AFTERWORD

FRICTION GAINS IN ART AND SCIENCE COLLABORATION: MORE THAN NOISE

by Claudia A. Schnugg

Introducing art and science collaboration to new audiences can raise some eyebrows. First, why would a person want to do this? Second, art and science are vast terms, so this could involve anything. What does it involve and how might the outcome be interesting? In other words, *is all of this work (with no definable outcomes to speak of) just all noise?* Are all of these experiences, semi-structured inspirations, and outcomes (in-between the fields of art and science) more than noise that we should bother with? In this chapter, we will explore these questions in terms of 1) the overall concept of art and science collaboration, 2) from the perspective of the actors in the process, and 3) with a final view on the outcome.

To mingle and to make noise

This book's beauty is that it brings together the most recent series of Biofaction artist-in-residence initiatives. These four artists were provided with the opportunity to work within a selection of scientific projects in synthetic biology, thereby demonstrating the diversity of scientific work even within the discipline of science. Molecular biologists, geneticists, chemists, and other disciplines came together to work on projects in synthetic biology. In so doing, each group of scientists had the opportunity to seize upon a valuable and even impactful collaboration with an artist. Conversely, we see huge diversity in the collaborating artists' artform and artistic practices that were brought to the collaboration: musical composition, sculpture, photography, film, and visual arts employing various media. Breaking down the boundaries of disciplines and inviting joint exploration, research, and production between the arts and sciences has been realized as a rich experience

in many constellations of artists and scientists. To that end, any art and any science can be involved – including engineering and technology. Thus, art and science collaboration can be understood through a more general term or method such as 'transdisciplinary'. Traditionally understood as 'transdisciplinary', because art goes beyond academia, thereby fusing these diverse forms of knowledge, but also opening the potential to connect to audiences. In collaborations in which artists and scientists investigate together, the arts can also be understood as another discipline, a field of knowledge production with its own set of methods. Thus, the term 'interdisciplinary' is also sometimes used in this context.

Bringing art into the mix is about more than adding another scientific/academic discipline; it also involves more than just adding an expressive craft to the execution of ideas. Artists can look at complex issues from the perspective of their strong artistic research processes. They also relate to a diversity of forms of knowledge in their artistic research process through which they add complex contexts that other disciplines traditionally are not in the habit of including. Moreover, the arts' strong foundation in aesthetics, aesthetic investigation, aesthetic understanding of processes, and aesthetic expression are precious contributions to collaborative processes, insights, and outcomes.

Friction gains

I will first introduce some general thoughts, and then link some of these to the examples of the four art-science pairings as presented in this book in order to explore why engaging in such a complex thing as bringing together art and science, and investing time in the process of artists and scientists working together, is worthwhile.

Stories of mingling art and science are also stories of frictions. Friction is something that frequently rings alarm bells for engineers and managers. As a technical term, friction in engineering can pose challenges to the constructions or can affect either a machine's materials or moving parts. Friction in economic terms can be interpreted as extra time, energy, and money needed, which often boils down to additional costs.

What is the merit, then, in speaking positively about friction in stories of art and science collaboration? Friction can, for example, arise when an artist and a scientist come together and have completely different ideas about what an interesting research question would be; friction can emerge from

problems in communication, the artist meaning one thing, the scientist understanding something different; or friction can be caused by additional obstacles in an organization such as special permissions and bureaucratic requests, changing routines, or adjusting to another person's habits. Moreover, friction implies additional learning processes or skills needed, or changing pre-determined routes into something that connects more deeply with the given environment, or even critically challenging one's own perspectives or assumptions on the basis of the engagement with the artistic or scientific counterpart. Situations like these point to what is needed in such collaborations, in addition to enthusiasm, imagination, dedication to a subject matter, and some ideas: the willingness and freedom to invest time and resources and the ability to be unafraid of being misunderstood or of not having all of the answers.

When working together, such frictions can become challenges that can be overcome and can provide rich potential to either learn or to push boundaries. Embracing frictions with a positive attitude, curiosity of the collaborating partner's ideas, and respectful conversation help to engage in understanding the reasons for the friction. This leads to learnings, adds a better understanding of other people's or disciplines' perspectives, and thus can also leverage the joint project. In so doing, friction is turned into something that I like to call *friction gains*. Such friction gains offer plenty of opportunities to learn and take advantage of and they introduce opportunities for creativity and increase the likelihood that innovative approaches or ideas will be generated. Understanding friction gains also implies looking at what happens along the way during such a collaboration, what the intense conversations are, what is needed to get to know and to understand each other, and to make the effort to make space for something new to emerge. Friction also certainly implies that there is the potential for challenges that need to be overcome, misunderstandings that lead to disruption, or additional efforts that need to be made; however, investing time and the energy in dealing with friction, using it, and learning from it provides rich and fruitful opportunities. Thus, it is possible to encounter friction and work with it in a constructive way.

The actor and the process

In order to grasp this idea more easily it is helpful to see the art and science collaboration as a *process* that unfolds between individuals from different backgrounds, thereby seeing these individuals as *actors* who can learn from, and are subject to, social dynamics and who are embedded in cultural environments. For example, engaging with art and science addresses different skills needed for professionals in any of these aforementioned domains (Root-Bernstein et al., 2012) and, thus, helps these practitioners to train these skills in diverse settings or even to acquire new skills. Moreover, misunderstandings (Hauser, 2021) in the process between artists and scientists can provide valuable lessons. For example, artists and scientists need to elaborate on what they mean and this means in turn that they need to both talk their arguments through and present their perspectives in order to better understand each other and to understand where possible friction in their conversation might emerge. Moreover, different disciplinary jargons, which they use in their disciplinary work, can give rise to problems in communication across disciplines. Lastly, ideas that the artist discusses might excite the scientist, but possibly due to a misunderstanding or in terms of an aspect that the artist did not put at the forefront of their idea. The reason for this might be found in the language they are used to using, or in the professional cultural context that they are referring to – the scientific context proposes an altogether different framework than the artistic one. In such cases, when these misunderstandings are openly addressed as friction in their communication, they become valuable sources of insights. Both collaborating partners need to be aware of such friction and must engage to avoid this potential. In cases in which such misunderstandings are dismissed as noise, the situation can become frustrating for both parties: opportunities are missed and lessons delayed – or occur only for those who reflect on the misunderstanding.

Stories of friction in art and science collaboration can also include new lessons through changing ways of work processes that help individuals to learn and to reflect, and many more. Such a collaborative process can be intense, irritating, unexpected as artists and scientists often challenge each other in a different way than project partners from the same field or discipline might – or even could. Nevertheless, the frictions, that can lead to discussions, to explorations of new media, new experiments, new perspectives, or even adding unplanned work to the project partners, are more than just 'noise' – as frictions can be the root of noise – , but they also heighten the

probability to distill new insights, lessons, and to explore the potentials that open up after boundaries have been pushed.

In that sense, it is possible to identify such friction gains by drawing from the comprehensive knowledge and theories found in fields as diverse as psychology, social psychology, sociology, pedagogy, social network theory, and cultural studies by looking at the actors and at their processes. For example, communication theories offer a lot of insights into why engaging art and science collaboration, and overcoming issues in communication, can be impactful (Schnugg, 2019). Taking insights further, it is possible to employ strategies that are also used in organization studies and to use these insights to make strong arguments for why organizations or funders might engage in this process (Schnugg & Song, 2020). A broader body of work is emerging that elaborates on this approach, adding more theoretical insights. For example, the potential knowledge production in art and science collaborations can be linked to learning theories (Kuchner, 2022) that elaborate upon the psychological processes of a challenging interaction that demands that project partners think in new ways and engage with new work processes and skills. Qualitative case studies aim to demonstrate how the interaction of artists and scientists push the boundaries of scientific disciplines, help to envision new scientific approaches, and establish mission-driven relationships with stakeholders (Jung et al., 2022). Other approaches aim at substantiating insights from theories for questionnaires, in order to evaluate art and science collaboration programs along the lines of potential impact on individuals, participants, and on the audience (Lau et al., 2022). These endeavors attempt to show the value for all participants and contribute to an environment in which artists and scientists can collaborate on a level playing field. In the remainder of this chapter, I will use a selection of social, psychological, organizational, and cultural theories that have previously been used to describe the impact of art and science collaborations to illuminate some valuable aspects of the processes of the four artistic residencies presented in this book.

I was curious to see how the four artists-in-residence selected would be able to dive into such an intense collaboration with their hosting scientific partners in a time at which COVID-19 restrictions challenged the process, e.g., by complicating travel and by limiting in-person meetings as well as access to laboratories for external partners. There is much to say about each of them, but we will have a look at their processes by singling out a few prominent aspects of their work in the following section.

As a composer with an additional background as computer programmer, Eduardo Reck Miranda's work was the perfect fit to engage with the SinFonia project at Prof. Pablo Iván Nikel's laboratory. The artwork that the artist realized, as well as the way in which he and the scientific team at the lab reflected on the process, shows that the high expectations that the matchmakers had were surely met. In his contribution about the residency, Eduardo Reck Miranda elaborates upon his creative process during the art and science collaboration along the lines of Nietzsche's idea of the dichotomy between the Apollonian and Dionysian that is found within the artist. In this concept, 'Apollonian' can be understood as the rational and structured approach, whereas 'Dionysian' stands for the irrational, passionate, and intuition-led approach. Eduardo Reck Miranda not only shows his personal battle between the inner need to organize versus the need to go wild, imagine, or explore along aesthetic[1] preferences, but he also elaborates on the challenges encountered during the process. Art and science collaborations are often advertised as being a cradle of creativity, both for the artists and for the scientists involved. Of course, an artist might be associated more with the Dionysian aspect by some people, whereas the scientist might be ascribed more Apollonian traits. In fact, both sides meet in each profession in order to lead to creative processes, even though the Dionysian and the Apollonian side might manifest differently in artists and in scientists. When they meet along the lines of a shared interest, such a collaborative process can challenge and truly inspire both, given time and willingness to engage with recurring open questions, irritations, and frictions. Leaving philosophy behind, looking at more recent psychological, social, or organizational theories of creativity, such as those by Teresa Amabile (1996) or by Richard Woodman et al. (1993), it is easy to demonstrate that such a process is charged with numerous triggers to heighten creativity, e.g., by giving the actors situations, new connections, questions, skills, or resources at hand to act and to think differently.

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[1] "Aesthetic" here refers to the "judgment of taste", as for example elaborated by Immanuel Kant in his *Critique of Judgement*, which is not limited to visual impressions, but can relate to any art form or medium and can, thus, also be applied to sound. In order to better understand "aesthetics" that refers to diverse sensory stimuli – not only the visual – we might examine the approach based on the work of German philosopher Alexander Baumgarten, which draws upon the human senses and is applied to various art forms, including e.g., visual arts, performative arts, and poetry.

How the experience with the artist pushes creativity and diversity in the laboratory is also nicely expressed throughout the chapter by the scientists who collaborated with Eduardo Reck Miranda. This kind of open and reflective engagement helps, on a personal level, to gain new insights and to broaden one's horizons, which is something that the scientists state. This can have a lasting impact on the ways in which they approach their work in the future, or insights that might be influential in shaping future projects – even in case no specific ideas they discussed with the artist are planned to be taken any further.

Visual artist Isabelle Andriessen, whose artistic practice revolves around the creation of 'performative' sculptures, was invited to work in Prof. Lee Cronin's lab as part of the Madonna project. Her application stood out due to her artistic practice of having worked with inorganic materials, integrating them in sculptures and installations that seemingly come to life. The aesthetics of her work are driven by chemical processes as well as by a delicate balance of (apparently) non-living materials that expose processes that evoke lifelike impressions. Her work taps into chemistry while proposing developments without human intervention, which is why her work seems to have been fated to benefit from the experience at the Cronin Lab. In contrast to these expectations, Isabelle Andriessen was able to go further in her artistic work than simply integrating the knowledge provided in the laboratory into her artistic production. A delayed, short residency amidst lockdowns and video meetings neither provided the time or opportunity to dive deep into the nitty-gritty details of the scientific work during ongoing discussions with the scientists on-site, nor did it leave much space for hands-on work in the laboratory. Nevertheless, the deep dive into the subject matter in the time leading up to the residency, and the residency experience on-site thereafter, provided her with the opportunity to juxtapose the scientific knowledge researched in the lab and the media that the artist employed in her artistic installations. Starting with Prof. Lee Cronin's vision of chemistry computers and robots becoming the chemists of the future, Isabelle Andriessen developed a future vision of such a space: What does it look like? How does it feel? Who is operating it and how? This visual thought experiment is visually pleasing, but at the same time it enters into a challenging discussion with the scientist's vision. Engaging in this discussion, embracing the friction and potential for reflection, can reveal new insights that help to connect to stakeholders, audiences, and cultural values that can improve scientific and philosophical arguments around the ideas pursued by the scientists.

In both art and science processes it is not only theoretical insights, but also on-site experiences that can help the actors to step away from their traditional path and structures in order to see their own work – and their collaborative partners' work – from a truly different perspective.[2] Using an aesthetic and experiential approach supports such a learning process and this makes the collaboration of art with science especially valuable.[3] This helps to leverage existing practices onto a new path or to gain a meta understanding that helps us to connect to broader contexts. Even the medium chosen by the artist speaks to the necessity to abandon disciplinary hangups and, in this case, the artist employed film to tell a story, thereby stretching the boundaries of her established work. It will be interesting to see how reflections and insights from this process will become visible in Isabelle Andriessen's future work and how it might provide a challenging point of discussion for scientists.

Artist and filmmaker Karel Doing teamed up with Prof. Julian Ma's lab to explore their work within the Newcotiana project. Arriving at the laboratory, the artist had already developed a technique to work with plants in photography. Working in the laboratory, he was meandering between exploring his artistic practice among the plants with which the scientists were working, the scientists' tools, apparatuses, and physical environments including gestures, and the social and cultural environment in which the scientists operated. Karel Doing's process revolved around ideas of social and cultural constructs of understanding what we see: plants, scientific data, gestures, symbols, and materials. Such reflections are also necessary within scientific settings as they create an awareness of human agency and of the scientific process's human dimension. Although it has been a long time since Science and Technology Studies and philosophers of science have been able to create an awareness of the social embeddedness of scientific work,[4] mirroring

[2] Much of the arguments for STEAM in education draw upon such insights, often going back to specific studies and to the seminal writings by Dewey (1934), Cassirer (1944), and Berger (1972).

[3] This has also been shown explicitly in the case of cosmologist Marcos Pellejero-Ibanez, who found a different perspective on his data through engaging with music and drawing parallels between sound, the physics of sound, his data and his own sensemaking of the information, see Schnugg (2019).

[4] Seminal works following Thomas Kuhn's *The Structure of Scientific Revolution*, but also prominently represented in the work of Bruno Latour and Donna Haraway.

practices and the reflection on cultural and social integration opens up scientists' minds within their everyday practice. Additionally, the scientific work – its content, object of research, or symbols used, traditions drawn from – can be reflected upon through artistic approaches. For example, artists often aim to contextualize their work, as well as the subject with which they work, within historical trajectories, social assumptions (is the tobacco plant the root of evil tobacco, or a generous plant that might be the source of remedies?), and mental constructs that education and living in a society entail. Just as Karel Doing concludes his chapter with the question of 'does everything have to be *either-or*, or can we find an *and-and* mentality including awareness of contexts and measure?', an awareness of these issues and of these questions is needed to reflect upon scientific processes and outcomes.

Visual artist and medical doctor Lara Tabet was invited to work in Prof. Víctor de Lorenzo's lab within the Madonna project. Looking at her process in the lab demonstrates how this temporary connection between a scientific group and an artist can work out as a liminal space. Liminality is a concept that has been developed in anthropology by Arnold van Gennep ([1909]1960) and Victor Turner (1966) who coined the term and elaborated upon it by linking it to their observations while working in the field with indigenous communities. It is a process that is linked to finding oneself at a threshold in a phase at which structures and previous knowledge become fluid before a change can happen. This can involve a change of status, such as the transition from childhood to manhood in indigenous communities, but it can also be understood as a time of transition at which a person starts a new position, or is allowed to realize a project in an organization that is not linked to the usual structures and demands, much like when a scientist is allowed to spend some time exploring new ideas while working with an artist instead of focusing on the next scientific journal publication. Artist-in-residence projects have been shown to support such liminal spaces for scientists or for the host institution's other collaborating partners (Schnugg, 2018). Lara Tabet's process is a wonderful example that provides insights into the liminal space that is also created for the artist-in-residence. As an artist, she has been working with a variety of visual media, developing a strong aesthetic in her work. Prior to the residency, she was engaged in exploring certain philosophical theories. She put all of this together in a proposal that was selected for the residency. When she arrived at the lab, these structures and ideas became fluid because she learned more about the processes, the science, and about the project's specificities and the laboratory. Thus, her thoughts evolved and took some turns so that two new strong artistic outcomes could emerge.

Conversely, Prof. Víctor de Lorenzo reflects on the process with the artist-in-residence by elaborating on the new perspectives and provocative questions that arose in the discussion with the artist. These discussions, and the artistic outcomes envisioned, inspired new experiments in the laboratory, e.g., new ways of dealing with their own materials and thought experiments around their scientific work that included human, cultural, and environmental contexts; this confronted the scientists with questions that they had not been confronted with previously. Some of these questions could also constitute interesting scientific projects and might, perhaps, even have paved the way for future projects that have been planted.

The outcome and its relevance

Engaging in a process traditionally implies some sort of outcome. In project-oriented work, both art and science often operate on a project-by-project basis and writing funding applications also implies envisioning an outcome. The collaboration between artists and scientists can, thus, yield artistic outcomes, hybrid art-science outcomes, and scientific outcomes. Some questions about such outcomes, at the fringes of disciplines, arise therefore: Can there be outcomes that have a valuable impact within the respective discipline? Is the outcome interesting? Is anyone interested in the outcome?

Outcomes in art and science collaboration processes can originate from unforeseen frictions along the way, they can be planned before the start of the collaboration – such as public engagement or the goal of developing the envisioned artwork – , or they can manifest after the collaboration has ended. Lessons and friction gains are not usually considered as outcomes,[5] even though they are meaningful and contain valuable results from the collaboration process. They are rather considered as impact. Nevertheless, friction gains that are harnessed throughout the collaboration process inform the envisioned outcomes and elevate them to becoming stronger works: more innovative, more insightful outcomes are generated with greater depth. Artists, scientists, and curators regularly state that outcomes are

[5] There are only a few art and science programs that focus on the lessons and friction gains instead of artworks, scientific or other innovative outcomes. The Mission Art-Space Exchange Artistic Research Residency at the European Space Agency ESTEC is a noteworthy exception.

richest in art and science projects that also allow for additional exploration and for unexpected outcomes (in contrast to the realization of previously planned outcomes), as argued in Jung et al. (2022), Wilson, Hawkins, and Sims (2015), and Schnugg (2019). Artworks, scientific insights, new research questions, and hybrid art-science manifestations of the collaborative process are all typically understood as outcomes. The stronger these works are, the more relevance they will have in their respective fields of art and science; they will also be more impactful in the conversation between the fields and for engaging with audiences. In the remainder of this chapter, we will briefly look back at the four cases and will reflect on some of their outcomes.

Reflecting on the artwork, and upon the possibly related public engagement, scientists and artists often team up because these are issues that are dear to them and are central to the work that they want to critically discuss with the public. Víctor de Lorenzo and his team discuss how they want to address certain global challenges with their work, and Lara Tabet also aims at a critical and open reflection about the implications of synthetic biologists' work. Through open discussion, and sometimes colliding views between artists and scientists, an awareness among them in their collaboration process is created, and this new awareness and their intentions can feed into processes that engage with public audiences. By tapping into art in particular, it is possible to go beyond transmitting content to an audience, but to also connect this content to the cultural, social, and even political dimensions in which it needs to be discussed. It is important to note that this kind of artistic work is not considered as just another kind of science communication, but can involve engaging with the artwork and learning about it which helps to connect to the science with which the artwork deals. Aspects of working with art, such as storytelling, experiences with the artwork, aesthetics, contextualization of the artwork within cultural, societal, and political issues, tapping into multiple ways of knowing, and connecting to the audience in a personal manner all support this process.

Karel Doing's artistic work plays on symbols, gestures, and historical contexts that are also important in terms of how societies might interpret both science and scientific endeavors. Scientists engaging in such reflections can become aware of routines, habits, and the additional cultural or societal meaning of their processes. Isabelle Andriessen's work goes beyond cultural and social contextualization, but thinks scientific ideas consequently to the end, thereby mirroring this back to herself in the artworld, science, technology, and society. Deeply researched work, such as this, is also relevant in the artistic discourse on knowledge production, societal and cultural values, or

political questions. Such work is gaining growing interest in the contemporary art discourse, especially in the growing discussion about plurality of knowledge, around more-than-human connections (Haraway, 2016), and in the wake of global challenges.

Though art-science work often has this inherent drive of critical discussion, relevant artworks in the context of the contemporary art world are becoming more frequent – and art and science work are becoming recognized in terms of their aesthetic and thematic contribution, as even the most recent Biennale di Venezia 2022, curated by Cecilia Alemani and national participations, show. Artists working in art and science are no longer just working at the fringes of the artworld, but are increasingly becoming part of new developments in their field. Thus, art and science works are also making noise within the art domain, thereby adding to critical reflections about what art is in this ever-changing world that is confronted with global challenges and with rapid developments in both science and technology.

As frictions often come from the meeting of different perspectives, different background knowledge, and different languages, the interaction between art and science professionals from different backgrounds is also characterized by translation: translation processes between the arts and the science, translation processes between experts (artist, scientist) and non-experts (non-artist, non-scientist), but also a translation process of knowledge to different forms of expression: music, (micro-)performance, visuals, and sculptures. These translations play a role within the process – and contribute to friction gains – and they become experienceable for an audience in the outcome through aesthetic expression. The artwork – the outcome – of Eduardo Reck Miranda translated the work of Dr. Pablo Iván Nikel and his group into music, thereby creating a translation of enzymes into sound, something the scientists have not experienced before. As they say, they are used to seeing them as structures and models – which are also aesthetic translations from the actual enzyme into something that can depict it visually or in code – , but they do not usually hear them. Perhaps this new kind of translation and experience will initiate another process between the artist and the scientists or it might bring new insights and future outcomes individually to the fore, on condition that they follow this direction.

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