PREFACE: THE RISE OF ART-SCIENCE

Seeking to understand the categories of art and science as labels with specific powers to order social worlds allows us to recognize the similarities and overlapping practices of these knowledge communities. There are many contexts in which this switch might be a fruitful approach to considering the constructed nature of knowledge systems. What happens when we encounter the word "art" in daily life or scholarship and replace it with "science" in our minds? In these quotes from Howard Becker's *Art Worlds* (1982), the word art has been replaced with science (my italics): "*Science* worlds consist of all the people whose activities are necessary to the production of the characteristic works which that world, and perhaps others as well, define as *science*" (34). The principle Becker puts forward here is immediately recognizable to science and technology studies (STS) scholars as ideas they apply when thinking about science as it is defined by its actors and their work, rather than an external philosophy of science. Continuing in this vein, Becker's remarks about art resemble STS ideas about science in relation to the subject of state control: "Like other participants in the making of *science* works, the state and its agents act in pursuit of their own interests, which may or may not coincide with those of the *scientists* making the works . . . the state pursues these interests both by supporting what it approves and by discouraging or forbidding what it disapproves . . . by intervening in the production of *science* it considers

inimical to its interest" (165–167). This suggests that there may be many works that have been written with art in mind that might inspire the STS scholar to look for similar patterns in science.

Related discoveries may ensue from examining STS work's potential applications in art. Here, *science* is replaced with "art" [my italics] throughout the following quotes from Thomas Kuhn's foundational *The Structure of Scientific Revolutions* (1962): "That element of arbitrariness does not, however, indicate that any *artistic* community could practice its trade without some set of received beliefs" (4). Many of Kuhn's ideas function well in describing assumptions in art. They are also helpful in considering the transition between art movements: "The successive transition from one paradigm to another via revolution is the usual developmental pattern of mature *art"* (12) and "Men whose research is based on shared paradigms are committed to the same rules and standards for *artistic* practice" (11). Transposing art and science and vice versa reveals that many ideas developed to consider art might be recognizable in STS as applying to science or may usefully extend our understanding of science . This is not to suggest that art and science are interchangeable or identical but rather to suggest that if STS seeks to understand the character of knowledge production, we should be eager to seek out similarities as well as differences. Particularly given the extent to which STS has pointed out differences among sciences, we should be equally eager to see the differences and similarities across the sciences and the arts, which are themselves philosophically and practically diverse. We should also be interested in all the actors involved in these knowledge networks, which may include some people, objects, and ideas that are usually associated with the other network. Analysists of both art and science have faced this definitional inclusion problem.

To be this point, Becker grappled with the problem of who makes up the art world, the same problem encountered by STS scholars considering who to include as part of the scientific enterprise. Likewise, Becker's second quote is familiar to STS scholars, who have learned to think of marginalized science not as a failure of a truth claim but rather as an issue of social marginalization (Collins and Pinch 1998). Indeed, Becker's concept of "worlds" was employed in relation to the sciences by scholars such as Elihu Gerson (1983), Adele Clarke (1998), Susan Leigh Star (1995),

Geoffrey Bowker and Susan Leigh Star (1999), and Joan Fujimura (1996). Becker's art worlds are networks in which materials and people associated with art objects circulate. Galleries, studios, and museums are populated by multitudes of artists, curators, critics, patrons, and art-going members of the public who encounter materials and rhetoric. They collectively engage in labeling things as art and nonart to varied effects.

Similarly, many statements that STS scholars have made might well apply to art communities and practices of knowing. Kuhn's explanation of scientific "progress" through paradigm shifts can be applied to art, where periods of sustained and aesthetically similar art-making inside and among various schools and sub-disciplines are interrupted by sometimes extreme changes in form and content. This linguistic reversal offers a role reversal that reveals the thicket of indeterminacy from which the social power of categories makes order. A comparison of Kuhn and Becker's studies of their respective knowledge communities reveals that it is social processes, not universal attributes, that divide art and science.

STS has shown that the idea that scientists work with things, while artists work with representations, is not accurate: scientists spend their time working on representations too. Both scientists and artists are often engaged with representative means: they tell us something using something else. Often this takes the form of a narrative in which language is replaced with things to make an argument that is legitimized by material instantiation. As STS scholars, we might do well to think about why those arguments are effective for putting forward an agenda that separates the categories of art and science or that holds the two together. Both are constructions that require effort to maintain. In her plenary address to the Society for Literature Science and the Arts in 2011, philosopher Isabelle Stengers described the pressure on the "non-rational" world from the "rational" world as continuing to grow. She proposed that modernity has become associated with various forms of scientific rationality. Stengers distinguished between various scientific subjects and suggested that in the current way of categorizing knowledge, the non-rational is relegated to a non-civilized status. Because science is a constructive enterprise, a highly contingent system that does not simply discover preexisting truths but, through specific practices and processes, helps shape them, the non-rational is seen as inefficient and irrelevant, instead of

offering values that in times past would have signaled taste and sensibility. Stengers was particularly concerned that an embrace of the "rational" may signal the invalidation of other discourses.

Science communities have held that to participate in proceedings and discussions, a participant must use the community's standards, thus rendering moot any attempt by artists (or other outsiders) to comment from a non-science perspective. This could be said for those wishing to contribute to artist communities too. By taking up the materials and subjects of scientists, many artists have been able to cloak their work in the signs of science and participate in or comment on the community in ways that look much like science that has already been deemed legitimate. On closer examination, scientists themselves or the public may reject these claims, but a surface of signs creates a temporary opening for non-scientists to discuss science-related subjects.

Because of art's resistance to science's attempts to subsume and colonize other forms of knowledge, art has special value to STS as an exemplar, an area full of objects and practices for examination, and a new set of methods. Art is proving the basis for a new subdiscipline called Art, Science, and Technology Studies, complete with new kinds of STS practitioners. These include curators and facilitators, who use a distinct methodology drawn from the STS canon and share many of the same philosophical principles and tradition of critical inquiry but with substantially different material practices and ways of reaching beyond the academy into a plurality of publics. ASTS methodology and conceptual toolkit enable a way of knowing science and art that should be recognized by STS and developed as another way to examine knowledge-making practices.

Art's refusal to accept science's hegemony makes it a worthy object of study. Early science studies took aim at physics because of its powerful standing in the social world. This standing was partly based on the idea that laboratory practice was the heart of science and that it was a particularly "rational" theoretical and experimental practice. STS tools have been employed to examine the production and standing of non-science knowledge and the same tools that have been used to explore conceptions of rationality has been and continues to be employed in the study of that supposed bastion of the non-rational: art. The subjective could return as a viable site of knowing, given the correct social conditions.

In contributing to and exploring what science is, without an attempt to situate their work as the only potential viewpoint, these artists have the capacity to introduce the public to the subjectivity of science issues in a productive way.

It is often suggested that in the past thirty or so years, a distinct set of social relations and practices have emerged at the intersection of the worlds of art and science. This expansion of work considered to be at the intersection of these two knowledge areas gives occasional reflection on the categories of art and science and their longer histories. As even a cursory read of media coverage, museum documentation, and the web pages of interdisciplinary university programs shows, there is rising interest in the phenomenon of art-science, which takes several forms. Some art-science projects are intended to engage the broader public on pressing issues from science and public policy perspectives. Exhibits of art-science are proliferating, especially around such themes as genetics, biotechnology, and climate change.[1] Other art-science ventures focus on bringing disparate groups of experts together. Such efforts have attracted prestigious institutional support, including from the National Science Foundation (grants for Exploring Science in the Studio), the Swiss international exchange program Artists-in-Labs, and The University of California, Los Angeles Art/Sci Center. Still other artist-run initiatives operate as art-science collectives, often embedded in existing institutions, such as the University of Buffalo's Coalesce: Center for Biological Arts and the University of Western Australia's SymbioticA, both of which have complete biological laboratory facilities. Also increasingly prevalent are public participation/citizen science communities centered on community spaces for digital interventions, biohacking, and do-it-yourself biology. Such initiatives are often led by artist-scientist teams, opening laboratory spaces to users who would not otherwise be able to access laboratory space in universities or corporate spaces. Community laboratories have been organized in many cities, including Genspace in Brooklyn, MadLab in Manchester, England, and ASCUS Art & Science in Edinburgh, Scotland.[2]

Other organizations with longer histories of involvement in art-science have been rejuvenated by the upsurge in art and science activity. Founded in 1968, Leonardo/ISAST (International Society for the Arts, Sciences, and Technology) is today a major hub for such activities.[3] The Ars

Electronica festival, begun in 1979, currently hosts the foremost prize for art, technology, and society. In 2016, Leonardo/ISAST and the National Academies of Science launched the first full-scale study of the effects of teaching art and design methods to science students. Sponsored by the Cultural Programs of the National Academy of Sciences (CPNAS) in collaboration with the National Academy of Engineering; Leonardo/The International Society for the Arts, Sciences, and Technology; the journal *Issues in Science and Technology*; and The Alliance for the Arts in Research Universities (a2ru), the wide-ranging report attempted to assess and survey the results of art education on science and engineering student outcomes.[4] Such public policy initiatives encourage the move from STEM to STEAM and the hope that interdisciplinarity will have positive social, environmental, and economic effects.

Most art-science efforts have less focused outcomes, however. American funding bodies have been especially eager to develop standards to measure success. But such efforts present serious complications in terms of documentation and evaluation and have yielded inconclusive results to date. Capturing one-time data or learning about the effects of single and multiple informal science encounters is fraught with complications even as the number of such opportunities for understanding audiences' relationship to art and science works proliferate (Casini 2010; Born and Barry 2010; Barry, Born, and Weszkalnys 2008; de Ridder-Vignone 2013). It is not clear that stable or even coherent definitions of art and science are being used across these projects, and relatively little research has been done to understand how such work could come to belong to both knowledge systems.[5] To be sure, STS scholars have long worked to expand ideas about what science is and can be, effectively opening it as a field from which to draw subjects and methods and presenting a new set of institutions and practices to critique.

Similarly, across a similar time frame, artists began to contend that all techniques are appropriate to art, and even to assert that any object can be art, as in Marcel Duchamp's readymades. The concept of "relational aesthetics" developed by art historian Nicolas Bourriaud (1998) applies here, because many artists consider any human interaction and social context as a potential mode of art-making. This concept further radicalized the notion that "everything" is art. Hannah (2013) has argued that

this idea makes it possible to imagine scientific experiments as art and to open the spaces of science to "performative experiments" by artists. It is easy to imagine how these moments of art in social relations become further complicated in the context of the experiment as a form of argument or persuasion rather than the dispassionate unveiling of objective truths (Pinch 1993). If scientists perform in public and stage demonstrations for political purposes (the acceptance or rejection of a new technology, for example), their ability to coherently separate their aims and means from those of artists who work in this area remains an open question.

At the same time, other scholars have suggested potential limitations of the knowledge system art puts forth. Nora S. Vaage (2020) engages the concerns of scholars working in artistic research with the connotations of the word "knowledge" in this context. She cites Kathrin Busch (2009) and Hito Steyerl (2010) in considering the fear that the use of this term may reduce art to science communication or implicate it in capitalist structures, which much contemporary art seeks to critique. Vaage suggests that the word *wisdom* be used in place of *knowledge*. Such concerns about reductive understandings are real and yet they are highly contextualized. This interpretation relies on shared reference points in our current context, in which resources for actors' projects are bound up in specific understandings of what art is or ought to be in relation to science. They do not object to the idea that art and artistic experience constitute a form of knowledge. Steyerl's emphasis on tacit knowledge suggests one type of shared relationship; their objection is how these definitional associations might lead to limitations in artmaking and interpretation. Furthermore, the idea that a set of standards for knowledge production in science and technoscience exists at all is contested. Different areas hold different views of the most epistemically valued forms of verifiable and reliable knowledge conception and of their proper types of inquiry (Graham 1993).

Given this, I do not fear that art's fragmentary and diverse ways of recognizing knowledge will be subsumed by science's fragmentary and diverse ways of recognizing knowledge. Rather, the identification of current power relationships can help us to contextualize ongoing art-science relationships and recognize similarities in their respective operations. These questions are best addressed by considering the power relations

between art and science in context; the issues raised by these scholars relate to the way in which the standards of knowledge production from science might be wielded against art producers today and are not related to art's own forms of knowledge certification. As STS scholars have worked to enlarge the communities that are recognized as knowledge-producing entities in their home discipline and beyond, art is certainly ripe for analysis as a community of comparison.

With the rise in art-science work, the need for critical analysis of these developments has become increasingly clear. What is required is a new interdisciplinary field capable of fully theorizing this area, one that recognizes artists as contributors to the scientific project, advances new methods of work, and renews the STS commitment to analyze all forms of knowledge. The development of art-focused STS, or Art, Science and Technology Studies (ASTS), is a response to this demand. With roots in STS and critical theory, ASTS applies hybrid tools to investigating art-science collaborations and instances where art or science interact and intersect with each other. As articulated in the Routledge Handbook of Art Science and Technology Studies, ASTS draws on methods and concepts derived from STS, treating art symmetrically with science in analyzing both art and science as constructions of human knowledge-making (Rogers et al. 2021). The various methods used by scholars featured in that book include ethnographic studies, historical cases, and reflective pieces by art-science teams. Work positioned as both art and science requires a commensurate shift in our analytical and conceptual equipage. Gains that are possible by bringing a fuller understanding of the constructed nature of knowledge categories to bear on work may initially seem to slot easily into an art or a science camp. As an act of questioning in this tradition, this book does not take for granted the separateness of art and science. Art and science have interesting things to tell us about the ways in which we construct differences in types of knowledge. Rather than portraying a moment of divergence or border-building between science and art in the manner of Thomas Gieryn (1983) or relating to art and science through concepts like objectivity (Daston and Galison 2007), this book explores cases that complicate conceptions of art and science.

The range of relationships explored in the cases presented show how art and science dynamics resulted in changes in the ways that actors

perceived the two categories, provoking critical reflection of the value that people assign to them. An examination of these orientations offers opportunities to think about ways to avoid naturalizing the role of scientists or artists. The work to produce these categories involves the deployment of rhetorical strategies by experts and critics, in addition to artists and scientists. Together, these actors construct an apparatus for labeling objects, people, and stories, one so ubiquitous that it acts on both the knowledgeable and the less knowledgeable within the categories, as well as on lay observers and those participating in the other respective network.

Of course, the art-science boundary can be and is often contested and the ways the concept is expressed art-science versus SciArt or ArtSci carry particular meanings inside and outside of its related communities.* For many of the actors I investigate, that boundary is a chasm, created to be overcome by those who are able to utilize this system of categorization for their own purposes. Art is sometimes treated monolithically, much like science was spoken of before STS revealed diversity of paradigm, proof, and experimental style. Art, too, is endlessly diverse and protean, further complicating the idea of a liminal object moving between two poles. There is no single transition or traceable change in how objects fit the many definitions of art and science. Instead, the two categories are constantly in flux, with the potential to be employed by actors for specific purposes around specific objects.

A key goal of this book, accordingly, is to map the range of relationships encompassed by art and science and show how they shape art-science labeling. In this manner, this book casts into relief the dynamics that govern actors' perceptions of the two categories, provoking critical reflection of the value that people assign to them. This reorientation of

*SciArt is often understood to be science-driven artworks while ArtSci is often understood to refer to art-driven projects which are about science. Art-science is hardly a neutral term since it tends to suggest a pathway of collaboration between artists and scientists, while "art and science" is easily confused as suggesting a separation between the two. There are, of course, many nuances to this debate, but suffice it to say that I have chosen art-science to refer to these practices in the preface because I hope to suggest the similarities between the practices of these groups rather than art in the service of science or art influenced by science.

the power of artists and scientists is neither progressive nor linear. Each of these modes of power between artists and scientists is persistent, and an examination of these orientations offers opportunities to think about ways to avoid naturalizing the role of actors via prescribed categories.

The division of art and science is reinforced by signs deployed by the respective communities, the ways of talking about and seeing work that reference the terms of the other group. Swiss linguist Ferdinand de Saussure's response to the everyday notion of language as nomenclature is instructive here. As Ian Hacking noted in interpreting Saussure (1983), language does not simply provide the ability to name pre-existing categories. It also creates new categories for thinking, rather than standing in for things in the world. In assuming that language describes predetermined categories, non-linguists "repress the reciprocal determination of values in the language system which arises from their very co-existence." The limits of linguistic conventions are well known in studies of race, class, and gender. Like binary gender labeling, where only two available designations are commonly assigned to everything from language to objects, objects are typically assigned either an art or science valence.

Similarly, objects, people, and even certain ways of framing stories that appear in the cases in this book are frequently described by the actors I researched as either art or science. The affinities between the treatment of art and science and their relative gendering continues to create complications in the way in which the two areas are valued. Once the roles artists play in relationship to science is understood, we can see and appreciate them in the company of other marginalized and long-ignored groups that STS has helped to bring into the historical record. Artists, too, have contributed to scientific knowledge, in ways hitherto dimensioned by our understanding of their work as auxiliary, at best, in the knowledge-making enterprise.

The stereotype of bipolar science and art mirrors some historical modes of understanding gender. In the western context, particularly since the early modern period, the two genders were seen as opposites in a complementary fashion that created a "complete" household. This process was transferred into science and art, which have typically been depicted as distinct yet harmonious spheres when in each other's company. Good science is often masculinized, described as rigorous, logical, and is best

performed by those with an "objective" temperament, usually meaning not only men but also men of admirable masculine character. The "hard" sciences were long assumed to be superior.

Art, on the other hand, has often been accorded the passive role of muse for science with *emotion* and *subjectivity* as its watchwords. Rarely has art been seen as a direct contributor to scientific enterprise. The work of feminists is central to this book in two senses: first, in deconstructing binaries and in identifying the way in which sex in dimorphism has been used as a metaphor in contexts otherwise unrelated to sex; and second, in recovering contributions rendered invisible by bias. Just as the gender segregation outlined here has begun to be broken down, the potential exists for the separation between the arts and sciences to be deconstructed.

Understanding the relationship that is being configured, either through documents that explain a story of ideas and objects or by encounters with the object itself, requires a type of attention that matches the story being told. The attention commanded by art versus science has been crafted differently by different sets of actors. For example, we understand that a newspaper demands a different sort of attentive attitude than a poem, yet both require some of the same skills to read. Like art theorists considering what art consists of and science studies scholars querying definitions of science, we might consider the possibility that art and science are best thought of as particular types of attention, rather than features that indelibly mark them as one or the other.

The ideas and information that we extract from a sculpture or data chart depends both on our identification of the object with a category and on our trained interpretive power. In the latter sense, questions about the identity of people and objects are brought forward. Understanding an object or person in terms of an art or science network positions the object of analysis for comparing and contrasting to others of its type. Hence, reflecting on the type of attention we pay based on our identification of the relevant knowledge network can reveal ideas about what the category involves and the relationship that we perceive between form and content.

One place to look at the relationship between form and content is the way in which art and science align materials and argue for their meaning and rhetoric. In both art and science, this material-rhetorical complex

is frequently referred to as *experiment*. Like the designs of technologies that argue for particular worldviews, experiments, too, propose worlds by organizing materials that stand in for things not present. In short, ideas are represented through materials. Sometimes, materials are the same in kind as the counterparts that they are meant to represent. At other times, they are figuratively or analogously represented. Deconstructing experimentation and its contexts to understand how empirical systems are socially valued was the focus of much early STS work, notably by Bruno Latour and Steve Woolgar and by Steven Shapin and Simon Shaffer. The practices of science align materials to make arguments about general principles; they reach for ideas using objects rather than texts.

Hence, the practices of art and science have much in common, in the way objects are forged to meet their respective standards and how the actors perceive the categories and their potential uses through the logics and norms of each pursuit. Rhetoric and objects and the people who use them become both signs of the category and the thing—art or science—itself.