disarm the audience and create a space where we can laugh at our questionable decisions and our shortcomings.

These two plays are personal stories that examine aspects of the human condition in order to help people practice facing future challenges. *Piece of Cake* does not dictate whether one should or should not have children; the characters make different decisions, and revealing their motivations provide insight into the complexity of the topic.

The playwrights explored values that can support a transformation toward sustainability and play a role in binding our global societies together. For example, in *Piece of Cake,* one of the characters asks: "Can I be ok if WE are not ok"? In *Good Neighbor*, one friend, marveling at the regenerated ecosystem that has now replaced the farming couple's dying land, remarks: "Imagine if we all did something like that. The possibilities…"

Both *Piece of Cake* and *Good Neighbor* show that scientific findings can be embedded into compelling narratives. The plays seek to fulfill their potential in inspiring sustainable thought and action. How the characters are crafted varies depending on the nature of the publication that inspired the play. A PNAS paper analyzes a topic, whereas a WWF report advocates for change. Thus, in *Piece of Cake,* the characters merely reflect on different perspectives to convey the complexity of the topic; in *Good Neighbor*, a protagonist takes measures to reverse biodiversity loss.

## 3. SCALING UP: THE STORIES FOR THE FUTURE INITIATIVE

Sustainability science has uncovered what would be required technically to get humanity, and as many species as possible, through the current bottleneck of sustainability. This is reflected in the 17 Sustainable Development Goals adopted by all UN Member States. Yet, while the Goals are clearly defined, the path to achieve them is not. We seem to be able to tell the beginning of the story (where we are now) and the mechanics of the end of the story (what we need to achieve) but we do not yet have a clear vision of what happens in between—how we go from here to there—and what the world will actually look like if we succeed with this transition. That part of the story is still missing. Following the successful *Stories for the Future* pilot project at IIASA, Martin Puchner, Professor of English and Comparative Literature at Harvard University and author of *The Written World: The Power of Stories to Shape People, History, Civilization*, and I initiated the Stories for the Future Initiative. Incorporating findings from the pilot project, and featuring the resulting plays as examples of stories for the future, the initiative is an open platform that publishes stories that meet the challenges of our time, and a place for writers to find resources that can help them generate those stories. www.storiesforthefuture.org

# WHY STORIES FOR THE FUTURE MATTER[64]

*by Martin Puchner and Gloria Benedikt*

After centuries of progress, the future has become uncertain again. Every morning brings news of a new plague: dead bees are dropping from the skies; the seas are suffocating; and deserts are swallowing arable lands. We do not know when, but we know that it is coming. And that's how the story ends.

But does it? And which story are we talking about?

Humans are storytelling animals. We tell stories to make sense of the world and our place in it. Stories connect us to the past, to great causes beyond ourselves, and they offer glimpses of the future. They have mobilized individuals and groups into action across the span of human history and contributed to reshaping the world.

The power of stories to shape history is part of the greatest of all stories: the evolution of life on earth. Life records and processes information through DNA, which relies on random gene mutations observed over millions of years. But the emergence of language has allowed one species, *Homo sapiens*, to develop an additional way of recording and processing information: cultural transmission. Cultural transmission does not rely on random gene mutations, but on the deliberate transmission of knowledge encoded in stories from one generation to the next. Culturally transmitted information has been so powerful that in a few hundred thousand years—an evolutionary blink of an eye—it allowed *Homo sapiens* to take dominion over the earth.

For hundreds of thousands of years, oral stories stored information in memorable forms, allowing specialized bards to pass them down. Then five thousand years ago, this rapid process of information storage was supercharged by the invention of writing. Proverbs and stories could be written down, preserved, and transported farther afield. New areas of knowledge emerged, from organized religion to philosophy, preserved on clay tablets and other early forms of writing. Recorded on external storage devices, this information could even survive a break in transmission and be rediscovered by future generations.

Over the last five thousand years, written stories have allowed territorial empires to expand their cultural power to distant realms. Alexander the Great was inspired by Homer to embark on his conquest of Asia and exported the Homeric epics throughout his vast empire. Portable scriptures such as the Hebrew Bible allowed Jews to retain their identity in exile. The teachings of philosophers and prophets such as Buddha, Confucius, Socrates, and Jesus introduced new ideas and ways of life, ushering in an age of universal philosophies and religions. The first novels, such as those of Murasaki Shikibu, offered new ways of understanding individual identity, and science told new

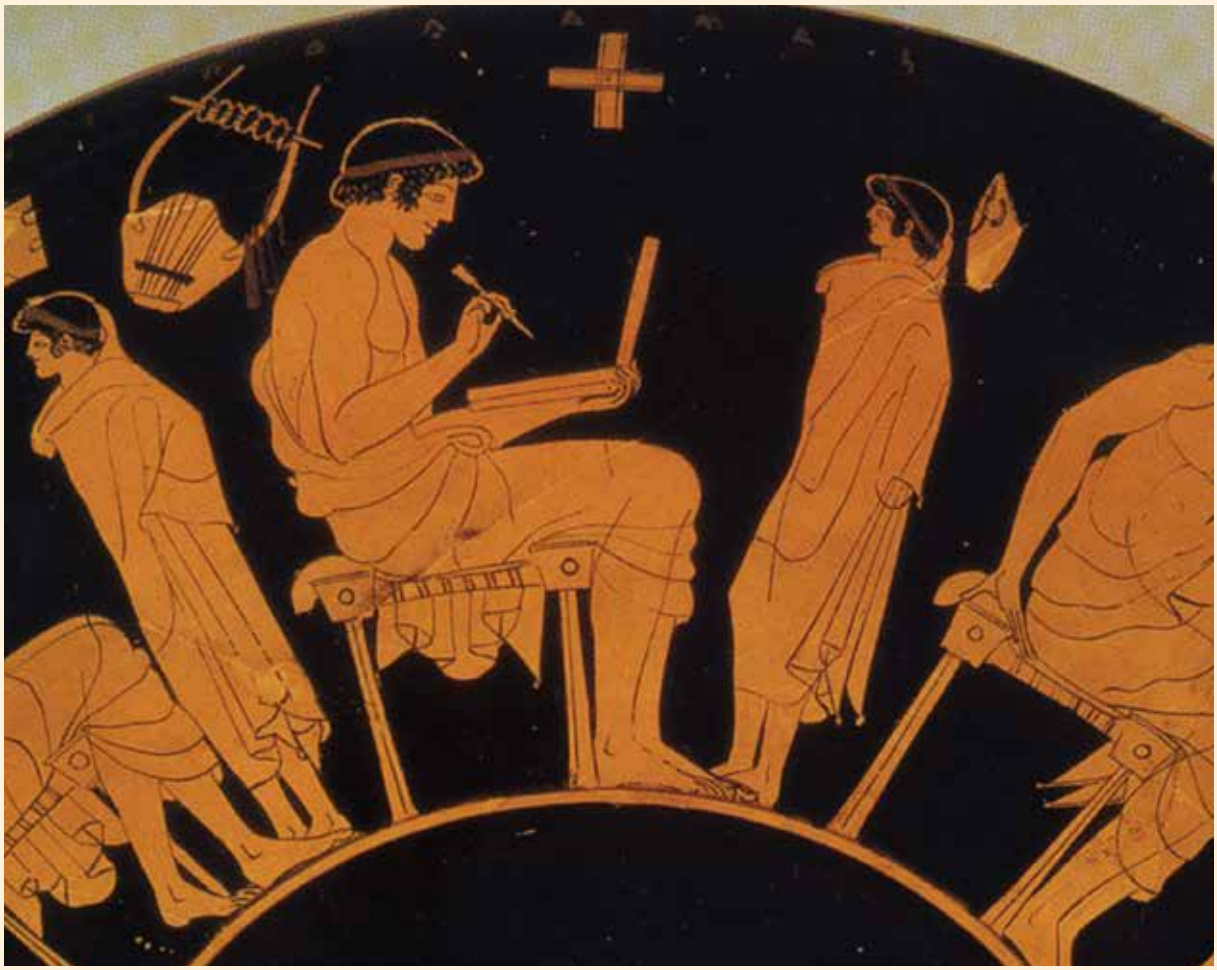


Photo of a Greek drinking cup from 4th to 6th century B.C.E., showing a scribe writing on a wax tablet. Staatliche Museen Berlin. © M. Tiverios, Elliniki Techni

stories that explained the origin of life and its evolution. Manifestos, aided by the printing press, called on the literate masses to change the world through revolutions.

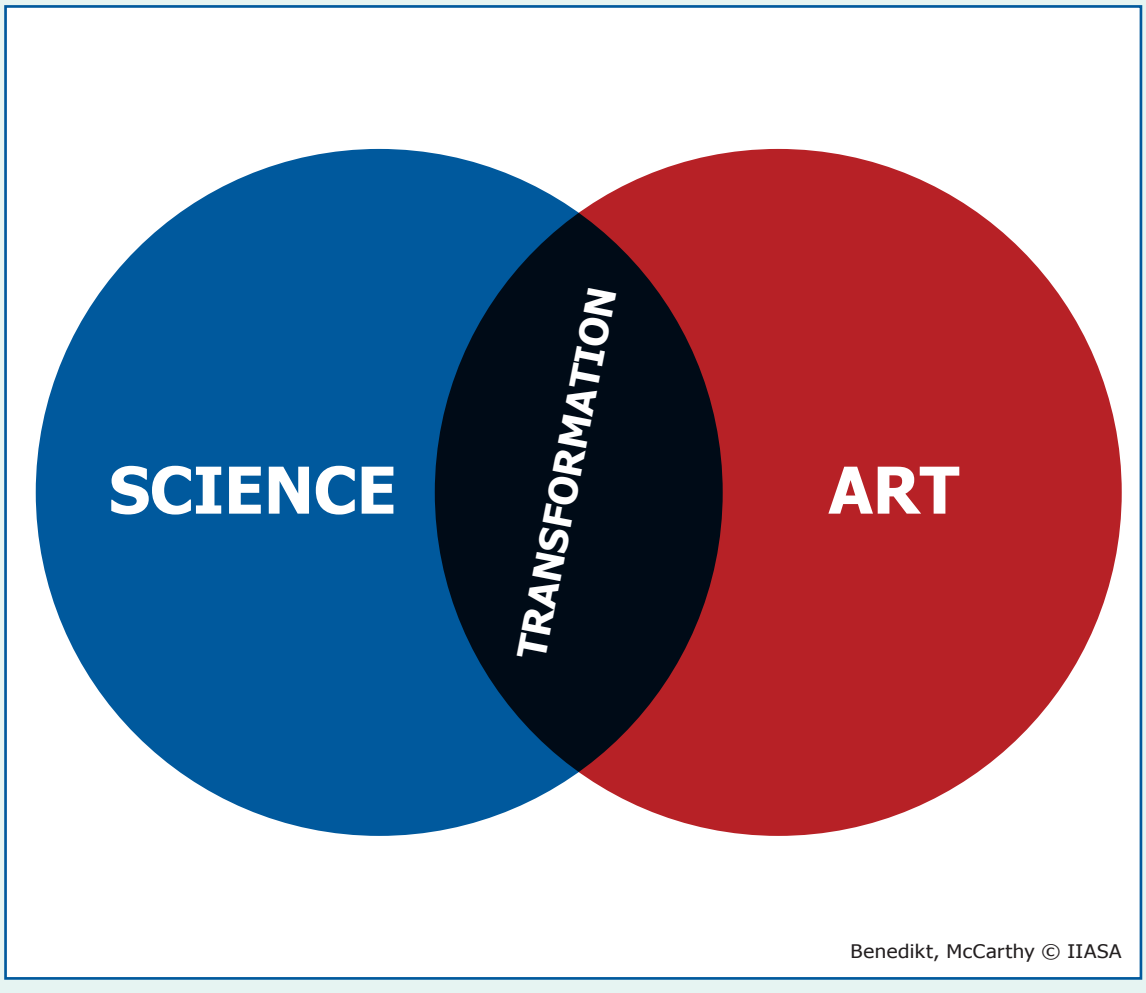
Today, our world is faced with new challenges, from global warming to the fourth industrial revolution, that require action on a global scale. But some of the collective stories that have steered human action in the recent past, from 19th-century progress to world revolution, have lost their power. As a result, we have reverted to old stories: plagues and floods ushering in the apocalypse. We are lacking new stories at the exact moment when we need them most. What kind of stories could help us through the current evolutionary bottleneck and propel us into a sustainable future? Which stories that didn't make it into the written record, or that have been marginalized, might help us now? And where can we find them?

Many of the universe's mysteries, which have been communicated through stories for most of history, have been unraveled by science. Yet scientific papers and reports are not the only—and maybe not the best—medium to help us imagine the future. We need new kinds of science-based stories, combining the two powerful tools we possess: storytelling and knowledge

## CONNECTING SCIENCE & ART
## PROCESS IN PROGRESS

The next production during my tenure at IIASA, *UnEarthing*, sought to further explore insights gained from previous productions. *Dancing with the Future* used projected images to enhance what was being communicated when text and movement were not enough. Feedback gathered after that project indicated that the use of images should be expanded. *Stories for the Future* revealed that storytelling should be incorporated in Science & Art productions. *Migraspectives* showed that dialogue and movement, and interactions with the audience, were effective. *UnEarthing* sought to incorporate all of these different approaches. This meant increasing the the use of visuals, further breaking down barriers between acting and dancing—in the arts, these are considered separate disciplines—and between performance and interactive game, to create a "Gesammtwerk."*

** The 19th-century term "Gesammtkustwerk," means "all-embracing art form," and is best known in its reference to opera (especially Wagner). Here, we defined* UnEarthing *as a Gesammtwerk, as it not only brings together performing and visual elements, but it also engages with science—which is traditionally not the case in the arts. Thus the word "kunst" (art) was taken out resulting in "Gesammtwerk."*




Benedikt, McCarthy © IIASA

Premiere of *UnEarthing* Top (L-R) Krisztian Gergeye, Marietta Kro, Piotr Magnuszewski, Gloria Benedikt, and Alexander Mays Bottom: Audience members © Tamas Szigeti

# CHAPTER XI
# UNEARTHING

**Can a better understanding of the relationship between humans and nature yield robust measures that combine technology-based and behavior-based solutions?**

*UnEarthing* premiered in a special plenary session at the World Science Forum on November 22, 2019.

> *As we hasten to blanket Earth with a humanized environment, we should—we must—pause to consider how and why our relation to nature exists. That degree of self-understanding can be achieved only by a blending of science and the humanities.*
>
> **Edward O. Wilson[65]**

## 1. MOTIVATION

What might the world look like in 2050? Will small-scale, distributed facilities surrounded by trees, that harness renewable energy, dominate the landscape? Or will there be large-scale solar farms, smart grids, and geo-engineering? Competing solutions affect what a sustainable world might look like. Why do we tend to prefer one set of solutions over the other? How can we constructively combine these solutions and figure out a way forward that enables us to move toward a sustainable future? After all...

> *If one does not know to which port one is sailing, no wind is favorable.*
>
> **Seneca (c. 4 BC-AD 65)**

## 2. PROCESS

### *A. Setting the goal*

#### Innovation

When we think about the two different types of solutions science offers to transition to a sustainable future, we tend to think about two schools of thought that evolved in the 20th century: one with a greater focus on staying within the limits of our planet, the other with a greater focus on technology. The values underlying these two approaches, also called sufficiency-efficiency debate, can, however, be traced to philosophies that evolved centuries earlier and are based on different understandings of how humans perceived their relationship to nature and their role in the world. The goal of *UnEarthing* was to connect science as we know it today to age-old cultures to derive a more holistic understanding of two worlds that are traditionally seen as separate: the world of culture, which is based on value systems, and the world of science, which is based on facts and data. This is how, over the years, I also came to see the IIASA Science & Art project fulfilling its potential.

#### Impact

Can this holistic approach help people envision what a sustainable world could look like? Could live interaction during a performance help them make better-informed decisions when it comes to employing the solutions science provides? Can applying aspects of cultural theory be helpful in such a process?


### *B. Researching how culture led to science*

**Lead:** Gloria Benedikt
**Input:** Wei Liu, Piotr Magnuszewski

Is it possible to better understand how we attempt to solve the sustainability crisis today by examining the evolution of the different world philosophies that led to the scientific revolution? To answer this question and lay the foundations for the performance segment of the project, three sources in particular served as inspiration: two books, *The Patterning Instinct: A Cultural History of Humanity's Search for Meaning* (2017) by Jeremy Lent, and *Prophets and Wizards: Two Remarkable Scientists and Their Dueling Visions to Shape Tomorrow's World* (2018) by Charles C Mann; and the mechanisms of cultural theory.

Mann attributes the different scientific schools of thought to two 20th-century founding fathers: William Vogt, the intellectual forefather of the environmental movement, who advocated for what is known today as "living within planetary boundaries;" and Norman Borlaug, the intellectual forefather of "techno-optimism," who promoted the idea that science and technology, the fruits of human ingenuity, will solve the problems humanity faces. While this analysis is very helpful in terms of understanding the types of solutions on offer today, and demonstrates how science is not value-free since all human beings, including scientists, gravitate toward one or the other school of thought based on their values, starting the story mid-last century didn't seem enough. These schools of thought were based on assumptions that were deeply embedded in the cultural understanding of our role as humans on this planet: is it to take care of, or to conquer it?

Lent's book draws a convincing trajectory of these two ideas throughout history. The former can be found in philosophies across the world, while the latter is unique to Greek philosophy and eventually led to the scientific revolution.

Cultural theory tells us that values are rooted in worldviews, and when looking at the world through the lens of worldviews, the notion of plural solutions becomes apparent.[66] When applying this approach to the solutions offered by the two scientific worldviews, it becomes clear that both are logical, and that both have strengths and weaknesses.

Cultural theory proposes that there are no "elegant" long-term solutions, but there are robust, "clumsy" solutions that emerge from compromise.[67] The weakness of Lent's analysis, which is written from an environmentalist perspective, can be seen when employing the lens of worldviews as suggested by cultural theory. The goal of this performance piece was to avoid adopting any one worldview and stay neutral. A difficult task, as it became clear throughout the process.

### *C. Choosing the title*

**Lead:** Gloria Benedikt

The title *UnEarthing* was chosen for its double meaning. "Unearthing" can mean resource depletion, climate change, biodiversity loss, and ecosystem collapse—a rapidly accumulating list of crises, which may evoke fear of a pending apocalypse. The original meaning of this ancient Greek

word is, however, "when things reveal themselves." A synonym for "revealing" is "unearthing."

The second meaning of "unearthing" is "finding something that has been hidden or lost for some time." Using this definition, the piece aims to reveal the cultural foundations of the solutions on offer today, and to uncover how they could lead to a sustainable future.

### *D. Writing of the text*

**Lead:** Chantal Bilodeau
**Input/Review:** Gloria Benedikt, Piotr Magnuszewski

The next step in the process was to create a story for the performance part of the project based on the information I had gathered. In the first draft, playwright Chantal Bilodeau attempted to tell the story of human evolution from the agricultural revolution to the development of the different philosophies that led to the scientific revolution, and then to the present.

The prologue starts with the narrator telling the story:

> *First, there was a world of bounty. With everything we could possibly want there for the taking. And take, we did: from giant marsupials to saber-tooth tigers, from camels to mastodons, slowly, without realising it, we caused massive extinctions everywhere we went. This was thousands of years ago. Then, after creating this problem, we created the technology to solve it. Agriculture was born.*

Piotr Magnuszewski, however, detected a bias. Similar to Lent's approach, the story was already being told from an environmentalist's perspective. Even with the intention of remaining as objective as possible, we didn't notice that we were taking sides. After another round of discussions, we agreed that two narrators were needed. Narrator 1 would tell the story from the perspective of a person who sees the role of humans as taking care of the planet, while Narrator 2 would depict humans as the unique species who can bring about progress through technological innovation:

Narrators Cynthia Festin and Marcus Thomson record the text © Private

**NARRATOR 1**

*First, there was a world of bounty. With everything we could possibly want there for the taking. And take, we did: from giant marsupials to saber-tooth tigers, from camels to mastodons, slowly, without realizing it, we caused massive extinctions everywhere we went. This was thousands of years ago. But after creating the problem, we invented a way to solve it. Agriculture was born.*

**MASTER OF GAME**

*This is a nice story. But is it the entire story or is there another way to look at what happened? What if there is a different perspective?*

**NARRATOR 2**

*First, there was a harsh environment. With danger around every corner. In order to survive, we had to fight giant marsupials and saber-tooth tigers, camels and mastodons. But we were smarter than them. We learned to work together and pass on our knowledge to the next generations. We even designed a new technology so we could finally stop wandering. Agriculture was born.*

The story continues with the two narrators alternating, sometimes disagreeing and asking to go back to retell the story from a different perspective, until they get to the present where the audience is presented with two sets of solutions:

**NARRATOR 1**

*For thousands of years, we have pondered over our role and our relationship to the Earth. Today, it is interesting to be alive at the exact moment when a crucial decision has to be made. Do we scale back and learn to live within the limits of our planet or do we rise up to the level of gods by engineering the weather?*

**NARRATOR 2**

*The result of our evolution is a greater understanding of how the world works. Equipped with this unprecedented scientific and technological know-how, we now have capacities we never had before. It is our responsibility to use these capacities wisely by contributing to the wellbeing of all human beings.*

**ENVIRONMENTALIST 1**

*We care about the Earth. We care about its inhabitants. We've always managed to adapt and survive.*

**TECHNO-OPTIMIST 1**

*We're creative. We're smart. We've figured out ways to feed millions before.*

**ENVIRONMENTALIST 2**
*Our greatest gift is our ability to form community through meaningful connections.*

**TECHNO-OPTIMIST 2**
*Our greatest gift is our ability to innovate our way out of crises.*

**ENVIRONMENTALIST 1**
*We propose organic agriculture; reforming institutions and changing our habits around water –*

**ENVIRONMENTALIST 2**
*– small scale, distributed facilities that harness renewable energy; and reforestation and afforestation. But first of all—less consumption!*

**TECHNO-OPTIMIST 1**
*We propose crop modification; desalination and technological innovations –*

**TECHNO-OPTIMIST 2**
*– large-scale solar farms, superconductivity, and smart grids; and geo-engineering.*

### *E. Writing the script*

**Lead:** Gloria Benedikt
**Input/Review:** Wei Liu, Piotr Magnuszewski

The next step in the process was to convert the text into a script. Scenes 1 to 4 are performance-driven, scenes 5 and 6 are interactive, and scene 7 is conclusive.

**PROLOGUE:** The narrators set the scene

**SCENE 1:** Agriculture is born, people appeal to the gods for rain—a common practice in every ancient culture throughout the world.

**SCENE 2:** The journey continues to show emerging philosophies, revealing each philosophy's view of humans' relationship to nature. It becomes apparent that all philosophies see humans as part of nature/the ecosystem until Greek philosophy arises and a new idea emerges: humans have the ability to understand the laws of nature, and with this understanding, they can rule the world in a way no other species can.

**SCENE 3:** This idea gives rise to new disciplines that have the potential to change the world, logic and mathematics, which eventually lead to the scientific revolution.

**SCENE 4:** The scientific revolution leads to the industrial revolution, which brings unprecedented progress. This takes us to the present and brings up a very old question: Instead of appealing to the gods to get good weather, can we engineer the weather using technology? In other words, can humans become weather gods?

The four performers represented humans throughout history: two gravitated toward a nature-based understanding of the world, and the other two toward technology. During the performance part of the production, they are mainly dancing and have very little dialogue. But once they get to the present, they become actors, advocating for one of the two types of solutions science has to offer.

In preparation for the first rehearsal period, music and images were chosen to support the storytelling. The artists familiarized themselves with the script. The text was recorded with two narrators, and the rehearsal sound file combining narration and music was prepared.

### *F. Rehearsal period 1*

**Lead:** Gloria Benedikt, Krisztián Gergye, Marietta Kro, Alexander Mays

During this phase, the four dancers had to translate the script into choreography. Their first task before rehearsals began was to come up with two short solos where they invoke the Rain God in different cultures: Oya (Africa), Tialoc (Aztec), Indra (India), Freyr (Northern Europe), Horus (Egypt), Chak (Maya), Adat (Middle East), and Jupiter (South-East Europe). The four scenes were drafted over the course of six rehearsal days. Unlike traditional choreography, which is set to certain counts in the music, the text at times had to serve as a guide and movements had to

Shooting the trailer against a green screen (L-R) Patrick Zadrobilek, Alexander Mays, Krisztian Gergye, and Marietta Kro © Private; Still from trailer: Gloria Benedikt

correspond to certain words rather than counts. At the end of this first rehearsal period, the trailer was recorded against a green screen to make it possible to add a background at a later stage.

### *G. Developing the interactive segment*

**Lead:** Piotr Magnuszewski
**Input:** Gloria Benedikt

The interactive segment was designed so the audience would experience the dilemmas resulting from looking at solutions through the different worldviews presented during the performance parts. In scene 6, the audience is asked to negotiate a new binding climate agreement, given that the 2015 Paris Agreement is not working. All participants have to choose between the two worldviews (techno-optimism or self-restrained environmentalism). Those with similar mindsets are then asked to gather in small groups to discuss specific solutions. To increase the realism of the simulation, a third worldview is added using extras—their position is that there is no problem to start with and thus no action is necessary. This group may be actively denying the science or the urgency of the problem, or they may be disengaged.

A group of scientists present at the World Science Forum was recruited to represent this third worldview and to act as protesters, disturbing the negotiations, advocating for fossil fuels, and expressing their disengagement and/or denial of climate change. During the discussions, the protesters trying to preserve the "status quo" push the other two groups to continue business as usual—they want to keep their jobs and life as they know it. Participants are asked to submit their solutions using an online platform (SLIDO) so that these can be projected on a large screen on stage. Since the solutions are created within like-minded groups, they tend to only emphasize one worldview and therefore the dancers, who represent the decision-makers, reject them. In scene 7, where the second round of discussions takes place, the participants are asked to form mixed groups that include more than one worldview and to formulate solutions again. This leads to the creation of more balanced solutions that are easier for decision-makers to accept.

A lighting technician discusses the sequence of the performance with Krisztian Gergye © Private

### *H. Rehearsal period 2*

**Lead:** Gloria Benedikt, Piotr Magnuszewski
**Input/Review:** Anita Barabas, Krisztian Gergye, Marietta Kro, Alexander Mays

During this phase of the project, sound and light files were finalized, and sound and light cues written. Scenes 1 to 4 were revised, scenes 5

Getting ready for technical rehearsal at the Museum of Fine Arts, Budapest © Jan Marco Müller

and 6 were drafted, and scene 7 choreographed. Particular challenges for the dancers entailed developing the skills to switch from dancing to acting.

Furthermore, when rehearsing the entire performance, the performers needed to simulate the interactive scenes as much as possible without knowing exactly how the audience would react. The scientists who volunteered to act as protesters were briefed. The entire cast, including the protesters, was assembled for the first time during the technical and dress rehearsals.

## 3. OUTCOMES AND DISSEMINATION

### Premiere

*UnEarthing* premiered as a special plenary session at the 2019 World Science Forum. A stage was built in Budapest's venerable Museum of Fine Arts and the performance was

Scene 1: Invoking Rain Gods in cultures across the world. (L-R) Krisztian Gergye, Alexander Mays, and Marietta Kro © Tamas Szigeti

Scene 3: Paying tribute to logic and mathematics, which eventually led to the scientific revolution. Alexander Mays and Gloria Benedikt © Tamas Szigeti

live-streamed. In the audience were high-level decision-makers from the fields of science and diplomacy. A summary video of the performance was distributed through IIASA and the World Science Forum communication channels.

## HOW MIGHT THIS WORK SUPPORT THE GLOBAL TRANSFORMATION TOWARD SUSTAINABILITY?

We need to be able to envision the future before we can take steps toward making it a reality. *UnEarthing* helps translate the options offered by science into implementable solutions; it helps audiences understand how the past has led us to the present, and how their choices and actions in the present will shape the future. To find sustainable solutions, different worldviews need to be taken into account. In addition, a group of people that is typically ignored in sustainability discourse because it does not agree with the concept of sustainability in the first place, was included as protesters. Creating a coherent vision that strives to "bring on board" as many people as possible will be key for the sustainability transformation to succeed.


Scene 5: Protesters intervene: *"You spend all your time worrying about 'future generations,' but what about 'us' who are alive today?"* © Tamas Szigeti

# WHEN SCIENCE MEETS ART
## THIS IS NOT HOW PLENARY SESSIONS NORMALLY WORK!

*A review by Mercury Fox, director of the CODATA Center of Excellence in Data for Society at the University of Arizona and World Science Forum audience member*

*UnEarthing* presents an innovative take and a fresh history of humanity's role in sustainability. IIASA's Science & Art project Leader, Gloria Benedikt, expands the understanding of the reductionist theory that early hunter-gatherer societies "managed" dwindling natural resources through the development of agriculture, which led to the development of modern civilisation and the post-Enlightenment economic exploitation of the environment through technology. This nuanced work provides a global picture of science through the ages, using metaphors of ancient world religions to reflect contemporary disciplinary perspectives that explain the natural world, as well as the evolving relationship between humankind and nature.

As a work of performance art, *UnEarthing* is beautiful and compelling and stands on its own. But as a research approach, it provides an effective and powerful tool for science communication by challenging the audience to confront the tight coupling of bias, power, and politics that are embedded in today's sustainability issues. In particular, it uses a confrontational device that forces the audience—in this case, the global elite in science policy and diplomacy—to choose between Technology and Nature. The indecision and tension is palpable in a room filled with individuals reluctant to make their choice public without equivocation. It is the kind of electrifying moment that turns the performance from an innovative form of science communication into fine art, because it forces viewers to engage directly, examine personal beliefs, and make a philosophical (if not ethical) commitment. But then it goes deeper by tearing apart the many facile solutions to the environmental crisis that are offered up by the audience, via *UnEarthing's* social media tool, sli.do. The artists continue to put pressure on the audience by corralling them into a series of decisions, all the while compelling individuals to critically defend their own ideas.

At the end of this trial, exasperated members of the audience suggest sustainability solutions that include: "kill everyone," "let aliens come to our planet," "wipe out all humanity and start a new one," and "find another planet now." The artists respond to this resigned attitude from world's leaders in science policy with a spoken word poem that urges them to come together to protect the entire planet, using all of the tools available to humanity. The show ends with an interactive dance piece that calls for dignity and grace in this common endeavor. This is not how plenary sessions normally work! It is a powerful and engaging expression of science in society, examined through the lens of sustainability.

Audience members email potential solutions ©Tamas Szigeti


The proposed solutions are discussed ©Tamas Szigeti

# CHAPTER XII
# CONNECTING NEW APPROACHES TO INSIGHTS FROM PSYCHOLOGY

All Science & Art productions were created in an experimental setting, using typical artistic techniques and connecting them to knowledge provided by science. Over these five years, a clear pattern for collaboration between scientists and artists has emerged, imbuing scientific knowledge with personal meaning and inspiring action, and audience responses have been overwhelmingly positive. It is now time to examine whether insights from psychology can confirm the effectiveness of these approaches.

## MULTIMODAL COMMUNICATION

All of the productions developed at IIASA used multimodal communication. *InDignity* included projected text, music, and dance. Then progressively, with each production new elements were added until the last production, *UnEarthing,* combined music, storytelling, acting, dancing, projected images, and interactive games. Text, written by scientists and eventually in collaboration with playwrights, was laid over music, movement was combined with acting to visualize and humanize the content, and images were projected when needed as a backdrop. This multimodal communication approach, simultaneously appealing to reason and emotion, was developed from pure artistic intuition. But is there a scientific explanation for why the combination of verbal and nonverbal communication could be more effective than, let's say, a scientific lecture or press release on the same topic?

When exposing people to different forms of communication, neuroscientists have found that the more forms of communication are used, the more parts of the brain light up. And the more parts of the brain are active, the deeper and longer-lasting the experience.[68] Multimodal communication, thus, seems to be effective because it engages many parts of the brain.

## CREATING OPENNESS BY IMPLEMENTING THE FIRST PRINCIPLE OF MORAL PSYCHOLOGY

Science & Art productions always began with an artistic performance to set the scene, and

then scientific content was added. This approach is in line with the first principle of moral psychology: "Intuitions come first, strategic reasoning second."[69] Appealing to emotion, or "intuition" as the evolutionary psychologist Jonathan Haidt calls it,[70] has been identified as an effective and necessary approach to addressing moral issues.[71] Climate change and the sustainability transformation are moral issues. The concept of sustainability, "meeting the needs of the present without compromising the ability of future generations to meet their needs, while at the same time sustaining diversity and the functioning of Earth's environment," assumes that people ought to care about future generations and the health of the planet. However, the natural science community, which delivers much of the sustainability science data, typically refrains from looking at these issues through moral or ethical lenses. Over the past decade, research at the intersection of social science and philosophy has turned toward examining climate change as a moral and ethical issue.[72] In addition, some communication specialists on climate change have started to identify the root of the problem of ineffective communication; they found that much of it lies in the framing of climate change as an environmental issue rather than as an issue of public health, peace, and prosperity.[73] Art can be an ally, allowing the natural sciences to stay true to their culture of objectivity by taking on the needs for effective communication uncovered by the growing body of work in neuroscience, moral psychology, and moral philosophy. This is why grappling with the ethical dimension of scientific findings (or revealing moral and ethical dilemmas) has been defined as one of four principles for science and art (see Chapter XIII, table 1).

In *UnEarthing,* for example, a group of protesters was added to reflect the segment of society who is not on board with the concept of sustainability. When the group entered the scene, their leader asked:

> *There is so much talk about climate change. But you need to know we have other priorities. We don't care. You are scaring us with what will happen in 50 years. How can you know? When there is a problem, we will solve it. In the meantime, we don't want to change our lifestyle. You spend all your time worrying about "future generations," but what about "us" who are alive today?*

One of the goals of the production was to find a way to connect to people who reject the moral foundation of sustainability through the solution-finding process. In the theater play *Piece of Cake,* a young woman describes how many people have just died because they could not protect themselves from the heat, and then adds:

> *That won't happen to me. I'll be okay. But, I don't know.*
> *Can I be okay if WE are not okay?*

Science confirms that art, because it appeals to our emotions, can help break down barriers

to new ideas. When people decide to read a book or watch a play or a film, they expect to be entertained, not lectured. As the psychologists Murrar and Brauer point out, "subtle messages included in narratives" leave room for people to digest the information at their own rhythm as opposed to being directly confronted with it and are thus "less likely to create resistance."[74] Since findings from sustainability science tend to meet resistance on an ethical level, conveying messages through a medium that is able to create openness is important.

## METAPHORS, SYMBOLS, AND ARCHETYPES - METHOD TO DELIVER MEANING

Metaphors, symbols, and archetypes were used to convey information. For instance, *Courage* featured the archetypes of "the conqueror" and "the protector" to show humans' dual relationship with the earth's resources. In *InDilemma*, cheese was used as currency for the public goods game. *Migraspectives* used a boat to embody the dilemma of migration, and *Contextual Matters* illustrated the effects of disintegrated SDG implementation through cacophony. In the play *Piece of Cake,* the cake the family keeps eating is a metaphor for the earth's resources and in *Good Neighbor,* a reference to the "three sisters"—corn, squash, and green beans, which were planted together in Indigenous agriculture—is a metaphor for the interdependence of species.

Metaphors, symbols, and archetypes are storytelling and artistic devices that require the audience to actively participate in creating meaning. Audience members are invited to use their imagination to complete or unpack the poetic images offered to them. Instead of being passive recipients of information, they are active creators of meaning. In contrast, scientists must provide accurate information that leaves no room for interpretation otherwise they risk losing their credibility. As a result, the audience is not as actively involved.

The cast of *InDilemma* during the performance; cheese servings as a metaphor for money to illustrate the public goods game © Patrick Zadrobilek

## INTERACTIVE COMPONENTS

The aforementioned multimodal communication used to convey scientific findings leads to a better understanding of the science. But better understanding does not automatically translate into action. For this reason, interactive components were gradually integrated into performances. *Courage* and *Contextual Matters* concluded with the audience joining the performers in humming, clapping, and stomping together in time, a practice that has evolved throughout history to create a sense of unity.[75] The concept of engaging the audience as part of an artistic performance may have been uncommon in recent centuries but it is not new. As shown in Chapter I, for example, audiences had both passive and active roles in the court of Louis XIV, where courtiers watched the performances, but also participated in certain sections. At IIASA, we developed this concept further by mixing artistic performance with interactive games. Simulation games and serious role-playing games allow players to take on roles critical to the success or failure of policy.[76] Such games can be highly flexible and leave room for individual initiative and imagination—an advantage in games involving policymaking. Serious games have been successfully used in multiple sustainability-related contexts to address topics such as trade-offs between climate mitigation and adaptation in urban environments,[77] relational aspects of river floodplain management,[78] land use-related environmen-

Piotr Magnuszweski engaging the audience during *Dancing with the Future*

tal issues,[79] water-food-energy nexus,[80] and multiple aspects of disaster risk management.[81] In *InDilemma*, *Migraspectives*, *Dancing with the Future* and *UnEarthing*, the audience was asked to make decisions about the dilemmas presented on stage to help them understand the consequences of their decisions, and encourage better-informed decision-making.

## ENACTING ABSTRACT CONCEPTS

Some productions turned abstract data and concepts into embodied experiences. For instance, in *Four Drifting Seasons,* data on temperature rise was sung by a children's choir, allowing the audience to hear and feel what would otherwise be very abstract information. During the interactive game in *Dancing with the Future*, four dancers stood in for the "future generation." Audience members reported that literally seeing the future generation on stage made them realize for the first time that these are real people, like them—and it influenced their decision. Previously, the concept had been abstract and not something they connected to emotionally. After seeing the performance, they felt responsible for the people who would come after them. This shift in perception can be explained by the "identifiable victim effect." As the economist Thomas Schelling showed, people tend to respond with greater urgency to identifiable victims, as compared to indeterminate "statistical victims."[82] The term "future generations" was too amorphous to conjure up a clear image of real people. But when audience members saw real people on stage representing future generations, they identified with them, and felt they needed to take them into account when choosing how much resources to use.

## CREATING AWE-INSPIRING EXPERIENCES

When creating science and art productions, artists frequently asked, "How can we create an awe-inspiring experience?" Yet, interestingly, awe was not something ever mentioned by the scientists. None of the artists really knew where the idea came from—it just seemed ingrained in their thinking. This prompted the following questions: (1) What is awe? (2) What is the role of awe? (3) Could it be relevant to the sustainability transformation? (4) If so, could science and art inspire it?

Awe is an emotion. As Haidt points out, awe "acts like a kind of reset button: it makes people forget themselves and their petty concerns. Awe opens people up to new possibilities, values, and directions in life."[83] Awe-inspiring experiences often happen in nature[84] or through muscular bonding.[85] The latter, in particular, have evolved to build and strengthen communities. As will be seen below, they have enabled humans to transcend self-interest and to be moved by—and devoted to—things bigger than themselves.[86]

The sustainability transformation relies on the idea that we are part of something bigger than ourselves and we ought to "meet the needs of the present without compromising the ability of future generations to meet their needs." Given the above, awe would need to be its chief emotion. Could science and art be equipped to inspire it?

To answer this question, it is important to understand how art has evolved in relation to awe. Chapter I outlined some of the functions high art has had over the past 500 years; an example from 1581 mentioned a choreographer's intention to "inspire awe" through the dancers' demonstration that "number, geometry, and reason ordered the universe and men's souls."[87] Long before music and dance evolved into high art, their function was to bind societies together. (Once language evolved, they were joined by storytelling.) "Dance, music, and song are the most reliable way to generate inspiration; they also cement solidarity among participants," the historian William McNeill points out.[88] His initial interest in this subject matter stems from his own awe-inspiring experience as a soldier during World War II:

> *Words are inadequate to describe the emotion aroused by prolonged movement in unison that drilling involved. A sense of persuasive wellbeing is what I recall; more specifically, a strange sense of personal enlargement; a sort of swelling out, becoming bigger than life, thanks to participation in collective ritual.*[89]

The practice of "muscular bonding" as he calls it, allows people to focus less on themselves, and trust each other more, thus increasing collaboration as a unit, and outcompeting other groups.[90] He surmises that:

> *The habit of dancing together probably began to have a strong positive effect on survival before articulate language arose, and this trait most probably established itself among* Homo erectus *bands in the African savannah, at a time when hunting larger and larger animals began to assume a greater place in our ancestor's food supply.*[91]

Human evolution seems to have gone through two critical transformations, both contributing to improved communication. In the first stage, dance (that is, muscular bonding, where participants moved to a common rhythm for an extended period of time) established emotional links; next, articulated speech paved the way for the highly symbolic links that became possible once spoken language was fully developed.[92] McNeill then illustrates how this shared emotion brought about by muscular bonding has been practised throughout history, has connected communities more firmly, and has made cultural, economic, and spiritual cooperative efforts easier to carry through.[93]

With regard to music, the neuroscientist David M. Greenberg and the psychologist Ilanit Gordon make similar observations:

> *Music dates back at least 40,000 years in human history. Evolutionary theories about the origins of music are many, but most emphasize its social role. This includes strengthening group cohesion in hunter-gatherer times and as a way of signaling shared values and strength within and between tribal groups.*[94]

Neuroscientists have found that when people sing together, their social brain produces oxytocin,

a hormone that is active when humans socialize. Oxytocin is typically released when people form social bonds.[95] Furthermore, recent research shows that listening to music also increases oxytocin levels.[96]

In short, awe is a fundamental feature of the artistic experience. And, as shown above, the sense of being part of something bigger than oneself is key to enabling the sustainability transformation. Below is an example of how we attempted to inspire awe in a Science & Art production.

Martin Nowak's text for the final scene of *Dancing with the Future* emphasises how every human being is part of a much bigger story:

*You are the products of evolution*
*You are the fruits of a quest for cooperation*
*That has spanned billions of years*
*That began in primordial time*
*You know how to cooperate*
*You know how to defect*
*You are empowered with a sense of cooperation*
*That guides you*
*You can cooperate with those around you*
*Can you cooperate on a global scale?*
*Can you cooperate with the future?*
*Now that we have reached the limits of our planet*
*The answers to those questions*
*Determine our future.*

When the artists contemplated how to create an awe-inspiring experience, they noted that the text was already grand and there was a risk of the final scene becoming cliché or tacky. Yet, they wanted the audience to experience something like the overview effect—a cognitive shift in awareness that some astronauts experienced while viewing the Earth from outer space. The dancers chose to go through a series of lifting sequences, which required all of them to cooperate to make them spectacular for the audience, but also safe for themselves. During the last sentence, "the answer to those questions determines our future," the view of Earth from space was projected and the performers quietly stood together in the center of the stage. They faced the audience and then slowly turned around to look at our planet.

Final scene of *Dancing with the Future* © Jason Nemirow

# CHAPTER XIII
# TOOLS FOR SCIENCE & ART

**Framework**

The Science & Art projects developed over the last five years consisted of a research process that aimed to develop a methodological underpinning for science and art collaborations. This research resulted in live performances spanning disciplines from music to dance to theater and, at best, combining all three into an interactive performance. Both the research and the creation process made apparent four fundamental principles (see table 1) for artists and scientists who seek to engage with scientific findings that face the knowledge-to-action gap challenge. Findings in sustainability science are a prime example, but this methodology could also be applied to projects that engage with, for example, Artificial Intelligence or Big Data.

**Table 1**

| | |
|---|---|
| **1. COMMITMENT TO CONVEY SCIENTIFIC INSIGHT**<br><br>Artists such as Tolstoy saw their role as convincing the audience to adhere to their own ideas. But when it comes to science-based art, the challenge is to stay committed to scientific findings while employing a language that humans are naturally equipped to understand: the language of story, as well as non-verbal communication such as dance, and music. | **2. REVEALING MORAL AND ETHICAL DILEMMAS**<br><br>The role of artists is to infuse scientific knowledge and insights with personally relevant meaning and to highlight the moral and ethical dilemmas that arise from those insights. |
| **3. CONSTRUCTIVE OUTCOME**<br><br>Findings from sustainability science provide excellent material for tragedies and dystopian fiction. Or it might be tempting to create works with happy endings that make us all feel better about our collective fate. Because they lack nuance, neither of these scenarios is likely to help us move toward a sustainable future. A constructive approach that embraces the complexity of our situation necessitates a realistic assessment of where we are, a recognition of the need to acknowledge our subjective experiences, and a positive vision of the path forward that can propel us into action. | **4. ORIENTATION TOWARD ACTION**<br><br>Work should be designed to prompt questions rather than explicitly tell audiences what to do: "Now that I can apprehend what scientific insights say about the impacts our actions will have on our lives and on our world, what can I do?" |

**"FORMULA"**

**Science + meaning + ethics + engagement**
**= effective transmission of scientific insights to enable action**

## METHODOLOGY

The Science & Art productions described in this report vary depending on the topic, the discipline, the audience, etc. But a general structure for an effective process can be derived:

### 1. Identifying the topic

Artists research a crucial scientific insight that is relevant to society and requires action, and/or that highlights a moral dilemma that society needs to grapple with.

### 2. Getting findings from scientists

Artists discuss with scientists in more detail what the crucial understanding /emerging dilemma for society would be.

### 3. Writing the script

Together, the artists and scientists write the script, or they collaborate with a professional writer such as a playwright.

### 4. Translating the script into a performance

Ideally, artists combine different disciplines such as theater, dance, music, and visual art. Communication is designed to work on multiple levels, activating reasoning and intuitive parts of the brain, for instance through text accompanied by music, movement, and stories reinforced by images on screen as a backdrop.

### 5. Designing interactive components

A participatory segment is integrated into the performance to create an active learning experience.

### 6. Rehearsing

Scientists are involved in the rehearsal process, making sure that the science is translated accurately into art.

# CHAPTER XIV
# A WORLD MOVED BY SCIENCE THROUGH ART

Following decades of data on global warming and policy advice, 2019 emerged as a remarkable year for mobilization. Analyzing the success of the Fridays for Future movement in positioning climate change as the central theme of public and political agendas, in relation to the tools developed as part of the Science & Art project, provides clues on how to bridge the knowledge-to-action gap in the crucial decade ahead.

Doctors monitored the health of the patient for decades. Despite understanding what caused her suffering and identifying the required remedies, they faced a wicked problem. They didn't know *how* to prescribe the remedy: a shift in behavior from her citizens in order to reduce $CO_2$ emissions. At summit after summit, the first taking place some 40 years ago,[97] the severity of the problem and how to address it was outlined. But nothing changed. The link between knowledge and action was missing, climate scientists realized with frustration. Some speculated emotion was a precursor to action, but they felt helpless about wading into the messy, non-scientific pool that is the human heart. Plus, it was not immediately obvious who among their colleagues from other disciplines was in a position to help.

Some scientists hoped that science-to-policy advice would lead to the necessary change, as had been the case in the past with, for example, the ozone layer and acid rain. But it turned out that even politicians who are committed to science and understood the gravity of the situation could not, or would not, implement policies that might cost them the next elections. Meanwhile, politicians in other regimes, who didn't face this problem because they didn't rely on democratic processes, were unwilling to face the high costs of taking action, without rich, industrialized countries—the highest emitters of $CO_2$—leading the way. And so the tragedy of the commons[98] became a tragedy for the health of the planet.

That is, until an unlikely heroine emerged and seemingly changed the game. On August 20, 2018, a 15-year-old girl parked herself outside the Swedish Parliament and went on school strike for the climate. Within a few months of Greta Thunberg's campaign gaining momentum, OPEC Secretary General Mohammed Barkindo identified the school strike movement and climate campaigners as OPEC's "greatest threat;"[99] several countries and regions declared climate emergency;[100]

© Dreamstime

© Dreamstime

Green parties gained support in national[101] and European elections;[102] and Oxford Dictionaries named "climate emergency" word of the year following a hundred-fold increase in usage, which demonstrates a "greater immediacy" in the way we talk about the climate.[103] Climate action was finally infiltrating the field of policy because citizens were demanding it. The new European Commissioner, Ursula von der Leyen, now sees a European green new deal as her first priority.[104]

If we look through the lens of the Science & Art methodology, Thunberg's success in getting her message across and mobilizing people does not come as a surprise. She uses the same elements described in the "formula:" science + meaning + ethics + engagement = effective transmission of scientific insights to enable action. First, she conveys science in a language that is clear and understandable to all people. Second, she explains what the science means for individuals and what kind of decisions we need to make.[105] Third, she asks the moral questions that consequently arise from those decisions.[106] Fourth, she engages with people directly. But while direct engagement within the framework of the Science & Art project is achieved through simulation games designed

to help people better understand the consequences of their decisions, Thunberg engages people in a way that is designed to build movements.

She uses an approach that has been known to work for millennia to change behavior and prompt a shift in values. Throughout history, thought leaders have inspired people by going beyond simply writing down what needed to happen and why, as is customary in the scientific culture. Socrates, Jesus, Buddha, and Confucius, for example, developed methods of direct engagement with their followers.[107] Thunberg does the same. She engages in dialogue. She lives by example. And she sticks to her main activity, which has become something of a ritual: striking every Friday. Rituals, like all collective experiences, can bind people together and motivate them to act on something bigger than themselves.[108] As some social scientists have suggested, it takes a surprisingly small percentage of the population actively participating in protests to ensure significant political change.[109]

Finally, although this is not intentional, Thunberg's presence on the world stage, her purity, her authenticity, her angelic appearance and performance-like speeches have artistic qualities. She can speak truth to power and ask tough questions such as "How can we face an existential crisis and not make it our first priority?"[110] and "Why should we learn facts in school, when facts don't matter in society?"[111] Grown-ups attempting to do the same are much more likely to be dismissed as alarmist or annoying, or to face professional backlash. Historically, adults have had to question the status quo as characters on theater stages to benefit from the "protection" that the filter of the art form provides. This reality appears to still be true today.

## BUILDING EFFECTIVE DISSEMINATION PATHWAYS

Scientific institutions have historically focused on what they see as their "core mandate:" research and knowledge creation. Some institutions have adopted policy advice as a channel for their findings, but few, if any, have found ways to engage with the public. Yet science, technology and new business models alone cannot bring about the sustainability transformation we need. As established in Chapter I, a shift in perception and attitude that leads to a change in public opinion on a large scale, which results in a change in behavior—essentially, a cultural shift—is necessary.[112] But as I have observed in conferences and meetings over the years, those responsible for bringing about this "cultural shift" are never identified. This responsibility crisis needs to be addressed quickly.

As shown in Chapter XII, effective communication on moral and political issues entails appealing to intuition (emotion) before appealing to reason.[113] In addition, communication specialists on climate change, such as Ezra Markowitz and Adam Croner, who have observed and studied how people, media, and organizations speak and think about climate change for more than a decade, suggest the root of the problem of ineffective communication is the framing of climate change as an environmental issue rather than as an issue of public health, peace, and prosperity.[114] Effective communication would require scientists

to grapple with the ethical dimensions of their findings, among other things, and to use direct engagement. However, this would go beyond what we traditionally understand as scientific research. Scientists observe natural phenomena and deduce their laws and properties; it is not their role to determine what we should do with this information. Other disciplines are better suited to grapple with the meaning, implications, and dissemination of scientific facts.

A growing number of skilled and dedicated artists are eager to join forces with scientists to transmit scientific findings to—and engage with—the public to help bridge the knowledge-to-action gap. As has been shown in previous chapters, through words, sounds, movements and images, artists can create emotionally engaging works that translate climate change and sustainability science into powerful ideas that connect to our day-to-day lives. But, just as Thunberg works with scientists to ensure that she has accurate information when she gets on stage, artists need to work closely with scientists to infuse their art with the right scientific insights. Short-term residencies aiming to "facilitate collaboration between artists and scientists" are not enough. As can be seen from the work created and the insights gained through the Science & Art project at IIASA over the past five years, it takes a long-term commitment, clear objectives, a framework, and a methodology to create spaces for meaningful and effective dissemination of scientific information through art.

A coherent dissemination pathway to enable the much-cited "cultural shift" would require scientists to establish *what is* and artists working with scientists to establish *what it means* so people can make informed decisions. This would relieve the pressure on scientists to act as expert communicators and instead, let those whose expertise it is to create meaning to communicate with the public. This approach, as outlined in detail in the previous chapter, takes scientific findings as a starting point, grapples with what these findings mean for society, uncovers ethical dilemmas (if applicable), creates constructive narratives, and engages audiences so they are better equipped to understand their role and the consequences of their decisions. Not every artist wants to engage intensively with science, and not every scientist has the capacity to work with artists. But those who do need dedicated support to be able to work together over extended periods, so the potential of science guiding humanity into a sustainable future can be fulfilled.

> *"Avoiding climate breakdown will require cathedral thinking. We must lay the foundation while we may not know exactly how to build the ceiling.*
>
> **Greta Thunberg**[115]

# CHAPTER XV
# INSIGHTS FROM ARTISTS BEYOND THE IIASA SCIENCE & ART PROJECT

Around 2005, ten years prior to setting foot in Laxenburg Castle, I started to question whether my art form was fulfilling its potential in the world. I had spent my teenage years training for several hours a day at the Vienna State Opera's Ballet Academy to understand how to apply the laws of physics to the body. For a few years, I enjoyed performing in classics such *Swan Lake* and *Sleeping Beauty*, and helping to preserve our cultural heritage. But dance can do so much more and I sensed the world I was growing in needed this ancient art form to be an integral part of society again. I was able to explore this idea further through my academic studies at Harvard University, and then I started creating works that I called "choreographed papers." I met very few artists with similar ideas at the time, but today I know I was not entirely alone. Despite the absence of institutional support, several artists beyond the IIASA Science & Art project have started to connect their work to science and sustainability with remarkable depth. Two of them share their insights here.

## MUSIC AND SUSTAINABLE DEVELOPMENT: A PROMISING FUTURE

***By Isabel Pérez Dobarro***

When I first attended a sustainable development-related conference, I remember introducing myself as an artist. "I am a classical concert pianist," I said. I felt that as an innovator and entrepreneur, a creative, curious, empathetic person—in other words, an artist—I could contribute to these discussions. Since I was four years old, I have devoted countless hours to problem-solving, innovative thinking, and conveying knowledge through music. Each piece of music is an interpretative effort that involves looking into the most efficient approach to translate a music text into sound and communicate it in a coherent and effective way. So I thought I could offer what artists do best: inspire, communicate, think out of the box, and propose unique perspectives on our past, present, and future. Yet, I always met skepticism after introducing myself in those terms and had to add that

I studied law and international relations to be taken more seriously. Frustrated by these encounters, I decided to research more deeply not only how we artists, can be part of the sustainable development transformation, but also how we can explain our role better and gain recognition for it.

I focused on the role of the musician, with a special emphasis on classical music composers and performers. As a genre, classical music has a rich and deep tradition, while also constantly innovating. Starting in the 19th century, the classical music tradition gradually expanded the boundaries of the European-centered, white, male-dominated repertoire and incorporated diverse influences from non-Western cultures into other genres, such as jazz or rock. Classical music creators include, of course, Johann Sebastian Bach and Frédéric Chopin, but also Afro-Cuban composer Tania León, and Japanese born Tōru Takemitsu.

## Culture as the fourth pillar of sustainable development or as an enabler?

Several authors have claimed that culture should be considered the fourth pillar of sustainable development, alongside economic viability, social equity, and environmental protection. Economist Keith Nurse even affirms that it should not be considered additional, but one of the key elements. He argues that culture's construction and the communication of a society's identity, values, and hopes are a "critical strategic resource" in moving towards sustainability.[1] Along the same lines, Jon Hawkes writes about creating a "cultural paradigm," alongside economic, social, and environmental paradigms, to evaluate public policy since cultural vitality is linked to healthier and more sustainable societies.[2]

UNESCO, however, views culture as a transversal enabler to sustainable development.[3] The organization considers that culture-engaged actions are related to more participatory, peaceful, and diverse processes. To support the inclusion of culture within development policies, UNESCO adopted, back in 2005, the Convention on the Protection and Promotion of the Diversity of Cultural Expressions. With the new 2030 Agenda Framework, UNESCO reinforced this relationship between culture and development by examining the crucial interactions between the SDGs and cultural activity.[4]

Within the broad concept of culture used in these sources, the arts are probably the most challenging field to define. Since painter and sculptor Marcel Duchamp showed his piece *Fountain* in a museum, and composer John Cage proposed a silent piece as his *4'33*, the definition of art has significantly changed.[5] For the purpose of this paper, I will define art as the process and/or result of a creative or interpretative effort by an individual or group of individuals that one or several societal groups consider aesthetically meaningful. I see three possible avenues for music to contribute to sustainable development: through awe, innovation, and dialogue facilitation.

## Awe

How can music inspire awe and move to action without words? The programmatic nature of music appears already in the Middle Ages, a practice systematized in the Renaissance under the concept of *madrigalism*. Music described what was sung through specific devices. For example, if the text spoke about death, it was common practice to place a descending chromatic scale to represent it. These conventions were eventually passed on to purely instrumental music. As a result, in the Baroque, one can find Antonio Vivaldi's depiction of a storm in the *Four Seasons* or Johann Sebastian Bach's *Capriccio sopra la lontananza del suo fratello dilettisimo*, which imitates a post horn as a symbol of his brother's departure.

The musical theorist Johann Mattheson (1681-1764) linked musical gestures to specific affects, indicating, for example, that shorter distances between notes (intervals) reflect sadness.[6] In the 19th century, program music, understood as purely instrumental music based on a script, became extremely popular. Examples ranged from Hector Berlioz's *Symphonie Fantastique* to Modest Mussorgsky's *Pictures to an Exhibition*. Many of the conventions laid out in these pieces were absorbed by film music, and these semiotic codes became mainstream in the 20th century.

So, while individual reactions vary, it is plausible that most people listening to a diminished chord anticipate that something uncomfortable or scary is about to happen.[7] Julia Wolfe's *Fire in my Mouth* addresses working conditions, immigration, and gender equality, describing New York's catastrophic Triangle Building Fire in 1911. The repetitive percussive effects in the orchestra resemble the machinery work as well as the fire that ended the life of 146 textile workers in the disaster. The emotional effect of the feminine voices singing the word "fire" over it is unparalleled.

Despite the vast possibilities of enhanced communication that music provides, one should also understand its limitations. Just by listening to *Fire in my Mouth* without any contextualization or visual aid, it would be challenging to understand the number of casualties, the workers' backgrounds, the precarious working conditions they faced, or the legislative framework within which the victims of the Triangle Building Fire operated. Yet, after listening to the piece with the proper context, their story remains vivid in our memory, and we might feel a higher level of empathy with their fate than after just reading the facts.

## Innovation

Historically, music has been an inspiration for science in multiple ways. The problem of the vibrating string was vital to develop post-calculus mathematics, while continued fractions may be linked to research on best numerical ratios for each of the intervals.[8] Conversely, mathematics has been at the core of the delineation of tuning systems, serialism, electroacoustic music

research, and new analytical methods, such as the "geometrical musical theory."[9] In fact, there are several dual university programs in mathematics and music.[10] Music technology programs are also widespread. Students in these degrees are adept in programming, music composition, production, editing, and acoustics. In addition, new journals such as SAGE's *Music & Science* promote interdisciplinary research that combines both fields. Developments in music cognition and acoustics have opened substantial opportunities in both areas of inquiry. Thus, the interaction between music and science can lead to a positive impact in the SDGs in areas such as the reduction of noise pollution (SDG 11) or enhancing health and well-being (SDG 3), where both disciplines can work together.

In recent years, ecomusicology has emerged as one of the most promising new disciplines within the musicological field. Aaron S. Allen defines it as "the study of music, culture, and nature in all the complexities of those terms. Ecomusicology considers musical and sonic issues, both textual and performative, related to ecology and the natural environment."[11] Thus, ecomusicology studies the interaction between non-human and human sounds, providing a bridge between science and the arts to gain a deeper insight into the role of culture in facing sustainability issues.[12] As Allen points out, Donald E. Worster's research emphasizes that societies are not merely the product of climatic or environmental conditions; values, morals, and social norms play an essential part.[13] Allen argues that, within ecomusicology, topics of discussion can range from musical representations of nature or human emotions portrayed in the environment to the study of any musical work that is actively contributing to improve the climate crisis.

Historically, there are countless examples of musical pieces inspired by nature in the classical repertoire. From Clara Schumann's *Am Strande* where the singing voice moans the distance that separates her from her beloved to Amy Beach's depiction of the rain in *The Rainy Day*, these pieces reflect the composers' visions of nature and the interactions between human emotions and the environment. This category is closely related to the awe-inspiring nature of the arts mentioned above. However, its goal might not necessarily be to move to action—as many of our current climate change concerns were unknown at the time—but rather, to provide a subjective perspective, enhancing an imaginary description of the environment. There is, however, in traditional music, music expressions that address the consequences of climate change or desertification directly. In this sense, Sebastian Hachmeyer's research on the relevance of music in the cosmological equilibrium of the Kallawaya culture of the Bolivian Andes,[14] provides a good example of these types of studies. This research shows how local cultures react to climate change and create their own body of knowledge concerning the consequences of global warming.[15]

While these types of studies are not common in the field of classical music, the exploration of how climate change affects music composition and performance in the classical repertoire, and vice versa, and how classical works contribute to the knowledge of environmental phenomena are

possible avenues for further research and practice. Here, again, there are points in common with the awe-inspiring nature of music mentioned above. From this perspective, music does not only inspire but also creates a form of knowledge to relate to environmental concerns. Also, our perception of the environment might change dramatically if we are listening to a recording of John Dowland's lute music or Franz Liszt's *Totentanz* while observing a river. A fascinating study by Miguel Mera and Simone Stumpf showed, with eye-tracking techniques, how film music can change our visual attention to different parts of a scene (depending on whether the music was distracting from or focused on the visual image).[16] In the same way, the use of one music or another can bring our attention to certain elements while distracting from others, shaping our perception of a natural phenomenon.

Interactions between music practice and the environment should be promoted; not only does music enhance our experience of our surroundings, but it also shapes our perception and understanding of it. It is a way to connect us with nature since music is full of "environmental implications and meanings."[17] Music can also reflect positive environmental practices as is the case with the Paraguayan *Orquesta de Instrumentos Reciclados de Cateura* (Cateura's Orchestra of Recycled Instruments), which uses string and percussion instruments created out of waste. This approach contributes to promoting responsible consumption and provides an opportunity for children from low-income families, who cannot buy an instrument, to access the musical world.[18]

Besides the interactions described above, music and nature can interrelate through the incorporation of nature sounds in music, and vice versa, using classical music in the environment. Olivier Messiaen's *Petites esquisses d'oiseaux* includes transcriptions of bird songs while Jean Claude-Risset's electro-acoustic work *Sud* uses recorded sea sounds. These pieces do not evoke nature by traditional means, and their representation of nature expands the existing musical timbres and possibilities. Conversely, the benefits of exposure to classical music in certain animals have shown new possibilities in the interaction between nature and music. Lori R. Kogan, Regina Schoenfeld-Tacher, and Allen A. Simon concluded that classical music helped mitigate stress in kenneled dogs.[19] While not specifically music, the use of acoustic means to improve a coral reef's health has been studied by Gordon et al.[20] They suggest that using a pre-recorded healthy reef sound can increase "fish settlement and retention to a degraded habitat."[21]

## Dialogue

The third way in which music can contribute to sustainable development is through its role as an enhancer of cultural dialogue and understanding.

In their article, "Strategic Arts-Based Peacebuilding," Michael Shank and Lisa Schirch have delineated possible artistic interventions during the four phases of a conflict: conflict escalation,

conflict management, conflict transformation, and conflict prevention. In relation to music, the authors suggest using hip-hop during the conflict escalation, chants to manage the ongoing conflict, music therapy to promote the conflict transformation, and arts education to prevent new disputes from arising.[22] The researchers stress the untapped potential of the arts in ameliorating these complex situations. Most of the research in arts and peacebuilding, however, focuses on the role of music in the post-conflict phase, using music as a vehicle for healing and reconciliation.[23]

Nevertheless, there are notable musical efforts focused on ending the existing conflicts. One of the most outstanding examples is the West-Eastern Divan Orchestra, created by pianist and conductor Daniel Barenboim and philosopher Edward Said, which promotes dialogue and peace in the Middle East and North Africa (although the project initially focused on the Israeli/Palestinian conflict). An equal number of Israeli and Arab musicians are part of the orchestra, together with members from Turkey, Iran, and Spain.[24] By playing together and setting common artistic goals, the members of the orchestra leave their differences aside and collaborate.[25] Yo-Yo Ma's Silk Road Ensemble pursues similar goals. The group "engages difference, sparking radical cultural collaboration and passion-driven learning for a more hopeful and inclusive world."[26] Several studies support these actions. Lesley Pruitt points out that "musical activities can be a relevant and effective way to engage youth in a dialogue for peace."[27] Ruth M. Stone shows how music brought communities together at the height of the Ebola crisis in Liberia.[28]

All of these efforts should be carried out with caution. As Elaine Sandoval states, music can be used both as a means of reconciliation but can also reinforce racism or hate.[29] Understanding the context in which these musical practices happen, and giving a voice to each of the diverse members of the community, seems essential to the success of these endeavors.

## Music and international relations: a long history of cultural diplomacy

In recent years, three schools of thought have emerged when looking at the intersection between musicology and international relations: "international concerns in musicology, the aesthetic turn in international relations (IR), and the cultural turn in international history."[30] These have led Cécile Prévost-Thomas and Frédérick Ramel to coin the term "acoustic turn of international relations."[31] Studies under these three trends involve the role of music in transnational conflicts, the study of similarities between transnational exchanges and "sound-music, noise, and silence" in the international arena,[32] and studies on musical diplomacy.

Under this prism, varied perspectives have emerged, including: the analysis of the possible role of music in improving Armenian-Turkish relations;[33] David R. M. Irving's study on French-Siamese musical exchanges in the 17th century;[34] the role of trumpeters in diplomatic meetings right before the Thirty Years War;[35] and the international solidarity campaign derived from the imprisonment of a musician.[36]

However, there is a lack of research and music practice addressing the SDGs specifically. Despite its work supporting and making visible local music initiatives, UNESCO's only substantial music program linked to the SDGs is "Cities of Music." This program, part of the Creative Cities Network, celebrates urban settings where creativity is considered a "strategic factor for sustainable urban development."[37] The UN Development Program promotes local music initiatives, yet it does not host a particular program on music and the SDGs.[38] Regional international organizations include music within their cultural actions, but the SDGs are not at the core of their endeavors.[39]

The situation is not new, as there are scarce precedents for studying the interaction between music and the Millennium Development Goals, and putting what is learned into practice. Jaime Booth Cundy studied the Song for African for Enrichment program under the MDGs lens. She concluded that music was a "cost-effective tool in the pursuit of the MDGs,"[40] and a key in development and peace efforts, and in forging effective partnerships. I haven't found relevant performative projects using music as a means to help achieve the SDGs. Most of the existing studies focus on music festivals and sustainability, looking at how these events have developed sustainable practices.

## Can music contribute to the implementation of each SDG?

Music can contribute to specific SDGs. In my experience, the interaction between music and the SDGs 5 (gender equality) and 17 (partnerships for the Goals) can be very fruitful. In relation to SDG 5, the music world and, in particular, the classical music field, is experiencing a notable transformation. For centuries, women composers and conductors have been neglected despite the evident talent of composers such as Marianne von Martinez, Fanny Mendelssohn, and Lili Boulanger. Their work has not been incorporated into conservatories' curricula and the concert repertoire canon, and their pieces are barely programmed. Young women music students are being deprived of important role models. Statistics from the 2014-2015 season show that only a 1.8% of the pieces included in major US orchestras' programs were composed by women.[41]

Only in rare exceptions, such as when Antonia Brico conducted the Berlin Philharmonic in 1930, do women have access to major conducting roles. It was only in 2007, when Marin Alsop became the music director of a major orchestra, the Baltimore Symphony, that a woman had a principal conducting position at a world-class orchestra.[42] The reasons behind the scarce presence of women in the compositional and conducting fields are multifarious. Anna Beer points out how women used to be considered "talented angels," incapable of profound compositional creativity.[43] After several years of extraordinary creative activity, the lack of role models led Clara Schumann to leave composition, declaring that if no woman had ever become a relevant composer, why would she.[44] For Karien Pendle, the conductor's leadership role in the spotlight was at odds with the traditional roles of women, so women were systematically excluded from conducting positions.[45] Starting in the 1980s, the emergence of feminist musicology began a slow path for the recognition of women. Authors such as Susan McClary, Marcia J. Citron, Marisa Manchado, and

Cecilia Piñero Gil, among others, have been pioneers in claiming a space for women composers and performers in musicological research.

All societal sectors shall be involved in the implementation of the SDGs, and music can be an enabler of those connections, promoting SDG 17 (Partnerships for the Goals). A music festival can gather private sponsorships, promote exchanges between local and international artists, engage civil society, and model positive values to the community. The BBC Proms, the largest classical music festival in the UK, has been collaborating with Julie's Bicycle, a charity working on sustainability in the creative industries, to ensure the festival's commitment to environmental protection. Another initiative, the Beethoven's Pastoral Project, has gathered musicians from all over the world, UN senior members, radio stations, and cultural organizations to show their commitment to environmental preservation. This commitment is done through both petition-signing and live-streamed performances.

As performing artists, classical concert pianists can contribute to one or several SDGs. Personally, ensuring gender equality in classical music is one of my main missions. In my recitals, I always include at least one piece by a woman composer. I also lead initiatives to foster international exchanges through women composers' works, lecture at conservatories and schools on the topic, and lead a series of online interviews on women composers and performers. I am putting special emphasis on promoting symphonic works by women, including a recent concert with female conductor Claudia Dubé at the prestigious Palau de la Música Catalana in Barcelona in January 2020, where I performed Clara Schumann's *Piano Concerto for Piano and Orchestra op.7* and Clara Gil's *Frágil.*

The opportunities for music's contribution to sustainable development are varied and meaningful. While this is only a first approach to the topic, I hope to have laid out some starting points for further study. Friedrich Nietzsche affirmed that "without music, life would be a mistake."[46] Sustainable development without music will be an error too. This art form may not solve all the pressing issues we are currently facing but could contribute to creating a better world. I hope this research report inspires many fellow artists, and those who can support them, to take action for what is right and help others see us as relevant change-makers.

**ISABEL PÉREZ DOBARRO** is a Spanish concert pianist and researcher, who has performed and given lectures and speeches at the UN General Assembly Hall, European Parliament, Harvard University, the Vatican, Carnegie Hall, and the Tchaikovsky Conservatory in Moscow, among others. She is a graduate of the Madrid Conservatory, the Manhattan School of Music, and NYU where she started teaching as an Adjunct Instructor at age 19.

# ENDNOTES FOR CHAPTER XV

1 Keith Nurse (2006), 28-40
2 See: Hawkes
3 Aa. (2018), 6
4 See: Hosagrahar (2017)
5 For the evolution of the definition of the concept of art, see: Davies, 213-222
6 Grant, 53
7 For more information on emotions and film music see: Cohen, 879-908.
8 Maor, (2018)
9 Ibid
10 There are double degrees offered by universities in the UK (Birmingham, Leeds, Edinburgh, and Cardiff), and most recently, at the Universidad Politècnica de Barcelona in collaboration with the ESMUC conservatory
11 Allen, Ecomusicology.
12 Allen, et al. (2014), 7
13 See: Worster, 27
14 The Kallawaya is an indigenous ethnic group in Bolivia.
15 Hachmeyer, S. (2017)
16 Mera, M. and Stumpf, S. (2014)
17 Pedelty, 11
18 See: Orquesta de Instrumentos Reciclados de Cateura
19 Kogan, L.R., Schoenfeld-Tacher, R. and Simon, A.A. (2012): 274
20 Gordon, et al. (2019)
21 Ibid
22 Shank, and Schirch (2008): 231
23 Sandoval (2016): 203
24 See: Divan
25 Beckles Willson has critiqued these efforts, claiming that the orchestra is a utopia and the repertoire is inadequate to fulfill its diversity goal (see: Beckles Willson (2009)). However, Beckles Willson falls into several traps. She only analyzes a tour and one of the pieces included in their concerts, the epitome of the European repertoire, Beethoven's Ninth Symphony. The WEDO, however, has commissioned and premiered new works by non-European composers, including Syrian-American Kareem Roustom and Israeli Ayal Adler. She also considers that the group's musicians are just a symbol, and their only goal is to advance in their careers. Nevertheless, Beckles Willson fails to understand the difficulties in managing an orchestra, especially considering the many religious and racial cleavages of this ensemble. The fact that music serves to overcome them, gives a positive message of integration. Also, Beckles Willson points out that the orchestra and the Barenboim-Said Foundation's actions have been detrimental to Andalucía's musical scene. However, she fails to recognize that the orchestra has given countless opportunities to local musicians and has attracted artists from all over the world to Spain. Audiences in Andalucía have also been exposed to world-class performances. 9
26 See: Silk Road Ensemble
27 Pruitt, L. (2011): 100
28 Stone, R.M. (2017): 79-97
29 Sandoval (2016): 209
30 Prévost-Thomas, and Ramel, 2
31 Ibid
32 Prévost-Thomas, and Ramel, 3
33 Çevik (2018)
34 Irving (2012)
35 Rose (2012)
36 Fléchet, and Buch
37 See: Cities of Music Network
38 See: From Rio to New York-localizing the SDGs through music and art
39 The European Commission developed the Music Moves Europe framework (as part of Creative Europe), which supports the music sector in the continent. The African Union Music Group was created in 2012 to communicate African Union and its citizens' values through music. ASEAN's Ministers Responsible for Culture and Arts has developed a Strategic Plan for Culture and Arts 2016-2025. The Arab Academy of Music is the League of Arab States' specialized body in charge of promoting Arab Music and fostering music education. Finally, the Organization of American States supports the OAS Orchestra Program in the Caribbean, which aims to promote social justice through music.
40 Booth Cundy
41 Fairouz
42 Before that, Marin Alsop had been principal conductor of the Colorado Symphony Orchestra and Eugene Symphony (Oregon).
43 Beer, 7
44 See: Jusicia
45 Pendle, 361
46 Nietzsche, 7

# BIBLIOGRAPHY FOR CHAPTER XV

## BOOKS


Beer, A. (2016). *Sounds and Sweet Airs: The Forgotten Women of Classical Music*. New York: Simon & Schuster.

Cohen, A.J. (2010). Music as a Source of Emotion in Film. In Sloboda, J., editor. *Handbook of Music and Emotion: Theory, Research, Applications*. Oxford: Oxford University Press. 879-908.

Citron, M.J. (1993). *Gender and the Musical Canon*. Cambridge: Cambridge University Press.

Davies, S. (2001). Definitions of Art. In Gaut, B. and McIver Lopes, D., editors. *The Routledge Companion to Aesthetics*. London: Routledge. 213-222.

Fléchet A. and Buch, E. (2018). Music, Diplomacy, and International Solidarity: The Campaign for Miguel Ángel Estrella (1977-1980). In Prévost-Thomas, C. and Ramel, F., editors. *International Relations, Music, and Diplomacy*. Cham, Switzerland: Palgrave Macmillan. 193-211.

Grant, R.M. (2020). *Particular Attunements: How Affect Theory turned musical*. New York: Fordham University Press.

Hawkes, J. (2001). *The Fourth Pillar of Sustainability: Culture's Essential Role in Public Planning*. Champaign, Il: Common Ground Publishing.

Manchado, M. (ed.). (1998). *Música y mujeres. Género y Poder.* Madrid: Horas y Horas.

McClary, S. (1991). *Feminine Endings: Music, Gender, Sexuality*. Minneapolis: Minnesota University Press.

Maor, E. (2018). *Music by the Numbers: From Pythagoras to Schoenberg*. Princeton, NJ: Princeton University Press.

Nietzsche, F. (2019). *The Twilight of Idols*. Mineola, NY: Dover Courier Publications.

Pedelty, M. (2011). *Ecomusicology: Rock, Folk, and the Environment*. Philadelphia: Temple University Press.

Pendle, K. (2001). *Women & Music: A History*. Bloomington: Indiana University Press.

Piñero Gil, C. (2011). Latinoamérica y el feminismo en música: caminos recorridos. In Iniesta Masmano, R., editor. *Mujer versus Música: itinerancias, incertidumbres y lunas*. Valencia: Rivera Mota. 37-76.

Prévost-Thomas, C., and Ramel, F. (eds.) (2018). *International Relations. Music and Diplomacy.* Cham, Switzerland: Palgrave Macmillan.

Worster, D.E (1993). *The Wealth of Nature: Environmental History and the Ecological Imagination*. New York: Oxford University Press.

## PAPERS


Allen, A.A. et al. (2014). Sustainability and Sound: Ecomusicology Inside and Outside the Academy. *Music & Politics* 8 (2):1-26.

Beckles Willson, R. (2009). Whose Utopia? Perspectives on the Wester-Eastern Divan Orchestra. *Music & Politics* III (2).

Çevik, S.B. (2018). Can Turkish-Armenian music diplomacy emulate the Turkish-Greek example?: prospects and limitations. *Caucasus Survey*, 6 (2):130-146.

Gordon, T.A.C., Radford, A.N., Davidson, I.K. et al.(2019). Acoustic enrichment can enhance fish community development on degraded coral reef habitat. *Nature Communications* 10, 5414.

Hachmeyer, S. (2017). Music Climate and Therapy in Kallawaya Cosmology (Part 2): Dysfunction of Seasonal Change, Climatic Reversal, and Musical Worldling. *Ecomusicology Review* 5.

Irving, D.R.M. (2012). Lully in Siam: music and diplomacy in French–Siamese cultural exchanges, 1680–1690. *Early Music* XL (3): 393-420.

Kogan, L.R., Schoenfeld-Tacher, R. and Simon, A.A. (2012). Behavioral effects of auditory stimulation on kenneled dogs. *Journal of Veterinary Behaviour* 7: 268-275.

Mera M. and Stumpf, S. (2014). Eye-Tracking Film Music. *Music and the Moving Image* 7 (3): 2-23.

Nurse, K. (2006). Culture as the fourth pillar of sustainable development. *Small States: Economic Review and Basic Statistics* (11): 28-40.

Pruitt, L. (2011). Creating a musical dialogue for peace. *International Journal of Peace Studies* 16 (1): 100.

Rose, S. (2012). Trumpeters and diplomacy on the eve of the Thirty Years' War: the album amicorum of Jonas Kröschel. *Early Music* XL (3): 379-392.

Sandoval, E. (2016). Music in Peacebuilding: a critical literature review. *Journal of Peace Education* 13 (3): 200-217.

Shank, M. and Schirch, L. (2008). Strategic Arts-Based Peacebuilding. *Peace & Change* 33 (2): 217-242.

Stone, R.M. (2017). Ebola in Town: Creating Musical Connections in Liberian Communities during the 2014 Crisis in West Africa. *Africa Today* 63 (3): 79-97.


## OTHER


The Culture for the 2030 Agenda. Paris: UNESCO, 2018. Report.

Allen, Aaron S. Ecomusicology. Grove Music Online, retrieved from https://www.oxfordmusiconline.com/grovemusic/view/10.1093/gmo/9781561592630.001.0001/omo-9781561592630-e-1002240765.

Beethoven Pastoral Project. BTHVN2020, retrieved from https://pastoralproject.org/project-information.

Booth Cundy, J. "Music and the Millennium Development Goals What is the potential impact of music-based programming such as Song for Africa's Music Enrichment Program and how can that impact be best utilized?," *Canadian Artists for African Aid (CAFAA Inc.)/Song for Africa*, accessed May 2020, retrieved from https://www.psychologytoday.com/files/attachments/45883/music-and-the-millennium-development-goals.pdf.

Cities of Music Network, retrieved from https://citiesofmusic.net/.

Divan. West-Eastern Divan Orchestra, retrieved from https://west-eastern-divan.org/divan-orchestra.

Fairouz, M. (1.5.2017). Women are great composers too, why aren't they being heard?. NPR, retrieved from: https://www.npr.org/sections/deceptivecadence/2017/05/01/525930036/women-composers-not-being-heard.

From Rio to New York-localizing the SDGs through music and art. *UNDP*, October 24, 2017, https://www.undp.org/content/undp/en/home/news-centre/announcements/2017/localizing-SDGs-music-art.html.

Hosagrahar, J. (2017), Culture: at the heart of the SDGs. *UNESCO Courier*, retrieved from https://en.unesco.org/courier/april-june-2017/culture-heart-sdgs. "Orquesta de Instrumentos Reciclados de Cateura," retrieved from https://www.recycledorchestracateura.com/.

Jusicia, A. (14.2.2019). Compositoras brillantes (y silenciadas). *La Vanguardia*, retrieved from: https://www.lavanguardia.com/cultura/culturas/20190414/461563408233/compositoras-musica-anna-beer-armonias-y-suaves-cantos-francesca-caccini-barbara-strozzi-elisabeth-jacquet-marianna-martines-fanny-hensel-clara-schumann-lili-boulanger-elizabeth-maconchy.html.

Silk Road Ensemble, retrieved from https://www.silkroad.org/.

Sustainability Information. BBC Proms, retrieved from https://www.bbc.co.uk/programmes/articles/1W11YxrwKlP5Xpx4KWbsswP/sustainability-information.

## THE VITALNESS OF THEATER IN SHAPING A THRIVING FUTURE

***by Jeremy Pickard***

Theater, humanity's oldest artform, is live storytelling using a variety of mediums. For most of human history, theater was a regular part of life, a public service that intertwined science, spirituality, civics, and history. Everyone—rich or poor—was expected to engage. Theater involved ritual, ceremony, and spectacle, and was seen as necessary for society to function; performative narratives were the primary medium for communicating ethics and establishing social values. Cave paintings are remnants of prehistoric stories that were used to pass down the wisdom of survival from one generation to the next; these stories were carried by hunter-gatherer societies through oral storytelling. The image of a group of people gathered around a fire while a storyteller sings, dances, and speaks a story is the heart of theater: live storytelling as a tool for social practice is in our DNA. Ancient texts like the Nāṭya Śāstra from India or Aristotle's Poetics are rulebooks for how to make theater in a way that best helps society to function. Indigenous cultures around the world today still tell the stories and practice forms of live storytelling that their ancestors created thousands of years ago. We make theater to preserve our ways of life, to remember our relationship to the land, to humble ourselves in the face of the natural world and all that we don't know, to help us evolve as a species.

It was only in the last few hundred years—and predominantly in white Western imperial cultures—that theater was siloed into the extracurricular realm of popular entertainment,

Panoramic view of Theatre of Dionysus in Athens, view from the Acropolis © dreamstime

institutionalized by royal power, and appropriated by religion, television, and politics. Shakespeare's plays were commissioned by Queen Elizabeth and so her worldview heavily influenced (and likely censored) his content. The popular plays of 17th, 18th, and 19th century Europe predominantly told stories of aristocrats; playwrights like Molière had to camouflage their activism through satire and metaphor. Most of the shows produced on Broadway today are the descendants of forms that were established to favor rich white audiences: American musical theater evolved from opera (commissioned by aristocracy and inaccessible to the poor) and vaudeville (which built upon the music, comedy, and variety format of racist minstrel shows).

But theater has never stopped being a nonhierarchical tool of the people. The early 20th century movement we now call Theater of the Avant-Garde or "experimental theater" emerged from the wreckage of the World Wars as a deliberate alternative to and condemnation of the institutions that held power over people and art. It demolished traditional forms in order to better reflect the unjust society that was revealed by war and genocide. Futurism, Dadaism, Antonin Artaud's Theater of Cruelty, Samuel Beckett's Theater of the Absurd, the playwrights Bertolt Brecht and Eugene Inonesco began a legacy of experimentation that was deepened and honed by late 20th century artists like Carol Churchill, María Irene Fornés, and Suzan-Lori Parks. In the 1970s, Brazilian activist Augusto Boal created the monumental Theater of the Oppressed, still practiced all over the world today, which involves using the tools of theater to "rehearse the revolution." Audience members—historically people from oppressed or disenfranchised communities—are the actors and the storytellers with full decision-making power over the story told onstage and how it resolves. Today's theater is a student of these movements; most theater that is made is never seen by tourists, but exists as it did thousands of years ago as a public service intrinsically tied to the communities it serves and as a tool for actively responding to the political moment.

September 2001 was the beginning of my freshman year of college. We were only two weeks into the semester when the Twin Towers fell in New York City, 240 miles southeast of Ithaca, New York where I was studying theater. By the end of my freshman year, the United States had illegally invaded Iraq, breaking international agreements. In the fall of my senior year, the 2004 presidential election exposed deep partisan division across the country, 11 states banned same-sex marriage, Hurricane Jeanne killed over 3,000 people in Haiti with little American relief, the US had accrued billions in debt, the mass incarceration of Black Americans was increasing, and the war in Iraq raged on. As I took drama classes, the country segregated into red and blue. The world burned.

Studying theater against the backdrop of global injustice laid a foundation for thinking of art as a vital tool for combating that injustice. When I graduated, I couldn't imagine separating a performance from the context of the world in which I was living and the news I was reading every day. I decided to focus my career on making original work (as opposed

to staging existing plays). I wanted to create new myths to help guide us toward a better world, and I wanted to have control over the intentions, values, and structures I felt were necessary to innovate my artform for this purpose.

I grew up surrounded by trees in a rural town in upstate New York, going camping in the Adirondack Mountains, and growing vegetables in our backyard. Ithaca is notorious for its natural beauty and a culture of sustainability and science (I would often run past the house of the late Carl Sagan, famous astrophysicist, who taught at Ithaca's Cornell University). So although I nearly failed high school science class and wasn't raised by tree huggers, it's no surprise that I entered adulthood with a passion for ecology.

In Lenapehoking ("New York City"), where I moved after college, I witnessed amazing theater tackling all sorts of real-world problems in highly personal, hilarious, strange, beautiful ways. But I saw no plays confronting environmental degradation. No theater colleagues were discussing climate change. I saw no theaters partner with local environmental justice organizations or theater artists collaborate with climate scientists. No one was talking about the environmental impact of theatrical design or the energy wasted in old inefficient buildings; the Broadway Green Alliance—the non-profit championing sustainable practices in the theater industry—wouldn't be formed for another three years.

I saw a need that met my passion, but no existing institutions or structured funding for it. So I started a grassroots theater company focused entirely and holistically—content, process, and production—on environmentalism. I would eventually call this approach "eco-theater." I named my nascent organization Superhero Clubhouse because I wanted to nurture an inclusive, empowering, playful community of creatives.

When I started experimenting with eco-theater, talking to friends and trying to engage the theater community, I was generally met with a disinterest and skepticism that echoed the news and public dialogue: climate change and environmental issues were perceived as depressing, boring, and even a little childish. It was assumed, therefore, that art about these topics could only be preachy, simplistic, and didactic. Even now in 2020, my eco-theater colleagues and I continue to push against this public perception every day.

However, the mid 2000s also marked a moment when public views on climate science were starting to change in significant ways. Al Gore's documentary *An Inconvenient Truth* was released in 2006; in 2007, it won multiple Academy Awards and had a huge viewership (2007 was also the year Netflix switched to being a streaming service, making films like *An Inconvenient Truth* more accessible at home). There was more and more news coverage of climate change, and friends and family members started bringing it up in conversation without prompting.

As the urgency of the climate crisis was gaining attention, I noticed the science community begin to confront its own limitations in disseminating and communicating scientific research, as well as in engaging the public. Artists are experts at communicating complex information in personal and digestible ways; scientists started to take more interest in artists, and take art seriously. In 2009 I was invited to a conference called Tipping Point, supported by The British Council, which brought together ~25 climate scientists and ~25 artists from many disciplines at the Lamont-Doherty Earth Institute (LDEO) in Palisades, New York to be in conversation with each other for three days. The conference was uniquely structured to bring these two groups together on equal terms: there were just as many science presenters as artist presenters, and most of our sessions were spent in mixed-discipline breakout groups, brainstorming ways to engage the public in confronting the climate crisis. This conference was my first real exposure to scientists, and my first time understanding the power and possibility of art-science collaboration.

Out of this conference, a consortium called PositiveFeedback was formed, based at Columbia University's Earth Institute, for the purpose of matchmaking artists and scientists around climate change. Thanks to the support of PositiveFeedback, I became connected to a network of environmental scientists, such as dendrochronologist Dr. Nicole Davi and paleobotanist Dr. Dorothy Peteet, both of whom would become my collaborators and friends for many years. We created pieces of eco-theater together that my company performed at LDEO's annual Open House event; I would bring students to their labs and seek their advice on separate projects; we would include each other in grants. Spending time with scientists immediately made clear the similarities between our fields, and the value of art-science collaboration. Beyond communicating their research, my job was to understand my collaborators' purpose for researching in the first place, the intended impact of the research, and the complex human questions that surrounded the research. I was trying to identify where science met story; what happened when research met human emotions, psychology, and decision-making. And my science collaborators' role wasn't simply to hand over their knowledge for my theatrical interpretation, but rather to engage with me in the creative process. This deep quality of collaboration is rarely given time or money—I've had very little of either in the decade I've been collaborating with scientists—but this type of knowledge exchange and collective envisioning is vital to the work of climate justice (and could make much more of an impact with funding). Cross-disciplinary collaboration remains a core value of Superhero Clubhouse and primary tenet of how we define eco-theater, and this has everything to do with the spaces and resources that were created 12 years ago to bring artists and scientists together as equals.

Eco-theater, as Superhero Clubhouse defines it now, is the intersection of live performance and environmental/climate justice. We use three tools to make eco-theater: Impossible Questions, Imposed Limitations, and Tangible Hope. In 2019 we took a decade's worth of learning-by-experimenting in this field and wrote a one-page Eco-Theater Manifesto, which

posits that eco-theater is holistic, hopeful, complex, and as diverse as a thriving ecosystem (the manifesto can be accessed on our website). Through the lens of climate and ecology, the process of making theater is a model for a just, regenerative society. We're creating intentional spaces for anyone to collaboratively forge the stories we need to guide us toward a better future.

The beautiful thing about unprecedented artistic research—much like unprecedented scientific research—is that it demands flexibility and failure in order to succeed. Superhero Clubhouse is long-term research. We're studying through practice how theater can help shift culture toward climate and environmental justice. But environmental justice is about centering the experiences, stories, and leadership of BIPOC (Black, Indigenous, People of Color) communities, who, because of racist policy and institutionalized discrimination, are at the frontlines of climate and environmental crises. And for the first eight years of Superhero Clubhouse's existence, I was centering myself, a white, middle-class, cisgender man. The plays we produced were written or co-written by me; our Big Green Theater eco-playwriting program—which serves mostly low-income Black and Brown elementary students in North Brooklyn—was taught and directed by me; any writing, speaking, or advocacy around eco-theater was primarily being done by me. Although I had many equal collaborators in all of these projects, the structure of the art and the organization was colonial.

The work of decolonizing Superhero Clubhouse began in 2015, as a result of many changes that happened quite quickly. The most significant change was Lanxing Fu coming on as my co-director. Lanxing has a wide knowledge of community-focused eco-art, a passion for transformative non-traditional theater, and personal experience with discrimination (she being an immigrant and a woman of color). Her partnership immediately helped shift the purpose of Superhero Clubhouse from an organization focused on making unique theater to an organization focused on using the tools of theater to envision and practice a regenerative, just society. Over the past five years, Lanxing and I rewrote our mission statement, articulated core values, developed new projects and plays led by BIPOC artists, created a paid fellowship program to initiate new cross-disciplinary eco-performance, formed a diverse group of core members and advisors, and began publicly prioritizing BIPOC folks in our hiring and casting, avoiding anything less than 50% BIPOC representation on all projects. In 2015, we also increased our Big Green Theater budget and added a second school to the program, which allowed us to hire several new teachers and artists, spreading out the leadership and moving closer to a nonhierarchical model. And 2015 was also a year when new institutional opportunities for climate-centered art started to appear, most notably from the Robert Rauschenberg Foundation. The Foundation created an "Artist as Activist" grant, a "Climate Art" grant, and a Rising Waters residency on Captiva Island in Florida. I participated in the residency with a group of multidisciplinary artists as well as some local scientists and conservationists. We spent five weeks together working solo and collaboratively in response to South Florida's climate fate, which is most immediately and

disproportionately threatening Black and Latinx Floridians, the Mickosoukee and Seminole people, and dozens of critically endangered non-human species in the Everglades.

Today, Superhero Clubhouse continues to experiment ever more deeply within the parameters of our holistic model of eco-theater in order to best serve the environmental movement. In resistance to capitalist ideals of productivity and achievement, we are slowly nurturing an ecosystem of people, plays, and programs, investing in a community-centered exploration of how live storytelling can help humans be in right relationship with the land and with each other. We are looking to ecology to teach us how to make theater, and looking to theater to teach us how to build a better society. What slows our progress, always, is lack of institutional funding and a reduction of the value of art from a vital tool of social and political change to extracurricular entertainment.

As I write this, the United States is experiencing a tremendous racial justice uprising with a level of participation and attention we haven't seen since what is called the Civil Rights Movement of the 1960s. For the first time in our country's history, white-led institutions and leadership are starting to respond to BIPOC demands to dismantle the white supremacist systems that we have perpetuated and exacerbated since the 1600s. The racial justice movement intrinsically intersects with the climate and environmental justice movement, and so work to dismantle white supremacy must extend to all who care about a habitable planet.

We live in a culture that devalues and defunds art, often far more than science. But as we've seen for 50 years since the term "global warming" was first coined by scientists, scientific research alone won't change culture and therefore won't change legislation. The arts are where we change people's minds and hearts. To truly stabilize the climate and prevent the most harm we possibly can, it is imperative that the environmental sciences, funding institutions, universities, media, and government declare themselves in solidarity with the racial and climate justice movement, commit to decolonizing their budgets and practices, and commit to defend and fund the arts as equal partners toward a common goal of realizing a just, regenerative, thriving society.

**JEREMY PICKARD** founded and co-directs Superhero Clubhouse, an interdisciplinary community engaged in shifting culture toward climate and environmental justice using the tools of theater. He is the co-creator of dozens of eco-theater works including The Planet Plays, Core of Me: A Hike-Play, and Flying Ace and the Storm of the Century!, as well as the annual Big Green Theater eco-playwriting program. Jeremy is a teacher, writer, performer, and advocate for the importance of arts in social movements.

# CHAPTER XVI
# MOVING FORWARD

**Toward global cooperation**

Chapter I began in 1570 by examining the idea at the core of an important institution of the Renaissance: the Florentine Platonic Academy. The Academy was designed to explore whether connecting various disciplines might bring about a more structured social order and morality. Humanity has made great progress in the 550 years since, yet we need to shine a light on this early idea again. The more interconnected our world becomes, the more our values and resulting behaviors matter. "If we don't urgently change our way of life, we jeopardize life itself," UN Secretary General António Guterres remarked when opening the 25th Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) in December 2019.[116] At the same time, sustainable development discourse typically focuses on the limited availability of natural resources and on technological transitions and innovations as the most important remedies. This bias toward the physical side of sustainable transformation is widely spread across science, policy, and business domains. Yet, if we want a real chance at achieving the United Nation's 17 ambitious and transformative goals toward a sustainable future, we need to recognize and fully emancipate in this discourse transformational needs in governance, political, institutional, behavioral, cognitive, and psychosocial domains. This holistic approach requires the inclusion of stakeholders from the social sciences, the humanities, and the arts. Concrete examples for what such a holistic approach, including the humanities and the performing arts, in particular, would look like, are shown in this report.

## BUILDING A MORAL FOUNDATION

*Dancing with the Future* (see Chapters IX and XII) highlighted that global cooperation and cooperation with the future are perhaps the biggest challenges we ought to solve if humanity is to succeed in transitioning toward a sustainable future. As shown in Chapter XII, the concept of sustainability, "meeting the needs of the present, without also compromising the ability of future generations to meet their needs, while at the same time sustaining diversity and functioning of Earth's environment," is a moral concept. One can feel responsible for future gener-

ations, and many people do, but one can also choose to believe, for instance, that an outside force will take care of them. Inspiring a sense of responsibility toward future generations, as also attempted in *UnEarthing* (see Chapters XI and XII), will be essential. Furthermore, the SDG agenda and sustainability transformation at large will require global cooperation. While the scientists Martin Nowak, Karl Sigmund, and many others have shown that the ability to cooperate has made humans so powerful that they now determine the future of the planet,[117] there are limits to this ability. Cooperation is why we are still here today, yet, as shown below, maintaining cooperation is our greatest challenge.

Joshua Greene, professor of psychology at Harvard University, who works at the intersection of neuroscience, psychology, and philosophy, points out that "morality has evolved as a solution to the problem of cooperation—as a way of averting the tragedy of the commons. Morality is a set of psychological adaptations that allow otherwise selfish individuals to reap the benefits of cooperation." However, "our moral brains evolved for cooperation within groups" to outcompete other groups.[118] Morality didn't evolve to promote global cooperation. But in our modern world, we need a kind of thinking that enables groups with conflicting moralities to live together and thrive. He suggests that we need "a *meta morality*," which he defines as "a moral system that can resolve disagreement among groups with different moral ideals, just as ordinary, first-order morality resolves disagreements among individuals with different selfish interests."[119]

The idea of a universal moral philosophy brings us back to the intellectual foundation of the Science & Art project, established in Chapter I. Moral thinkers started dreaming of it during the Enlightenment. The more complex and interconnected the world is, the more cooperation we need. To resolve global challenges such as climate change, global cooperation based on a universal moral foundation has become more important than ever.

The biggest disappointment of the last decades for the natural science community, as colleagues at IIASA have pointed out, has been that the overwhelming scientific evidence on issues such as climate change and biodiversity loss has not prompted the necessary action. When looking through a cultural lens, this is not surprising. Dan Kahan, professor of Law and Psychology at Yale University, and his colleagues have shown that "overall scientific literacy and numeracy were not very good predictors of people's beliefs about the risks of climate change. Instead, their beliefs were well predicted by their general cultural outlooks—by their tribal membership."[120] But there is hope. As Greene points out, "being wired for tribalism does not mean being *hardwired* for tribalism." Brains are remarkably pliable organs that can be "rewired through experience and active learning."[121] After all, "the human brain is more than a bundle of selfish and social impulses," he remarks. We have the ability to not only feel but *think.*[122]

As shown in Chapter XIV, throughout history, thought leaders have inspired people to change their behavior by going beyond simply writing down what needed to happen and why; they

developed methods of direct engagement.[123] Encouraging moral thinking rather than relying on moral feeling is where great potential lies. And this is where science and art come in, why one of the four principles of the Science & Art framework (see table 1) is concerned with the moral and ethical dimension of scientific findings and why science and art productions have been designed to create an active learning experience.

## ENCOURAGING MORAL THINKING

One might hope that reason, by itself, could cut through the mess of competing human values. But reason does not tell us how to make trade-offs and it also does not tell us "how people's competing rights weigh against one another."[124] Which brings us back to the Enlightenment idea of bringing disciplines together. Reasoning based on scientific evidence alone will not move the world toward a sustainable transformation. Active learning and experiences that combine scientific facts with ethics will be key to addressing the sustainability challenge and fostering a mindset that enables global cooperation.

The productions created at IIASA were designed to appeal to intuition and reason, use multimodal communication, embody abstract concepts, actively engage audiences in decision-making processes to help them understand the consequences of their decisions, and inspire awe. Together, artists and scientists created interactive performances that investigated the relationship between humans and nature to reveal robust measures for sustainable existence (see Chapter XI: *UnEarthing*); plays wrestled with facts about climate change, demographic development, and biodiversity loss to highlight how these issues impact individuals and communities (see Chapter X: *Piece of Cake,* and *Good Neighbor*); a new format for public discussion fusing performance, traditional debate, and audience engagement was created (see Chapter III: *Courage*); scientific theories such as game theory and the mechanisms of cooperation were translated into dance and connected to the problem of resource depletion so people could see these theories in action (see Chapter V: *InDilemma* and Chapter IX: *Dancing with the Future*); data on temperature rise was turned into music to make it audible and felt (see Chapter VII: *Four Drifting Seasons*); and ethical dilemmas, such as the implication of policy on population growth and migration, were turned into participatory theater games involving the audience in a solution-finding process (see Chapter VIII: *Migraspectives*).

The merging of science and art—or perhaps a better term would be "transformative art"—developed under the framework and through the methodology described in this report, provides personal and relatable ways of engaging with scientific concepts by translating scientific data into stories or music, for example, or by connecting abstract concepts to the reality of people's day-to-day lives. It can question beliefs, values, and identities by offering new perspectives as a first step to rethink our institutions, technologies, and relationship to the natural world. It can embrace complexity, nonlinear thinking, and create a greater

awareness of non-rational experiences that deepen our understanding of the challenges we face. It can propose different scenarios of the future that spark the imagination and potentially lead to strategies that foster transformative societal change.

## FUTURE OUTLOOK: SCALING UP

When artists and scientists, such as the ones featured in this report, reinvent the process and format of how we analyze and debate problems, embed scientific data into personal narratives, design experiential ways to engage with abstract ideas, and provide forums to question beliefs and values in order to shift behaviors, they are actively trying to find solutions to shift culture. Such collaborations are essential in our efforts to carve a path toward a sustainable future. Yet, while the need for this cultural shift is recognized, no strategic investment has been made and no system established to support it. Ongoing support provided by an institute or global platform for Transformative Art, for example, that would be designed to research and encourage positive cultural shifts, could do wonders to accelerate our transition toward sustainability. This institute could support the development of collaborative projects and their dissemination at scientific and policy conferences so the arts are better integrated in global discussions on sustainable development solutions. It could facilitate collaboration with other stakeholders to reach a broad audience, and, in addition to sustainability, it could include work related to other global developments that are poised to have significant impacts on society, in particular artificial intelligence and big data.

*Dancing with the Future* © Daniel Kruganov

## FINAL THOUGHTS

I am sometimes asked why I consider live performance so important. After all, digital recordings would be so much easier to distribute. I usually point out that active learning through live experience cannot happen at home while watching a video from the comfort of one's couch; that the act of gathering in a physical space where the lights—and these days, our phones—are turned off, cannot be replicated digitally. Part of the learning, and this has been the case for thousands of years, is the exchange that happens when people *share* an experience. But theaters are not the only places where the art of assembly is practiced. Science & Art productions have been presented at conferences and in open air venues, in a parliament and a museum. Just like in the 16th and 17th centuries, before dedicated performance spaces such as opera houses and theaters were common, performances were adapted to the specific venue. But the performance was always live.

As I am writing this report, in the midst of the COVID-19 pandemic, a time when so many aspects of what makes us human—the ability to meet, touch, assemble and experience together—have been taken away from us, it feels right to shine more light on these basic human needs. The art of assembly has transformative power. Humans are social creatures; wanting to share something, be it food around the fire while telling each other stories thousands of years ago, or a theater performance or conference presentation today, is a natural impulse that is part of human nature. As shown in this report, the ritual of assembling has bound societies together, enabled them to experience awe, and has given individuals a sense of being part of something bigger than themselves. This has enabled cooperation and spurred social progress.

When Joseph Haj, Artistic Director of the Guthrie Theater in Minneapolis, was asked to reflect on the current moment he said:

> *The very premise of theater is gathering people together in a shared space for a shared experience….As we move through this period of profound uncertainty I find it comforting to know that fundamentally our art form is the same that it ever was. We are storytellers. People gathered at the theater of Dionysus 2,500 years ago to hear stories that reflected their dreams, their loves, their fears and that is precisely what we do today. Given this centuries-old tradition of telling stories on stage, I would argue that theater is not some old-fashioned practice that has survived accidentally. Perhaps it has thrived because it is one of society's proven necessities.*[125]

Having temporarily lost the ability to assemble, we have urgently sought alternative ways to connect. Within a week of Italy's lockdown, videos of neighbors singing and dancing together from their respective balconies went viral—and the trend continued across countries. A few weeks later, people started assembling and marching for racial justice in the United States; soon people in countries across the world followed suit. "Amid the horrors of the COVID-19

epidemic," psychologists Greenberg and Gordon observe, "we are experiencing a global social psychological experiment that is giving insight into what lies at the core of our humanity." Lockdowns across the world highlighted humans' drive to connect with others to reduce the physiological and psychological stress of isolation.[126] How they bonded should no longer come as a surprise: through music and movement.

William McNeill, who devoted the later years of his career on this topic, unfortunately didn't live to witness this moment. He passed away in 2016. He showed that the muscular and rhythmic dimension of human nature has been a powerful tool in shaping social solidarity and spurring progress. In 1995, around the same time as the concept of sustainability science was born,[127] he remarked: "Opportunities for invention that will help to shape social solidarity in the future are wide open. Realizing that this is the case may even help guide invention along benign and sustainable paths."[128] Gestural, muscular communication bonds humans together into emotionally-connected groups, and this emotional connection is what, for millennia, has given meaning and purpose to the human experience. "Our contemporary disregard of this aspect of human sociality is unwise and probably also unsustainable over the long haul. Time will tell," he concludes. "In the meanwhile it is something to mull over, wonder about, and—for bolder spirits—to experiment with."[129] Twenty years of mulling over passed before a bold leader, Pavel Kabat, trusted me to experiment with this idea. It has yielded a new "formula" to help move the world by science: science + meaning + ethics + engagement = effective transmission of scientific insight to enable action. May bold leaders pick up this idea and run with it. May it empower many scientists and artists around the world to work together in the crucial decade ahead and fulfill their potential of guiding humanity into a sustainable future.


## ACKNOWLEDGMENTS

While writing this report during the spring and summer of 2020, the world was changing in profound ways. I am beyond grateful to Chantal Bilodeau who not only contributed as a playwright on various projects but also applied her writing gift to edit this report. As I was writing in Vienna, she kept editing in New York as if our collective future depended on it. And perhaps it does; time will tell. I would also like to thank external reviewers Verena Winiwarter from the Institute of Social Ecology Vienna (SEC) and Tsveta Andreva from the European Culture Foundation. My deep gratitude goes to Piotr Magnuszewski, Karl Sigmund, JoAnne Bayer, and Pavel Kabat for their support over the years and for reviewing the results of our work; and to Jan Marco Müller for managing the Science & Art project. The work documented here could not have succeeded without his steady support.

# ANNEX:
# CAST & CREDITS

## InDIGNITY

**Choreographed and performed by** Gloria Benedikt and Hussein Khaddour

## COURAGE

**Concept & direction:** Gloria Benedikt
**Dance:** Mimmo Miccolis and Gloria Benedikt
**Science:** JoAnne Bayer, Anneke Brand, Brian Fath, Fabian Heidegger, Nazli Koeseoglu, Julia Puaschunder, Vilma Sandström, Marcus Thomson
**Debate:** H.E. Tarja Halonen and Jonathan F. P. Rose
**Moderator:** Pavel Kabat
**Sound & Visual Editing:** Patrick Zadrobilek

## INDILEMMA

**Direction:** Gloria Benedikt
**Text:** Karl Sigmund
**Narration:** Narasimha Rao
**Choreography & performance:** Gloria Benedikt, Krisztian Gergye, Hannah Kickert, Mimmo Miccolis, Piotr Magnuszewski
**Game development:** Piotr Magnuszewski and the Centre for Systems Solutions Team: Michalina Kulakowska, Monika Madurska, Wladyslaw Zoloto, Aleksandra Solinska, Anna Koch
**Scientific committee:** JoAnne Bayer, Ulf Dieckman, Elena Rovenskaya,
**Lighting:** Mimmo Miccolis
**Sound & visual editing:** Patrick Zadrobilek

## FOUR DRIFTING SEASONS

**Composition & direction:** Merlijn Twaalfhoven
**Data translation & composition:** Kilian Elbers and Jan Driessen
**Data visualisation & video projection:** Jildert Viet
**App creation:** Marco Alkema
**Performers:** Every Voice Concert Choir, directed by Nicole Becker

## CONTEXTUAL MATTERS

**Concept & direction:** Gloria Benedikt
**Choreography:** Mimmo Miccolis and Gloria Benedikt
**Music:** Merlijn Twaalfhoven
**Text:** Brian Fath, Frank Sperling
**Narration:** Marcus Thomson
**Visual Design:** Mimmo Miccolis
**Performers:** Maya Belsitzman, *Cello*
Gloria Benedikt, *Dancer*
Revital Hachamoff, *Piano*
Gilad Hildesheim, *Violin*
Tali Kravitz, *Viola*
Mimmo Miccolis, *Dancer*
Alexander Osipenko, *Double Bass*
Merlijn Twaalfhoven, *Audience Engagement*
Cesare Zafini, *Violin*

## MIGRASPECTIVES

**Concept & direction:** Gloria Benedikt and Piotr Magnuszewski
**Artists:** Nour Barakeh, Gloria Benedikt, Krisztian Gergye, Hannah Kickert
**MC:** Piotr Magnuszewski
**Playwright:** Chantal Bilodeau
**Scientific advisors:** JoAnne Bayer, Wei Liu, Guillaume Marois
**Scientific actors:** Robert Burtscher, Katya Perez Guzman, Mateusz Iskrzynski, Katrin Kaltenegger, Wei Liu, Finn Laurien, Thomas Schinko, Marcus Thomson
**Facilitators:** Marzena Adamczuk, Frank Sperling, Barbara Willaarts
**Interactive audience engagement design:** Piotr Magnuszewski, Nour Barakeh, Gloria Benedikt, Krisztian Gergye, Hannah Kickert, Marta Magnuszewska
**Technical assistance:** Marta Magnuszewska

## DANCING WITH THE FUTURE

**Direction:** Gloria Benedikt
**Script:** Martin A Nowak
**Interactive Game Design:** Piotr Magnuszewski
Marta Magnuszewska & the Centre for Systems Solutions Team
**Choreography & Performance:** Gloria Benedikt, Hannah Kickert, Mimmo Miccolis, Henoch Spinola, Jessie J. Stinnett
**Narration:** Jeff Gerold
**Graphic Design:** Bartosz Naprawa, Babak Fotouhi
**Lighting Design:** Mimmo Miccolis
**Sound & visual editing:** Patrick Zadrobilek

## UNEARTHING

**Concept & direction:** Gloria Benedikt
**Interactive design:** Piotr Magnuszewski
**Playwright:** Chantal Bilodeau
**Choreography & performance:** Anita Barabás, Gloria Benedikt, Krisztián Gergye, Marietta Kro, Piotr Magnuszewski, Alexander Mays
**Narration:** Marcus Thomson, Cynthia Festin
**Scientific Advisor:** Wei Liu
**Visual editing:** Patrick Zadrobilek

# ENDNOTES

1 Wilson, (2014), 25
2 Wilson, (2017), 50, f
3 Homans, 5, f
4 Homans, 9
5 Homans,18, f
6 Wilson, (2014), 37, f
7 Wilson, (2014), 38
8 Wilson, (2014), 39
9 See e.g. D. Kahneman, (2011)
10 Wilson, (2014), 38
11 Wilson, (2014), 40
12 Wilson, (2014), 131
13 Definition of the concept of sustainability: meeting the needs of the present without compromising the ability of future generations to meet their needs, while at the same time sustaining diversity and functioning of Earth's environment
14 Wilson, (2014), 40
15 Wilson, (2014), 135
16 Haidt, 53
17 See e.g. Messner, D., Nakicenovic, N, COP23 Memorandum page 2, point 6
18 William Smith, A., 47
19 Homans, 6; Yates, 86
20 Homans, 7; McGowan, 43
21 Homans, 8
22 McGowan, 37
23 McNeill, 133, f; Homans 12
24 Homans, 19
25 McNeill, 133
26 Noverre, 138-9; Homans 73
27 Cassirer, 296
28 See e.g. Sigmund, (2017)
29 Homans, 309
30 Homans, 311, f
31 Homans, 310, f
32 Homans, 318, f
33 Homans, 361
34 Homans, 423
35 Homans, 463
36 Homans, 372
37 Buckle, 236
38 Benedikt, (2013)
39 Ma, 2013
40 Hicks, Xii
41 TedTalk, June 8, 2020 https://ed.ted.com/lessons/the-lost-art-of-democratic-debate-michael-sandel
42 Shome et al, (2009)
43 See e.g. Thompson et al, (1990)
44 IIASA-JRC-INGSA-GYA Evidence & Policy Summer School - Evaluation Report, 3, f (not published)
45 Hauser, Rand, et al, (2014)
46 Putterman, (2014)
47 Greene, 59
48 See e.g. Puchner, (2017)
49 Gottschall, 148
50 Gottschall, 103, f
51 Berman, M., (2003), Levit, N., (2011)
52 Levit, N., (2011)
53 Gottschall, 55
54 Gottschall, 67
55 Gottschall, 137
56 See e.g. Messner, D., Nakicenovic, N., COP23 Memorandum page 2, point 6
57 Krendl A., et al, (2006)
58 Jabbi et al, (2008); Gottschall, 62
59 Jabbi et al, (2008); Gottschall, 63
60 See e.g. Tolstoy: "The role of the artist is to convince the audience of his own ideas."
61 Gottschall, 66
62 Gottschall, 150
63 Murray, Brauer, 7
64 This text was first published on https://storiesforthefuture.org.
65 Wilson, (2017), 127
66 See e.g. Thompson et al, (1990)
67 See e.g. Verweij and Thompson, (2011)
68 See e.g. Zull, (2002)
69 Haidt, 106
70 Haidt, 53
71 Haidt, 59
72 See e.g. Gardiner, S. M., Hartzell-Nichols, L., (2012); Greene, J., (2014)
73 Markowitz, E., Corner, A., (2019)
74 Murrar, Brauer, 6
75 See e.g. McNeill, 75
76 Harvey et al., (2009)
77 Juhola et al., (2013)
78 Stefanska et al., (2011), Magnuszewski et al., (2018)
79 Krolikowska et al., (2007)
80 Mochizuki et al., (2018)
81 Solinska-Nowak et al., (2018)
82 Schelling, (1968)

83 Haidt, 264
84 Haidt, 264
85 McNeill,10
86 Haidt, 264
87 McGowan, 37
88 McNeill, 67
89 McNeill, 2
90 McNeill, 10 (see reflection of veteran Gray)
91 McNeill, 31
92 McNeill, 33
93 McNeill, (1995), chapter 3-5
94 Greenberg, Gordon, (2020)
95 Carter, (2014); Keeler et al, (2015); Schladt et al, (2017)
96 Yuuki et al, (2017)
97 The first World Climate Conference initiated by the WMO was held February 12-23, 1979 in Geneva, Switzerland.
98 Nowak, M. A., Highfield, R. (2011)
99 OPEC Secretary General Mohammed Barkindo said: "there is a growing mass mobilisation of world opinion… against oil… Civil society is being misled to believe oil is the cause of climate change." Mr. Barkindo complained of "unscientific" attacks on the oil industry by climate change campaigners, describing them as "perhaps the greatest threat to our industry going forward." www.independent.co.uk/environment/greta-thunberg-opec-climate-change-campaigners-oil-sector-mohammed-barkindo-a8990011.html
100 UK, Ireland, Canada, and France have all declared climate emergency. This can be considered progress but at the same time, the four countries combined still give an estimated $27.5 billion annually in support for coal, oil and gas. On November 28, 2019, the European Parliament declared climate emergency. www.climatechangenews.com/2019/06/24/four-countries-declared-climate-emergencies-give-billions-fossil-fuels/
As of December 12, 2019, 1252 jurisdictions have declared climate emergency. Populations covered by these jurisdictions amount to 798 million citizens. https://climateemergencydeclaration.org/climate-emergency-declarations-cover-15-million-citizens/
101 https://www.bloomberg.com/news/articles/2019-09-29/greta-effect-shakes-up-austrian-politics-in-signal-for-europe
102 Europe's Greens recorded their highest ever score in the European parliament, winning 69 seats compared to 51 in 2014. In Germany, Greens doubled their score and are second behind Angela Merkel's center-right CDU conservatives. Green parties also finished second in Finland, and third in France and Luxembourg. In Ireland, they won their first seats in 20 years. In Austria, the Green Party doubled its number of votes in the national election.
103 www.theguardian.com/environment/2019/nov/21/oxford-dictionaries-declares-climate-emergency-the-word-of-2019
104 https://ec.europa.eu/commission/presscorner/detail/en/IP_19_5542
105 E.g. "People are suffering. People are dying. Entire ecosystems are collapsing. We are at the beginning of a mass extinction." UN Climate Summit, New York, September 23, 2019 https://youtu.be/KAJsdgTPJpU
106 E.g. "What we do or don't do right now will affect my entire life and the lives of my children and grandchildren. What we do or don't do right now, me and my generation can't undo in the future." TEDx Stockholm, November 24,2018 https://youtu.be/EAmmUIEsN9A
107 Puchner, M., (2017)
108 See e.g. McNeill, 157
109 Chenoweth, E., Stephan, M., (2011)
110 Austrian World Summit, May 23, 2019 https://youtu.be/-uFO6p4lurw
111 Interview, June 29, 2019 https://youtu.be/9BNvj7VwIM8
112 See e.g. Messner, D., Nakicenovic, N., COP23 Memorandum page 2, point 6
113 Haidt, 53
114 Markowitz, E., Corner, A., (2019)
115 Thunberg, April 2019, speech at the British House of Parliament www.theguardian.com/environment/2019/apr/23/greta-thunberg-full-speech-to-mps-you-did-not-act-in-time
116 https://www.un.org/sg/en/content/sg/statement/2019-12-02/secretary-generals-remarks-opening-ceremony-of-un-climate-change-conference-cop25-delivered
117 See e.g. Nowak M.A., Highfield, R., (2011)
118 Greene, 23
119 Greene, 26
120 Kahan, Wittlin, et al., (2011), Greene, 93
121 Greene, 55
122 Greene, 102
123 See e.g. Puchner, (2017)
124 Greene, 185
125 Statement, May 7, 2020. https://youtu.be/eZ1b8XX0XZA
126 Greenberg, Gordon, (2020)
127 In 1996, a EU research project called *Ulysses*, with which IIASA partnered, started. https://www.jvds.nl/ulysses/eWP97-4.pdf
Its findings contributed to the first formal conception of sustainability science, published in 2001 by Kates, R.; Clark, W.; Corell, R.; Hall, J.; Jaeger, C. et al. "Sustainability science," in Science.
128 McNeill, 156
129 McNeill, 157

# BIBLIOGRAPHY

## BOOKS


Buckle, R. (1988). *Balanchine Ballet Master.* New York, NY: Random House.

Cassirer, E. (1951). *The Philosophy of the Enlightenment.* Princeton, NJ: Princeton University Press.

Chenowth, E. & Stephan, M. (2011). *Why Civil Resistance Works: The Strategic Logic of Nonviolent Conflict*. New York, NY: Columbia University Press.

Gottschall, J. (2012). *The storytelling animal: How stories make us human*. Boston, MA: Houghton Mifflin Harcourt.

Gardiner, S. M. (2011). *A perfect moral storm: The ethical tragedy of c limate change*. New York: Oxford University Press.

Greene, J. (2013). *Moral tribes: Emotion, reason, and the gap between us and them.* New York, NY: Penguin Press.

Haidt, J. (2012). *The righteous mind: Why good people are divided by politics and religion.* Pantheon/Random House.

Harvey, S., Liddell, A., McMahon, L. (2009). *Windmill 2009: NHS response to the financial storm.* London: King's Fund.

Hicks, D. (2013). *Dignity: Its Essential Role in Resolving Conflict.* New Haven, CT: Yale University Press.

Homans, J. (2010). *Apollo's Angels: A History of Ballet*. Granta Books/Random House.

Jørgensen, S., Fath, B., Nielsen, S., Pulselli, F., Fiscus, D., Bastianoni, S. (2015). *Flourishing Within Limits to Growth*. London: Routledge.

Lent, J. (2017). *The Patterning Instinct: A Cultural History of Humanity's Search for Meaning.* Amherst, NY: Prometheus Books.

Kahneman, D. (2011). *Thinking, fast and slow*. New York, NY: Farrar, Straus and Giroux.

Ladousse, G. P. (1987). *Role Play.* Oxford: Oxford University Press.

Mann, C. C. (2018). *The Wizard and the Prophet: Two groundbreaking scientists and their conflicting visions of the future of our planet.* London: Pan Macmillan.

McGowan, M. M. (1963). *L'art du Ballet de Cour en France, 1581-1643.* Paris: Éditions du Centre national de la recherche scientifique.

McNeill, W. (1995). *Keeping it Together in Time: Dance and Drill in Human History.* Cambridge, MA: Harvard University Press.

Noverre, J. G. (1966) *Letters in Dancing and Ballet*. Trans Cyril W. Beaumont from the Rev. and Enl. Ed published at St. Petersburg, 1803. Brooklyn, NY: Dance Horizons

Nowak, M. A. & Highfield, R. (2011). *Super-Cooperators: altruism, evolution and why we need each other to succeed*. New York, NY: Free Press.

Puchner, M. (2017). *The Written World*: *The Power of Stories to Shape People, History, Civilization.* New York, NY: Random House.

Rosen, M. (2012). *Dignity: Its History and Meaning*. Cambridge, MA: Harvard University Press.

Schelling, T. C. (1968). The life you save may be your own. In: Chase SB, Jr., editor. Problems in public expenditure analysis. Washington, DC: Brookings Institute. 127–176.

Sigmund, K. & Hofstadter, D. R. (2017). *Exact thinking in demented times: The Vienna Circle and the epic quest for the foundations of science*. New York, NY: Basic Books.

Thompson, M., Ellis R., and Wildavsky A. (1990). *Cultural theory.* Westview Press.

Verweij, M. & Thompson, M. (2011). *Clumsy Solutions for a Complex World: Governance, Politics and Plural Perceptions.* Basingstoke: Palgrave Macmillan.

William Smith, A. (1995). *Guglielmo Ebreo of Pesaro: "De Pratica Seu Arte Tripudii." On The Practice Or Art Of Dancing*, edited, translated, and introduced by Barbara Sparti, poems translated by Michael Sullivan. Oxford: Clarendon Press

Wilson, E. O. (2014). *The meaning of human existence*. New York: Liveright Publishing Corporation, a Division of W.W. Norton & Company.

Wilson, E. O. (2017). *The origins of creativity*. New York, NY: Liveright Publishing Corporation, a division of W.W. Norton & Company.

Yates, F. A. (1988). *The French Academies of the Sixteenth Century.* New York, NY: Routledge.

Zull, J. E. (2002). *The art of changing the brain: Enriching teaching by exploring the biology of learning*. Sterling. VA: Stylus Publishing

## PAPERS

Carter C. Sue. (2014). Oxytocin Pathways and the Evolution of Human Behavior. *Annual Review of Psychology*. 65:1, 17-39.

Fischhoff B. (2013). The sciences of science communication. *Proceedings of the National Academy of Sciences of the United States of America*, *110 Suppl 3*, 14033–14039.

Gardiner, S. M. & Hartzell-Nichols, L. (2012) Ethics and Global Climate Change. *Nature Education Knowledge* 3(10): 5.

Hauser, O. P., Rand, D. G., Peysakhovich, A., & Nowak, M. A. (2014). Cooperating with the future. *Nature*, *511*(7508), 220–223.

Jabbi, M., Bastiaansen, J. & Keysers, C. (2008). A common anterior insula representation of disgust observation, experience and imagination shows divergent functional connectivity pathways. *PloS one*, 3(8), e2939.

Juhola, S., Driscoll, P., Mendler de Suarez, J., Suarez, P. (2013). Social strategy games in communicating trade-offs between mitigation and adaptation in cities. *Urban Climate*, 4, 102-116.

Kahan, D., Wittlin, M., Peters, E., Slovic, P., Ouellette, L. L., Braman, D. & Mandel, G. N. (2011). The Tragedy of the Risk-Perception Commons: Culture Conflict, Rationality Conflict, and Climate Change. *Temple University Legal Studies Research Paper*.

Kates, R.; Clark, W.; Corell, R.; Hall, J.; Jaeger, C.; et al. (2001). "Sustainability science". *Science*, 292 (5517): 641–642.

Keeler, J. R., Roth, E. A., Neuser, B. L., Spitsbergen, J. M., Waters, D. J. & Vianney, J. M. (2015). The neurochemistry and social flow of singing: bonding and oxytocin. *Frontiers in human neuroscience*, *9*, 518.

Krendl, A. C., Macrae, C. N., Kelley, W. M., Fugelsang, J. A. & Heatherton, T. F. (2006). The good, the bad, and the ugly: an fMRI investigation of the functional anatomic correlates of stigma. *Social neuroscience*, *1*(1), 5–15.

Krolikowska, K., Kronenberg, J., Maliszewska, K., Sendzimir, J., Magnuszewski, P., Dunajski, A. & Slodka, A. (2007). Role-Playing Simulation as an educational tool for sustainable development - Karkonosze Mountains case study. *Simulation and Gaming.* 38 (2): 195-210.

Levit, N. (2011). Reshaping the Narrative Debate*. Seattle University Law Review,* Vol. 34.

Magnuszewski, P., Królikowska, K., Koch, A., Pająk, M., Allen, C., Chraibi, V., ... & Pan, D. (2018). Exploring the role of relational practices in water governance using a game-based approach. *Water*, *10*(3), 346.

Mochizuki, J., Magnuszewski, P. & Linnerooth-Bayer, J. (2018). Games for aiding stakeholder deliberation on Nexus policy issues. In *Managing Water, Soil and Waste Resources to Achieve Sustainable Development Goals* (pp. 93-124). Springer, Cham.

Murrar, S. & Brauer, M. (2019). Overcoming Resistance to Change: Using Narratives to Create More Positive Intergroup Attitudes. *Current Directions in Psychological Science*, 28(2), 164–169.

Ooishi Y., Mukai H., Watanabe K., Kawato S., Kashino, M. (2017). Increase in salivary

oxytocin and decrease in salivary cortisol after listening to relaxing slow-tempo and exciting fast-tempo music. *PLoS ONE* 12(12): e0189075.

Putterman, L. A caring majority secures the future. (2014). *Nature,* 511, 165–166.
Schladt, T. D., Nordmann, G. C., Emilius, R., Kudielka, B. M., Jong, T. R. & Neumann, I. D. (2017). Choir versus Solo Singing: Effects on Mood, and Salivary Oxytocin and Cortisol Concentrations. *Frontiers in Human Neuroscience, 11*.

Solinska-Nowak, A., Magnuszewski, P., Curl, M., French, A., Keating, A., Mochizuki, J. ... & Jarzabek, L. (2018). An overview of serious games for disaster risk management–Prospects and limitations for informing actions to arrest increasing risk. *International journal of disaster risk reduction*, *31*, 1013-1029.

Stefanska, J., Magnuszewski P. , Sendzimir J., Romaniuk P., Taillieu T., Dubel A., Flachner Z., Balogh P. (2011). A Gaming Exercise to Explore Problem-Solving versus Relational Activities for River Floodplain Management. *Environmental Policy and Governance* 21 (6): 454-471.

## OTHER

Benedikt, G. (2013) The Capitalist Sublime - Embodied through Movement. The Culture of Capitalism: Term Paper. Harvard University.

Bergman, M. (05/2003) A Few Words on Story-telling. Humanizing Language Teaching Mag.

Greenberg D. M., Gordon, I. (1.5. 2020) Lockdown Singing: The science behind why music helps us connect in isolation. The Conversation.

Ma, Yo-Yo. (08.04.2013). Art for Life's Sake: A Roadmap from One Citizen Musician. Nancy Hanks Lecture. Kennedy Center: Washington, DC.

Markowitz, E., Corner, A. (29.09.2019) Climate Change is really about prosperity, peace, public health and posterity, not saving the environment. The Conversation.

Messner, D., Nakicenovic, N. (11/2017). The Climate – Justice – Cooperation Nexus: 10 Cornerstones of the Great Transformation towards Sustainability. COP 23: Memorandum.

Shome, D., Marx, Sabine, Appelt, K., Arora, Poonam, et al. (2009). The psychology of climate change communication: A guide for scientists, journalists, educators, political aides, and the interested public. Center for Environmental Decision Making. Earth Institute, Columbia University.