

STRANGE ATTRACTORS: Art, Science, and the Question of Convergence
An online symposium held at strangeattractors.cueartfoundation.com
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Moderator's Welcome

Taney Roniger

As we open this forum to the public today, I'd like to welcome everyone to the online component of *Strange Attractors: Art, Science, and the Question of Convergence*. First, I want to extend my thanks to all our panelists for enthusiastically accepting our invitation to share their thoughts on art and science over the course of the next eleven days. Thanks to this diverse group of accomplished artists, scientists, writers, and curators, the forthcoming dialogue promises to be dynamic and illuminating.

For those of you who missed our opening presentations at CUE last night, we'll be posting links to both James Elkins's lecture and the diagram our audience participated in creating with Matthew Ritchie. We hope you'll take a look at those to get a sense of the ideas that sparked a lively and probing discussion at the end of the evening. (If it's any indication of the degree of interest in our subject, last night's event lasted for four hours, with many of our stalwart guests staying well past the stated end time.)

Over the coming days we'll be addressing four interrelated topics, each roughly delineating one aspect of our subject, to be introduced by a set of questions issued at the start of each session. Both the topics and the questions are intended to catalyze dialogue and to provide a structure for the discussion. Participants are welcome to respond in any way they see fit, whether from personal experience or from a theoretical perspective. Excursions, deviations, and musings of all kind are encouraged.

Throughout, we'll welcome moderated comments from our reading audience. Please note that there may be a slight delay before your comment appears, as we'll be making an effort to place reader contributions in a relevant context within the flow of the dialogue.

Our first topic, which we'll be exploring today through Tuesday evening, is:

Language Matters: Defining Our Terms. Below are the questions for Session I.

1.1 James Elkins has memorably called the dialogue between art and science a "drunken conversation," one in which both sides—even when mutually enamored—perpetually misunderstand and talk past each other. With a view toward a more sober exchange, how might we comprehensibly articulate the *essence of each*? Perhaps more important, what is each emphatically *not*?

1.2 With the sci-art movement gaining momentum, we're hearing more talk of the "convergence" of the two fields. What is meant by convergence? Is what's being proposed a synthesis, or something more like a complementary relationship? If the former, why is sci-art a branch of art and not science?

1.3 However we define convergence, what does each field stand to gain from a prospective partnership?

1.4 As currently conceived, what is sci-art, and who is its intended audience? Granting that it is a branch of art and not science, how does it expect to be met by the scientific community?

1.5 Given that art has always appropriated images and ideas from other domains of culture, on what grounds do we need a special category for art that incorporates scientific content? Why *sci-art*?

João Silveira (reader): Why sci-art? ... Why not Artscience ... or art-sci... or Art-Science? What I mean: does it matter if we have a name for this area?

Taney Roniger: Thanks for that, Joao. The term "sci-art" can indeed be replaced by any of the others you mention (my use of that one is arbitrary), but the larger issue is why the genre feels compelled to separate itself from the rest of art. Let's say, for example, that you make art that involves architectural imagery. Do you then call it "arch-art"? Or you make portraits with heavy psychological overtones; does this make your work "psy-art"? You'd probably just call it art, since the term is elastic enough to cover just about any kind of content. That it feels compelled to distinguish itself from other art implies, to me anyway, that the genre considers itself some kind of new hybrid form (i.e., part art, part science). This is a huge claim, because if that's the case we can reasonably expect it to involve some aspect of real science (as opposed to, say, poetic allusions to it, or an appropriation of its imagery for the work's own purposes). So to me it's not so much the language that matters but the claims, motives, and intentions implicit in it.

Joseph Nechvatal (reader) João and Taney: Considering this issue of exchanges between art and science in 2000, I settled on the novel term cybism rather than sciartism or sci-art, because cybism implies the technologically-based hyper-connectivity that both scientists and tech-informed artists share: where everything everywhere is connected in a rhizomatic web of communication by the internet. But by 2003, when curating a show called The Attractions of Cybism for Fairfield University (never realized), I understood that what was interesting here was more than the cross-pollinating access to both scientific and artistic information. The issue became a sensibility comfortable with going beyond the reductive logical methodology of both modern art and hard science. The attraction, the desire, to nurture that sensibility is what enables collaborations between scientists and

artists to proceed. Something that has proved beneficial to my art, and that of many others.

Taney Roniger: Joseph, I really appreciate your emphasis on the emergence of a new sensibility rather than that of a new art form per se. The impulse to push beyond the confines of modern art and science is not just understandable but — given the stultifying tendencies of both — profoundly laudable, I think. This approach also relieves the work of the burden of having to conform to any existing discipline (if what’s being proposed/promoted is a *sensibility*, the work is free to pursue that by any means necessary). What bothers me, frankly, about much sci-art I see is the pretense that it somehow involves “real” (which is to say conventional) science. I find this deeply problematic.

Leonard Shapiro: Taney, I agree that much ‘sci-art’ that one sees currently does not involve real science at all. Often, artists who try and draw on things scientific in order to include it in their art-making do nothing more than create a sign that reads ‘science’. This may take the form of a neat row of test tubes, each filled with a different coloured water (I have actually seen this) to signify ‘science’. Without wanting to criticize artists for this too heavily, let’s analyse this phenomenon in order to try and understand it. Surely this superficial attempt to include science in art is indicative of the chasm of prejudice that most artists have towards scientists and vice versa; a prejudice that prevents us stepping into and engaging with each other’s domains? At the same time, this chasm indicates a need to address this prejudice, hence this symposium.

But science, and those who market the image of science to us, are also responsible for reinforcing a superficial visual/artistic (mis)representation of science and consequently the regurgitation of similar images by artists (such as colour-filled test tubes). I recall a lecture by James Elkins at the University of Cape Town in 2011, in which he also spoke about the use, by researchers, of bright colours in images used in the garnering of funding from pharmaceutical companies. Most images taken of microscopic bacteria are monochromatic and perhaps uninteresting to non-scientists to look at; hence the need for scientists to colour these images in order to attract our interest. So, science is at least reaching out and making the idea of things scientific palatable for non-scientists. Now that science has made itself ‘attractive’, albeit superficially, to non-scientists, let’s now go a bit beyond the colour-filled test tubes.
<https://www.news.uct.ac.za/article/-2011-09-02-archive-and-curatorship-project-kicks-off>

Corina Larkin (reader): How might we comprehensibly articulate the essence of each? Day 1 of the conference: We heard several compelling viewpoints at the opening one of which seemed to argue against the possibility of convergence of science and art and two which seemed to argue for the possibility and indeed, the need for convergence.

In terms of articulating the essence of each, it might make sense to start with the process of each discipline. Any elementary school science class starts with scientific method: Hypothesis, test or experimentation, data gathering and analysis/drawing conclusions. The process is fact-driven and strives to eliminate ambiguity of interpretation.

The process of making art is different. It may start with a question: can I draw a likeness of the model's face, can I film and edit a video to convey an experience, can I assemble objects in a room to make people consider their perceptions or the facts of an issue differently?? The iterations are countless. There may be some experimentation along the way — the artist may try using a line differently, select a different color, edit video footage differently, shift the installation etc... But at the end of the day, art is always more than an accumulation of facts. In fact, its impact may lie exactly in its rejection of facts as overly simplistic. there's always an unknown quantity — a mysterious factor, an added interpretation, something that cannot easily be defined — that elevates the output to art. Without that unquantifiable, undefinable, ambiguous element, it won't be art.

So I am hoping to be convinced otherwise, but as of Day 1, I can't cross the bridge that tries to link these two subjects. The essence of each inquiry is diametrically opposed to the other.

Taney Roniger: Thanks, Corina. While I agree that “synthesis” is an impossibility (not to mention being far from desirable), there have been some convincing arguments suggesting we should abandon the idea of a diametrical opposition. The problem with binaries is that they tend to oversimplify what is in fact a complex and nuanced situation to the detriment of both “sides.” See, for example, Stephen's recent post here **[to appear later]**, in which he proposes that this insistence on conceiving of art and science as polar opposites (as in “strange attractors”) perpetuates the perception that sci-art is little more than a charming side-show attraction. It's a valid point. Perhaps a more nuanced conception might encourage exploration of the genre's more substantive dimensions.

Luis Schettino: As a scientist, I think that one of the interesting links between Art and Science is the playfulness of curiosity and method. Sure, we apply ‘The Scientific Method’, but it is not as rigid as sometimes our publications would make it to be. It is said that Isaac Asimov suggested that the most exciting words in science are ‘Hmm, that's funny...’ It is not uncommon that during the process of testing a hypothesis, the researcher notices a curious result which leads to a more interesting and successful line of work. Once I heard a talk, early in my career, where the speaker stated that scientists are ‘paid to notice things’. That ability to stop the internal chatter and notice that something interesting is before us is something that artists and scientists share. Most of the subsequent work is trying to understand the event/phenomenon, and couching it in a way that can be shared with others.

Taney Roniger: “Scientists are ‘paid to notice things’” — I love this, Luis. It’s something I’ve thought about a lot in terms of what we do; I often tell my students that artists are “the great noticers of society.” (One point of divergence is that most of us don’t get paid, but that’s another matter.) I do think the public’s perception of the scientist — i.e., the humorless, inaccessible eccentric who walks around in a white lab coat — is a caricature that needs to go. So maybe the scientific method is not so foreign to us after all. Thanks for pointing that out. One never hears about an “artistic method,” but it might be worth articulating, if only to underscore some more possible points of convergence.

Daniel Kohn (reader): While I value the art science axis, I usually say that’s just because I’m an artist and am interested in science. But not just in science.

Are we not perhaps in a larger moment which is not just about the opening of the boundary between art and science but about many fields trying to reach out of their boundaries towards many others.

Several people at the opening event yesterday mentioned that connecting across boundaries and languages can lead to miscomprehension or mistranslation. This does happen. But reaching beyond our boundaries also allows us to begin to see the metastructures which connect us, and perhaps, as we face many different types of globalization phenomena (cultural and climatic) we are realizing that the our cloistered modalities are no longer sufficient to account for a complex world, and that we need to collaborate, to contrast and compare our points of view, sometimes to aggregate them, in order to account for the realities we are experiencing.

And thanks Taney for organizing this framework for the larger discussion.

Taney Roniger: Daniel, I couldn’t agree with you more. I do think the move toward increasing inter-, cross-, and transdisciplinarity is rooted in an acute awareness of the multiple crises we face — and an equally acute awareness of, most certainly on the part of art, the limitations of our field. To be siloed away in our own little world feels increasingly inadequate, and I find this exciting. But if we’re to move out into other domains of culture in search of partnerships, it’s now incumbent upon us, it seems to me, to do two things: (1) to acquire at least a working knowledge of languages and sensibilities foreign to art, and (2) to assume an active role in the education of non-artists about what art is and does, and what it has to offer. On point number 1, one of the things I find most troubling about artists’ engagement with science is the general lack of concern for the scientific method. My feeling is that anyone who wants to genuinely incorporate science into their work should first take a course in the philosophy of science. Similarly, scientists with an earnest desire to engage with artists should take it upon themselves to learn the rudiments of contemporary art. And on point number 2, I’d very much like to see artists drop the pretentious language that plagues our field and make it our business to speak clearly and forcibly about why what we do matters.

Werner Sun: Ah, but I don't think scientists themselves are all that familiar with the philosophy of science. At least in my own experience, I have never had a conversation with any of my colleagues about Karl Popper or logical positivism or postmodernism. Scientists tend to just go about their work, use common sense, and let their results speak for themselves.

Taney Roniger: Interesting, Werner. It just seems unreasonable to expect that any non-scientist interested in science would take a crash course in, say, the higher mathematics. Barring this, what would you recommend to someone who wanted to learn about the core values of science without formal training? There's no dearth of books on popular science, but these seem to only perpetuate the problem.

Werner Sun: Good question. I think the core values of science are not fully absorbed through lectures or textbooks; instead, they *emerge* from doing actual research. I took physics classes like everyone else, but until I went through the experience of taking data, figuring out how to analyze it, and making all the pieces fall into place, I did not appreciate how seductive it could be to gain an understanding of (a small piece of) the universe.

Scientists believe that nature can be quantified and modeled mathematically because they have seen it with their very own eyes. And they have seen that equations describing one phenomenon can be applied in a different context and they still work. That's powerful stuff.

I think this is the challenge: communicating the fact that science is not just another belief system, another religion. There are reasons that scientists believe what they do. Science *works*, dammit, and if it didn't work, we wouldn't believe it. Of course, not everyone gets to do research first-hand, but I have found that well-told stories of how discoveries are made — how the pieces came together — to be useful in this regard.

Werner Sun: There are some great comments here! I wanted to respond in particular to something Corina said, contrasting the scientific method to what Taney calls the artistic method. I think the way the scientific method is taught in schools makes it seem like a recipe to be followed. And when you take a science class, the lab activities reinforce that notion because students already know what the answer is supposed to be, and they just go through the motions of "applying the scientific method". In reality, scientific research is playful — as Luis described — and it's not a linear path from hypothesis to result. There's usually a lot of backtracking, problem-solving, and trial-and-error behind any published result.

And in fact, I would say the starting point for the scientific method is not so much a well-formulated hypothesis, but a simple question, just like in art. A famous (possibly apocryphal) example: when Newton observed an apple falling to the

ground, his leap of logic was to ask: What if the force that pulls an apple to the ground is the very same force that holds the moon in its orbit around the Earth? With that seed of a thought, he set about trying to deduce the logical consequences of that “what if” (i.e. how can I construct a mathematical model that describes both phenomena at the same time) and ended up with a theory of gravity that could be tested against observations.

So, scientists often try out many different explanations for some phenomenon until they find something that both “feels right” and agrees with the prior body of knowledge. It’s not always clear when they start out that they will be successful. Nor is it clear, when they do find an explanation, that it will stand the test of time. Science is suffused with uncertainty, even if it isn’t presented that way in the popular press (to its detriment, I think, but that’s a whole other topic).

I really like what Luis and Taney said about scientists and artists being “paid to notice things” because I do believe they share the same fundamental impulses. But what they do with those sparks of attention leads them down different and equally valid paths.

Corina Larkin: Werner – you can tell that my “scientific” education ended very early in life.... very striking how similar the experience of the processes can be — backtracking, problem-solving, and trial-and-error — who hasn’t experienced that in the studio???? I also love what you say about “how seductive it can be to gain an understanding of (a small piece of) the universe

Werner Sun: Thanks, Corina! Yes, I also find my processes in the lab and in the studio to be remarkably similar, which is why I suspect there is some substance to the science-art linkage, drunken conversation or no.

Session 1

Leonard Shapiro

Thoughts on the Art and Science Worlds. Is the separation as great as we think? Artists inhabit a domain, a world they call the ‘art world’. Scientists inhabit a world they call the ‘science world’. Each of these domains has a specific language associated with it (for good reason) and the people who occupy each domain use this language to communicate with each other. However, while a particular language serves an important communicative and descriptive function *within* each domain, these languages can unwittingly serve to alienate those who are not familiar with the other’s domain. It is generally perceived that scientists view artists with suspicion and vice versa; myriad art vs science jokes and jibes attest to this divergence and ‘othering’. Artists are viewed as ‘laid-back’, ‘weird’, ‘alternative’ while scientists are viewed as ‘hard-nosed’, ‘matter-of-fact’, ‘down to earth.



Even as some scientists and artists follow a current trend to make the effort to approach each other for an embrace, they do so with the suspicion that the ‘other’ will never really be able to fit into and understand their respective domains.

Having myself inhabited the ‘art domain’ for most of my life, and still do (I studied fine art and practice it), I more recently stepped into the ‘science world’. It was actually more of a transition that began in 1991 when I came under the influence of a philosopher who taught logic, and speed up 4 years ago when I began teaching a multi-sensory observation method that involves haptics (touch) and drawing, to medical students to supplement their anatomy studies. I was amazed to find highly creative and quite ‘way-out’ people in this world; with the important difference that unlike many (but not all) artists I know, these scientists had their feet firmly planted on the ground.

Scientists are rooted in a discipline and universally accepted way of verifying and measuring that focuses and guides the creativity of their hypotheses that result in experiments, the conclusions of which can be replicated and applied to predictable effect in the physical world. The world of science demands (thankfully) a quantitative rigour and this is a pre-requisite for participating in it.

Artists are more rooted in science that they realize; an oil painter mixes precisely the right amount of mineral turpentine into their paint in order to achieve a specific paint viscosity. Jackson Pollock flung or dribbled paint, of various viscosities from specific distances and speeds, at his canvas to achieve a specific splatter. His paintings look haphazard and yet are more calculated in their execution than one sees at first glance.

A solution to this ‘drunken conversation’, and the beginning of a more sober one, would be for art and science to stop talking at and past each other and *do* something *with* each other. Some (not all) artists and scientists might find that they have far more in common

in their ways of thinking than they previously thought they had. A more ‘sober’ exchange between art and science will require those artists who wish to *contribute* to the pursuit and discovery of knowledge *with* scientists, to apply scientific thinking and method. This is not something that all artists may wish to do, in the same way that not all scientists may wish to explore the kinds of discoveries that take place when artists explore a subject visually.

What science and art have in common is ‘creativity’; a creativity in thinking and in doing, and these are linked. Artists and scientists apply their minds (their thinking), creatively. An artist may be guided in their creative thinking by social, political, economic, environmental issues. Artists might offer commentary on these issues or solutions to these issues. If an artist works closely with a social scientist or an environmental scientist, so much the better. Alternatively, the artist would have conducted close research on a particular issue before making artistic commentary on it. On the other hand, in the painting of a traditional landscape painting on canvas, creativity in this case will refer to creative thinking around the (scientific) use of materials in the reflecting of what is observed. In science, creativity can refer to the thinking that contributes to the formation of an hypothesis to be tested.

A few thoughts on 1.1 & 1.2 **Daniel Hill**

Many of the group dialogues I have been involved in with artists and scientists have indeed wound up like a drunken conversation. Often it seems both are using the same terminology but have different definitions. Another issue seems to be a more than average knowledge or awareness of current issues in science on the part of the artist and a lack of general knowledge of contemporary art on the part of the scientist. I think this is because in the potential sciart relationship, art needs science more than science needs art.

I see the most fundamental difference between art and science to be the objective nature of science and the subjective nature of art. Science is concerned with the world of the real and art is concerned largely with simulated realities. Science requires reproducible results and art depends on the inability to reproduce.

I think there is good reason to be concerned about the future of art. If art can potentially expand its audience through some sort of interaction with the juggernaut of science, it is a bet worth taking. But the epistemological differences between the two make a true convergence unlikely in our lifetimes and perhaps never. Still, I think the potential is so high that it is worth investing in. The drunken conversation may first aim to be slightly less drunken over a period of time by clarifying our language- and certainly if more scientists could find a value in art that merits educating themselves further on the issues of contemporary art.

Leonard Shapiro: “But the epistemological differences between the two make a true convergence unlikely in our lifetimes and perhaps never.”

Despite the epistemological constructs that separate art and science, one can still build a bridge and forge practical links (on an individual basis i.e. literally in the work that one does), between art and science. I teach drawing to medical students and medical practitioners in order to make them better observers. I see the work that I do as having made a bridge between art and science. More of these practical examples can happen.

Who’s the Audience?

Stephen Nowlin:

Thank you to the CUE Foundation and Taney Roniger for initiating this timely and important dialogue.

An initial thought: I think the title of the conference itself smartly points to the need for a deeper excavation of what Sci-Art is and what it means. “Strange Attractors” exposes the tendency, particularly in the popular media, to approach a convergence of science and art as a kind-of inspirational novelty — that is, as an implausible tale of romance, an affair noteworthy primarily because it seems to successfully pair what are stereotypically perceived to be polar opposite ends of a spectrum. As a result, the exposure of Sci-Art to the public through popular media remains largely superficial, more descriptive of its charm and novelty than analytical of its deeper meanings. While such may not be the case with academic journals and scholarly writing on the subject, it is the ability of Sci-Art to impact and influence change in the perceptions of a general audience, that I will propose is among its greatest challenges and its most significant mission. And to do so it must be not only inspirational, but subversive and provocative as well. So I would hope to hear in this dialogue over the next several days, what meanings embodied by Sci-Art might disturb and alarm, as well as stimulate and uplift.

Response to 1.1

Suzanne Anker

To begin with, what’s wrong with a “drunken conversation”? While some drunken conversations persevere and go on endlessly in the land of repetition, others invoke unconscious or otherwise non-linear concerns which can lead to innovative thoughts, processes and materials. When examining the nature of research and dialogue I quote Jacques Monod in that evolution operates by *chance and necessity*. If we liken language to a communication system, what is the relevance in which “drunken conversations” produce mutations of thought and its consequences? For Monod, “mutations constitute

the only possible source of modifications in a genetic text.....chance alone is the source of every innovation.”

Hence a “drunken conversation” may, in fact, be a method of generating knowledge. Additionally, a brief scan of Gregory Bateson’s *metalogue* can also unfold hidden aspects in dialogue. In *Steps to An Ecology of Mind*, Bateson introduces the concept of the *metalogue*: “A metalogue is a conversation about some problematic subject. This conversation should be such that not only do the participants discuss the problem but the structure of the conversation as a whole is also relevant to the same subject. Only some ...conversations achieve this double format.”

James Elkins: Sorry I missed the event: it sounds like it was great. I can be online until Wed. AM, when I’m off to see the opening of the Louvre Abu Dhabi, where you can imagine there won’t be a speck of science, except in the Renaissance galleries.

Regarding the notion of a “drunken conversation”: I agree with Suzanne. The expression “drunken conversation” was meant to indicate an interesting conversation: one driven by desires, one that overflows the boundaries of propriety, one that may not get anywhere right away but flows on with force and conviction until it arrives in some unexpected place.

I think we may have space for discussion when it comes to “knowledge.” I am not convinced by most of the theorizations of “knowledge” used, or implicit, in practice-led PhD programs. I don’t think “knowledge” is something always to be desired, and when it’s applied to visual art, I’m not always sure it’s the right word.

Just to get things started, there’s empirical knowledge, experiential knowledge, phenomenological knowledge, and tacit knowledge: which of those, or which other, should we say is appropriate as the goal of art-science collaborations?

Suzanne Anker: I think a way to address the aspects about knowledge, as James has pointed out, is to begin with Nelson Goodman’s “Languages of Art: An Approach to a Theory of Symbols”. Symbol sets reach back into pre-history as a way for ordering the world. Artists are truly engaged in world-making, aligning visual propositions to address mythology, psychology, optics, literature, history and science, among other disciplines. However, what do we mean by art-science collaborations? Do we mean artists who work with scientists on a specific project, artists who employ scientists as technicians, the way artists, for example, work with a master printer? Or, do we mean artists who employ scientific iconography or scientific tools and data to make art?

Linda Francis: James on “knowledge”: The philosophical divisions listed are all implicit in art and in science as structural conditions or as explicit exemptions from whatever is being formed or tested. Of course then, they are all included in each division. Last night, lack of common language was identified as the main issue that would defeat the purpose of sci/art re any kind of mutuality or

understanding and therefore ‘discussion’ qua ‘discussion’ could be the optimal situation for collaboration at this point. That “knowledge” can be defined in different spheres does not obviate the fact that it is what sapientia acquire as a condition of their continuance.

Taney Roniger: Suzanne, you make a really good point. But I would add: there is drunken, and then there is *drunken*. In the latter (which Jim apparently did not intend by the analogy), the misunderstandings are so grievous that the conversants become offended by each other’s presumptions and harbor ill will long after the dialogue. I’ll confess that I’ve grown tired of some of the persistent misconceptions on the part of scientists about what we do as artists. It seems that many of them just cannot be disabused of the notion that art is about making things look delightful. For example, one noted writer (a scientist by training and the author of several books on the art-science intersection) tells of his visit to CERN, where, he claims, the scientists there are no strangers to art. What’s the basis for this claim? The fact that all the wires in the collider are organized very neatly and color-coded in a sumptuous rainbow-like array. This kind of trivialization of what we artists do borders on the offensive. If we’re to have a productive conversation — even if it’s drunken — it seems imperative that some of these very basic misunderstandings be cleared up.

Suzanne Anker, Of course, we are in need of common languages. Besides some scientists, the general public is also ill prepared to evaluate contemporary art. Besides the traditional formal qualities of art -- line, color, form, etc. -- art can also employ satirical hyperbole, institutional critique, media manipulations (among others) to foster a dialogue into the cultural imaginary, that is, the underlying hopes and fears in a changing society. I think “sci-art” is well positioned to do that, given the fact that science has been a reigning theology. More later.

James Elkins: Taney, that’s precisely the assumption Leo Steinberg critiques in his essay. “Elegance,” “pattern,” and “composition,” along with the generic “beauty,” are the catchwords for this particular misunderstanding of art by scientists. Steinberg’s point was that if those terms really meant the same in art and science, why would people be driven by them to do things like break the fingers off Michelangelo’s “Pieta”? I think this is one aspect of the problematic that is sufficiently precise and bounded to be useful for conversations with scientists.

Taney Roniger: Exactly, Jim. What can be done about this? It’s one thing for scientists who have nothing to do with art to harbor these ideas, but it’s quite another when it comes to those who’ve the nerve to opine authoritatively on the subject (mostly men, as it happens). I find this just baffling. But in either case, surely there must be some way to disabuse the scientific community of these misperceptions. But scientists would have to demonstrate sufficient interest for it

to happen. Many of us artists at least *want* to understand science. How to convince them that what we do is worth learning about?

James Elkins: I don't think there's a way to change that. In my experience, scientists who think that both science and art are "elegant" etc. also think art is fundamentally about mute appreciation. A prominent scientist whom I knew for years never once asked me to take him through a museum or gallery, because he assumed my own profession was an ornament to the only thing that mattered: silent, solitary "appreciation." The entire edifice of the "Cafe Scientifique" (started by the British Museum) is based on the notion that a scientist can present a slideshow of her work and communicate something by sheer beauty.

Daniel Kohn (reader): Thanks Suzanne for talking about knowledge. It seems to me that we are trying to grapple with profound shifts in how we produce knowledge and what is considered knowledge, and that our attempts to reach across boundaries stems from this. Clearly we are seeking openings. Ways of seeing with fresh eyes, with other eyes, what we see every day. And what you mention about Bateson's metalogue is equally important. To try and be aware, as we move forward, of the context in which we operate. It seems to me that the early 20th century brought profound changes in the way we think about the world which we are still trying to integrate AND we have some serious new problems which we desperately need to solve. In order to address both these things effectively we need to understand the larger context in which we are operating (the paradigm) and find novel solutions (say to climate change). Is that not why we are doing trans-disciplinary work?

Suzanne Anker: Yes, trans-disciplinary work is a step in the right direction. Discourses concerning the "in-between-ness" of categories have circulated within the corridors of visual and critical studies for decades, including the field of science studies. The dyadic structure of art/science creates a problem in itself. When we experience a work of Minimalist sculpture, we don't refer to it as art/phenomenology. In Minimalism artists employ the attributes of phenomenology and its perceptual underpinnings as a data bank for its discourse. Since there are so many varieties of artists and a large range of scientific disciplines, what do we mean by "sci-art" and its origins?

Leonard Shapiro: Of relevance to this discourse. Date of article October 31, 2017: "In-text citations (APA style as opposed to MLA style, for those in the know) are creeping into philosophical writing and they do not belong there. Let me explain: It is traditional in papers in the humanities to use endnotes to provide source material – you put a little number in the text and a note at the end. Endnotes say something like: "1. This idea was most fully developed in R. Smith's 2017 work *Wankers and Hogwash* (Pretence Press, 2017)." But scientists use a different style, in-text citations, which are parentheses containing the author of a study and a date (Smith, 2017). The idea here is that there was a study that demonstrated something you are claiming. But philosophy and art criticism prove

nothing. Essays in criticism are not summaries of experiments done in labs. They just advance ideas. The use of this scientific reference style has crept into the humanities through the vaguely scientific social sciences (I'm looking at you, sociology). It has been welcomed by those who want to call criticism "research" so as to maximize its authority". For the full article: <https://beta.theglobeandmail.com/opinion/lets-stop-pretending-academic-artspeak-reflects-actual-research/article36785084/?ref=http%3A%2F%2Fwww.theglobeandmail.com&>

James Elkins: On the kinds of knowledge. If our conversation continues on this subject, I'd like to point to a passage in the book "Artists with PhDs." This part of the book is online, here: <http://www.jameselkins.com/yy/4-fourteen-reasons-to-mistrust-the-phd/>. Scroll to paragraph #176. It's a list of definitions of what counts as knowledge in visual art: it might help define some conversations.

Taney Roniger: To make things easier for readers, here's Jim's list of definitions of what me might mean by knowledge in the visual arts:

(i) Tacit knowledge: things you don't quite know yet, but know you may be able to do, or to describe. Tacit knowledge is held in suspension in a medium: it promises that it can be at least partly articulated, extracted from its material and brought into language. Of the possibilities on this list, this is the one that has attracted the most attention, although it isn't always clear whether tacit knowledge is, finally, a different kind of knowledge from the others on this list.

(ii) Visual knowledge: if visual art has a kind of knowledge that pertains to it, that is its possession and mode of articulation, then that knowledge might be called visual. This would include what modernists are said to have called "optical" knowledge, as well as knowledge that is said to inhere in the material or substance of the art, and knowledge said to inhere in the practice, disposition, or performance of the art. Such knowledge would be non-linguistic; it could only be found in the artwork, and not in the supporting materials for the PhD. Visual knowledge could be pointed to, indicated, paraphrased, analogized, but not articulated in language.

(iii) Affective knowledge: if visual art is primarily concerned with feelings, emotions, moods, and other affective states, then its form of knowledge could be called affective. Recently the various forms of affect theory have attracted growing interest in the art world. Brian Massumi's theories, the Affect Theory Reader, and the forthcoming book *Beyond the Aesthetic and the Anti-Aesthetic* are all concerned with kinds of affect theory. Affective knowledge is partly linguistic: it can be described, even if the description is structurally inadequate.

Response to Session I

Eve Laramee

Regarding question 1:4 -“who is the intended audience,” Stephen Nowlin brings up an important challenge facing Sci-Art: the possibility of being both inspirational and subversive. To my mind, it is critical for us to ask if Sci-Art can activate change, and if so, within which demographics and cohorts? With the current political climate and an administration that is dismantling environmental protection laws, there is an urgency to resist the obfuscation of facts. How better to create that field of engagement than through science-art collaborations? I believe there a place for activism within a Sci-Art convergence.

On the Question of Audience

Taney Roniger

I think it's significant that many of the posts so far have taken on the issue of sci-art's audience. This is so very important, and it's one of the reasons I'm interested in the genre to begin with. Above all, I see the growing sci-art movement as an earnest and impassioned attempt on the part of art to achieve greater cultural authority in these urgent times. And I agree with Stephen that if it's to be taken seriously, sci-art needs to stop presenting itself as a mere novelty. The question that comes to my mind is: If our aim is to reach beyond the ivory towers of academia and the narrow confines of the art world proper, how can we expect a nuanced and meaningful reception when the vast majority of the public is ignorant of art? Daniel, you say: “If art can potentially expand its audience through some sort of interaction with the juggernaut of science, it is a bet worth taking.” But as it happens, art and science are two of the most inscrutable disciplines, not just to each other but to the culture at large! Put them together and you get inscrutability squared. It's a bit of a funny partnership, if you think of it that way.

Colin Selleck (reader): One commonality between art and science is that the public is ignorant of both, much to our detriment. As someone who works in the sciences, this troubles me greatly. In fact, I call these times the anti-Renaissance, where science is pushed aside in favor of ideology and self-serving economic interests. The true power of science is that it allows for evidence-based decision making, which is inarguably the best path forward in any venture.

But what I see is a give-the-fox-the-key-to-the-henhouse approach to political appointments (say what?), an unregulated supplement market (possibly leading to a rejection of viable alternatives), a belief in the superiority of organic food (what food isn't organic?), an anti-GMO sentiment (we've been modifying the genetics of food since the dawn of civilization), non-renewable and climate-change-inducing energy sources (it's November 6 and we have yet to have a freeze in upstate NY), and alternative medicine (it's not even medicine).

Humankind is not so far removed from the savanna, where daily decisions had immediate and possibly deadly consequences. Can art help translate that sense of urgency onto the issues of our day?

Gianluca Gianchino: Taney, I agree with the inscrutability of both art and science and the two together often amount to inscrutability squared. But I wonder if audiences at large, even in their bewilderment are more compelled to look at this equation as a minus x minus = a plus? At least this would be the case for a successful work. In that sense, I see Margaret Wertheim's coral project as having that capability. Her project is an odd case where science meets art at a fair mid point, which is not an easy thing to accomplish, and It does it in the most beautiful way by presenting art with a muse it is all too familiar and enamored of: geometry, in this case hyperbolic geometry.

Daniel Hill: I used to like to make a thought experiment of trying to imagine the edge of any material object as magnification is slowly and steadily increased. Physics has shown that any solid object is mostly empty space, so at some point in magnification, the boundary between the thing and no-thing would become difficult to determine. Since thinking about the line between art and science can feel like wading into quicksand with no possible outcome, I like to think in terms of perspective. One thing we can be sure of is that our tenures on this planet are exceedingly brief. The universe exists more without humanity than with us. The vast majority of species that have existed on this planet have gone extinct. Until the 1920s the universe was only as big as the Milky Way Galaxy until Edwin Hubble made his breakthrough discovery. Now with the dark matter/dark energy problem, the fact that all the matter humanity has ever studied only constitutes 4% of the known matter in the universe, we actually know less proportionally than ever before. If we look at our history we see that the models we have created to explain the universe and our place in it have very frequently been wrong, but a zeitgeist of arrogance kept us from making the realization. Stephen Hawking talks about this Model Dependent Realism in his book *The Grand Design* saying it serves us well to assume that whatever models we construct are likely to be wrong and will need to be amended or scrapped altogether at some point. Paradigm shifts, if they do indeed occur, come from the places we least expect. This does not mean that a connection between art and science will usher in a paradigm shift, only that a more collectively open mind might help us to advance a bit quicker in identifying where our models are wrong.

It is stuck in my mind how just a week ago I was in downtown Manhattan trying to excite students on the importance of art, but the students were distracted by the steady loud thrum of helicopters and the wail of sirens. Just a few blocks away, eight people lay dead from an unimaginable act of a sick mind. Some part of our model is definitely flawed. There is a sense of urgency.

As someone who has devoted my life to art, I know art has the power to serve individuals and society in a way that is far from being utilized. It would seem that to hedge our bets would be smart in hopes that something may come from an apparently barren realm. Compared with other current avenues, the pursuit of art and science seems a harmless bet. The question remains: if some form of art and science moves forward, will it be more decorative data or the catalyst of human transformation? In my opinion, education is absolute priority.

Response from James Elkins [comment reposted by moderator to begin separate thread]

James Elkins

Sorry I missed the event: it sounds like it was great. I can be online until Wed. AM, when I'm off to see the opening of the Louvre Abu Dhabi, where you can imagine there won't be a speck of science, except in the Renaissance galleries. Regarding the notion of a "drunken conversation": I agree with Suzanne. The expression "drunken conversation" was meant to indicate an interesting conversation: one driven by desires, one that overflows the boundaries of propriety, one that may not get anywhere right away but flows on with force and conviction until it arrives in some unexpected place.

I think we may have space for discussion when it comes to "knowledge." I am not convinced by most of the theorizations of "knowledge" used, or implicit, in practice-led PhD programs. I don't think "knowledge" is something always to be desired, and when it's applied to visual art, I'm not always sure it's the right word.

Just to get things started, there's empirical knowledge, experiential knowledge, phenomenological knowledge, and tacit knowledge: which of those, or which other, should we say is appropriate as the goal of art-science collaborations?

Daniel Kohn (reader): Perhaps the creative tension in art-science discussions and experiments is that they get to oscillate between different types of knowledge, some of which are not "permitted" within the single discipline's discourse?

James Elkins: Daniel, I think so. The question, for me, is what people mean by "knowledge" in different contexts. I study this in the practice-led PhDs, where it's important for institutions to claim their graduates produce "new knowledge," even if what they're making is visual art. So if art-science collaborations aim at "knowledge," is it knowledge that's embodied in the visual art itself? And what exactly could that mean?

Taney Roniger: I'd like to think that it's tacit knowledge that these institutions mean with regard to the kind their graduates produce. But I don't think so. I suspect it's something more like discursive knowledge, such as the kind purveyed by said graduates' artist statements. The word "new" in the claim is also problematic. I mean, I suppose it's new in the sense that no one else has made these exact paintings and written this exact statement, but I'm not convinced the

kind of knowledge produced in grad schools is the product of anything but what's already circulating within academia.

But to be less cynical about things: I think tacit knowledge is enormously important and should be discussed within every field. [Michael] Polanyi did it for science; I'd like to see it addressed more explicitly — and more frequently — in our field.

Evelina Domnitch: It is not knowledge, but rather that which lies beyond the frontiers of knowledge that ignites our [with partner Dmitry Gelfand] pursuit of art. As it happens, this territory is rarely approached even by theorists.

Science itself cannot be reduced to knowledge alone: it is inseparable from scientific culture, history, language, equipment etc. (An excellent reference is Andrew Pickering's "The Mangle of Practice," where a distinction is made between big science and the scientific practice of an individual human).

Curiously, the words experiment and experience are identical in some languages, such as French (*expérience*) and Russian (*опыт*). This linguistic equality points to a moment of direct interaction with the physical world situated outside of the confines of any symbolic language – this very stage of experiencing the experiment brings us close to the practice of science. However, it is not the scientific and technological aspects of our experiments, but rather the phenomenological part that is paramount for us. Instead of unpacking existent knowledge of past events, a premonition of the unknown catches the observer in the act of observation. This sensorial, preverbal engagement determines the way we conduct the experience of our audience.

Taney Roniger: Thanks so much for that, Evelina. All this talk of knowledge has indeed eclipsed what's essential to any work of art that I admire, which is precisely its invocation of the unknown. We hear so much these days about art as "knowledge production" (which seems to me little more than an appeal for greater cultural authority), but perhaps it's more accurate to say that at its best what it produces is a felt awareness of the unknown — and, concomitantly, of the relative paucity of what we do know. The profound humility this incites is certainly not foreign to any scientist I've ever spoken with, so perhaps this is another point of convergence. (It's also something, perhaps not incidentally, both share with religion.) Since we've not yet had any images posted here, perhaps this is a good time. Maybe you'd like to post an image or video of your work?

Evelina Domnitch: Taney, thank you for your poignant elaborations! Indeed, a glimpse of our artworks can be helpful.

Force Field performance: <https://vimeo.com/201930765>

Implosion Chamber installation: <https://vimeo.com/129347368>

The Morning After
Gianluca Bianchino

A drunken conversation has often proven to be a good jump start to a great friendship since the vulnerable state of intoxication allows a level of truth and honesty to spill out of both parties (art and science). I'm certain we've all been in that exciting and yet naïve state of being (unless you don't drink). But in a drunken conversation there's always a small window of opportunity for that truth and honesty to establish a lasting meaningful relationship before one of the parties gets carried away by the effects of escalating inebriation spoiling the credibility of their quarrel. I would argue that the conversation between art and science has been drunk for too long now, certainly since the industrial revolution where the many failed attempts at collaboration started being recorded and probably further back in time, perhaps drunk since inception. A good place to rethink that exchange of drunken ideas might be at breakfast the morning after the party. Perhaps this symposium is an opportunity for having a sobering breakfast after a drunken feast where lots of things were said that only made sense sporadically in odd regions of our brains, or better, the gut. Sure it may start with a headache and a hangover but that's what the hearty breakfast sandwich and the two cups of coffee are for. Suddenly, when some clarity sheds in one of the parties will ask the slightly uneasy question that breaks the ice: about last night, what did you actually mean by that?

What I meant was this: The relationship of the two disciplines in the current state of drunkenness provides uneven results at best. On a practical level science may be potentially benefiting from the input of art. Art's emotional and intuitive understanding of processes in nature may provide science with just the right degree of jolt to disrupt its linear thinking pattern. The results could be stimulating in developing a broader unexpected approach in problem solving. I understand that this version of the partnership, let's call it Art-Science (60+% science), can work and even produce potentially beneficial results that could turn into practical use for humanity at large; particularly in the age of climate change this kind of interdisciplinary thinking is clearly encouraged. The romantic view might be that one day in a post Exxon Universe an artist, or a group of artists, will illuminate a scientist (possibly in a drunken conversation) on how to generate the equation for producing inexhaustible renewable energy. However, I am skeptical about the counter aspect of this relationship. Where does science meet art and what are the specific benefits of this other version of the partnership beyond the aestheticized seduction? This is perhaps where Sci-Art resides, solely as a branch of art, in which the artist is alone despite the attempts at dialog. It is a branch in which art can tap into scientific theories and try to make sense of data but the question remains as to how can Sci-Art produce products that offer more than visualizations of scientific inquiries? The problem of data based art remains an aesthetic purgatory for it isn't clear if it's able to reach beyond an illustration or interpretation of existing theories. Technology alone may not solve this question because technology is a product of all disciplines. Do we have here an opposite condition where artists are too emotional and unstable and need science to help contain that energy in order to produce a viable work of art? While this may appear like the logical mirror image to the first scenario, the Art-Science one, it isn't necessarily true. The methodologies developed for creating

works of art are innate to artists. Painting and sculpture studios in their essence have remained the same for centuries. The necessity to make a work of art demands the development of a proper facility and set of tools, which artists have often crafted themselves, and still do even in the age of specialization. In other words the use of technology does not justify science converging into the realm of art for help. There must be a far deeper philosophical implication I hope this symposium will reveal.

The question of audience is baffling at the moment. One interesting angle that Sci-Art can offer is accessibility to a wider audience that would otherwise dismiss most conceptual art as a classist affair. This can certainly open a dialog with a positive propensity but the problem of a potential scientist investing monetarily in a given Sci-Art piece remains slim. Art is considered expensive and people who invest in art are generally educated on either how that particular work holds its own against the avalanche of art history, or more suitably for our times, what is the potential for that work to accrue value in the greater art market. While the larger scientific community may be enthusiastic about a rising trend of artists using science as a muse I don't see them ready to undertake the problem of longevity, which is critical for an artwork, and requires investment. I think this issue is primarily rooted in our education system. We don't teach higher culture to our kids. We primarily direct them from too young an age to become compartmentalized thinkers, aka specialists.

It is likely though that in the interdisciplinary future art and science will give rise to a type of third culture but the acceptance of this new entity may come down to economic imperatives and therefore practical use. It's hard to imagine that a third culture made of art and science will be set in a philosophical higher dimension that will redeem us from ourselves. The power of art as a platform for dissenting intellectualism has been strongly weakened in the last few decades replaced for the most part by trendy lifestyles. Poetry is dead (or dormant as a best case scenario) and now we have advertisement instead. The visual arts are primarily alive because of the natural ability of the artist to solidify a poetic statement in a material object that can operate within a quasi-volatile market, in essence making its own currency. Had it not been for this economic model art may have joined poetry in the cemetery of the great expressions of the past and we would have been left with Hollywood instead as a consolation prize. I suppose the markets can be seen as both a curse and a blessing in this case; they killed poetry but saved art, at what cost though?

Leonard Shapiro: Greetings Gianluca! On the language of art and science, I just spotted this article on facebook and it is pertinent:

“In-text citations (APA style as opposed to MLA style, for those in the know) are creeping into philosophical writing and they do not belong there. Let me explain: It is traditional in papers in the humanities to use endnotes to provide source material – you put a little number in the text and a note at the end. Endnotes say something like: “1. This idea was most fully developed in R. Smith’s 2017 work *Wankers and Hogwash* (Pretence Press, 2017).” But scientists use a different style, in-text citations, which are parentheses containing the author of a study and

a date (Smith, 2017). The idea here is that there was a study that demonstrated something you are claiming.

But philosophy and art criticism prove nothing. Essays in criticism are not summaries of experiments done in labs. They just advance ideas. The use of this scientific reference style has crept into the humanities through the vaguely scientific social sciences (I'm looking at you, sociology). It has been welcomed by those who want to call criticism "research" so as to maximize its authority. Here is the full article: <https://beta.theglobeandmail.com/opinion/lets-stop-pretending-academic-artspeak-reflects-actual-research/article36785084/?ref=http%3A%2F%2Fwww.theglobeandmail.com&>

Gianluca Bianchino: Leonard! Thank you. I read the article and it is compelling to say the least and I immediately shared it with a scholarly colleague. Dangerous times! Certainly if Sci-Art wants to speak to scientists, which I don't think it really is at the moment, it has to tone down the artspeak, for starters. With the exception of specifically coordinated efforts, such as symposiums and residencies pairing artists and scientists, for the most part I see Sci-Art as still speaking to an audience of art enthusiasts (sometimes known as art goers - I'd be especially wary of these types). The relationship between compartmentalized movements in art, of which Sci-Art is one, and undefined audiences (that are primarily scouting art exhibits for good times and investment opportunities) gives further credence to the novelty aspect of that art movement.

Taney Roniger: Leonard, I salute your ongoing campaign against intellectual posturing. Practitioners of this sort of thing may think they're acquiring intellectual gravitas by association, but it seems clear to me that they're only hurting art's cause. I think I'll bring this up in a separate post, because it came up at our live event the other night and deserves further exploration. But to Gianluca's last couple of points: one of the things I find most troubling about art's reach toward science is that in becoming more discursive, art becomes increasingly impoverished in its poetic dimensions. Your take on this is really interesting, Gianluca; I hadn't really thought about the relationship between the commodification of art and the preservation of poetry. (And let's not declare it dead! Just dormant, indeed.) If we could see it this way, I'd feel much better about the commercialism I find so pernicious in the art world (I'm not sure I can, however). What I'd like to see is more sci-art that takes on not the (discursive) knowledge-disseminating aspects of science but rather what Margaret Wertheim calls its poetic dimensions. The poetry, she suggests, lies in the *questions.* So far there's been way too much emphasis on the answers.

Suzanne Anker: There is much discussion that references the term "sci-art". Where does this term come from? What is its origin?

Co-production or critique?

Dan Weiskopf

I find it useful to think about art-science interactions in terms of two broad models: co-production and critique. Each of these is pitched at a separate audience, and embodies a different idea about what the two practices have to offer each other.

On a co-production model, artists and scientists jointly aim to create something of potential value to both enterprises. In its strongest form this might mean producing a kind of knowledge (or new data or phenomena) that can be incorporated into science itself. Sciart here is *continuous* with scientific practice. Alternatively, it might mean generating knowledge that is *about* science and relevant to its practice without being directly part of it. Sometimes this is cast not in terms of knowledge but rather as producing a form of “insight” or “understanding”, each of which could be theorized much further. Finally, the hope of collaboration sometimes seems to be that art and science can be engines of discovery for each other. When the “creativity” of each field is emphasized, this notion of reciprocal generativity seems to be in the background. The co-production model tends to view sciart as an inward-looking and mutually beneficial exchange where the main audience is the participants themselves.

Less discussed so far is the critique model, on which sciart takes a more oppositional posture towards the methods, social standing, and products of science. This can take the form of institutional critique or ethical and political criticism, especially of applied technoscience. It can also include challenges to scientific epistemology or rationality more broadly. Art here operates in its perhaps overly familiar “problematizing” role, while science functions principally as the subject matter of art, something to be scrutinized from the outside rather than made into a fuller participant. The benefits of this model for science are not well articulated, particularly when it shades over into more radical forms of debunking or unmasking. Critique of this sort tends to be polemical and outward-looking, aimed at intervening in public debates over the cultural authority of science and raising consciousness about the ways it is transforming the world.

Note that it would be possible to place a more positive valence on the category of critique as well. Sciart that aims to elevate the values and practices of science and to promote them to a wider audience would fall under this heading. This seems to be a form of activism akin to what Eve was calling for; it’s also, I think, implicit in the role art plays in STEAM programs. We might think of this as a “Promethean” model.

Obviously these two forms are ideal types, always intermingled and impure in practice. But they are, to use Taney’s apt term, sharply distinct ways of positioning the *authority* of art vis-à-vis science.

Note to Readers

Taney Roniger

Since a lot of the action seems to be taking place in the comments sections here, I may be re-posting some of the comments in the main feed over the coming days. Until then, be sure to check the comments sections beneath posts.

Initial Thoughts

Sinead Maharaj

Thank you for the invitation to join a great forum. The discussion on the convergence of Science and Art is a personal interest of mine that inspires my work.

To enter this dialogue, I will refer to my initial difficulty, that of how the pedagogy has defined the disciplines of Art and Science, as two very separate ways of thinking. The pedagogy positions our minds to differentiate each discipline, as completely separate. Science is sold to students as the positioning of facts, with evidence to support, making something true or false. Art is positioned as creative thought processes. Through the pedagogy we learn a specific index for both, and tell students they are inclined to think in one way or the other. In the discussion to converge the two disciplines, I guess I ask, why Science and Art are treated as completely different containers in the first place? If we comprehend a world in an amalgamation of science and art, (along with other differentiating disciplines) why do we create a pedagogy that perpetuates a society in which we define science and art so differently from one another?

Ed Kerns: Observation is the root of these two powerful ways of modeling human experience. It is an internalized process of melding memory, sensory data and symbols into a whole. When looking at a Da Vinci drawing we see his “experience” of the skull or the vascular system. His drawings communicate the immediacy and empathetic quality of his observations. Just like most of us can “read” facial expressions and body language, Da Vinci speaks to us across the years with his visual probity. The same can be said of Santiago Ramon y Cajal’s drawings of neurons and brain architecture observed through a microscope. We see the emphasis and delineation particulars of his descriptions.

We have expanded our observations of nature with “artificial eyes” that see into deep space/time and make the very small available for contemplation.

Maybe trans-humanism’s offer of sensory extension and integrated consciousness will remove the carefully constructed walls that exist.

Max More says, “Art in the twenty-first century may come to constitute a form of mediation between human and post-human consciousness, just as in past cultures it has been used to mediate between mankind and the gods.”

My own inclination is to invoke E.O. Wilson's idea of "consilience" where the start point is an embrace of intellectual unity found through the convergence of modeling observations.

Semantic Sprawl

Werner Sun

Thanks to everyone for all the posts so far and for such a stimulating discussion at the opening event on Saturday. There are so many interesting threads to pursue here. But for now, let me begin with a somewhat prosaic pet peeve of mine:

As was alluded to at the opening event and also in several posts here, one barrier to productive communication and collaboration between artists and scientists is the lack of a common language or vocabulary (as in any interdisciplinary endeavor). And this disconnect separates practitioners in either field from the general public as well. It seems to me that these misunderstandings go all the way back to the two words "art" and "science" themselves.

For example, in popular parlance, it is not uncommon to come across phrases like "the science of frying eggs" or "what science tells us about climate change" or "with all the science we have, why do people still go hungry?". These formulations present science as just a set of facts or findings, and they only draw attention to the utility of science for other purposes. But to a scientist, science is so much more than that — it is a whole way of thinking, an open approach to investigating the unknown, sparked by pure curiosity. The heart of scientific research lies in the process, not in any particular outcome.

Similarly, the meaning of "art" is so broad that it can refer just as easily to a mass-produced poster in a dorm room or a diverting preschool activity, as to an Old Master painting hanging in a museum, let alone any of the diverse (and sometimes intangible) forms of contemporary art.

So, if "science" and "art" are both (mis)understood in so many different ways, how can we possibly speak of "sci-art" with any clarity? As both an artist and a scientist, I fully support the spirit of exploration and experimentation behind the sci-art phenomenon. But I worry about misconceptions getting multiplied and amplified when so-called "science" and "art" are randomly paired together. (I acknowledge that such misconceptions might themselves be a subject for sci-art, but I hope they would be addressed responsibly.)

I, for one, am interested in going back to basics, zeroing in on the core concerns of each field, and truly understanding how science and art practitioners view their own work. I think such a low-level conversation would be the first step to envisioning what an authentic practice of sci-art (not "sci-art") might look like.

Linda Francis: Yes, totally agreed!

Gianluca Bianchino: Agreed!

From the Ground Up (response to Werner)

Taney Roniger

Like Werner, I've also been impressed by the enormous range of responses so far, each of which alone could keep us busy for the next few days. But because I so strongly agree with him about "going back to basics," I want to pick up on that thread and see if we can take a stab at articulating the core concerns of each field. Werner has offered up a definition of science that cannot be emphasized enough, and this is that science is first and foremost *a way of thinking*. (Although we collectively swore the other night we'd never mention him again, indulge me here this one last time: even C.P. Snow perpetuated the ridiculous image of science as a grand filing cabinet of facts. One of his many blunders, to be sure.) Would anyone care to offer a similarly succinct corrective on what art is, or what it is not?

James Elkins: Since I'm the one who first raised the C.P. Snow specter, and since you're interested in drilling down to core concerns, let me propose that in this context: "Science" can be the sum total of conversations that begin with such things as $f=ma$, the Second Law of thermodynamics, the difference between velocity and acceleration, etc. "Art" can be the sum total of conversations that begin with such things as modernisms, the avant-garde, the Italian Renaissance, abstraction, realism, etc. In other words: two uncontained conversations, which start from different basic vocabularies. This is what I think is still valuable in Snow's and Sokal's interventions. It helps focus what we might mean, in any given case, by talking across the art-science gap.

Taney Roniger: No, we really appreciated Snow's "rude questions" in your lecture, Jim (and as a huge fan of the hoax, I can never get enough of Sokal). What we all lambasted was Snow's sexist, racist, imperialist, and downright imperious language. I prefer the Leavis comeback, myself. But anyway, one of the objections I have to Snow's argument is that he seems to equate knowledge of facts with their understanding. He makes it sound as though the two cultures problem would be considered resolved if people in the humanities could identify Newton's Second Law, or be able to say whether it was the special or the general theory of relativity that came first. Would that it were that simple! Recitation of facts and figures is hardly a display of real knowledge. As for your definitions, it seems to me, for similar reasons, that art and science are more than the sum total of conversations surrounding them. (A literalist might ask if you're including drunken conversations, but I am not that person!) I tend to see both from the inside out, I guess: as **approaches** to knowledge first and foremost, and only secondarily as the products thereby produced and their historical "situatedness."

James Elkins: It depends on what you mean by understanding.

1. Understanding = inference = being able to draw out consequences and connections. In that case, Einstein had the deepest understanding of physics.
2. Understanding = interpretation = Verstehen = “a process that employs all our capacities and is to be distinguished from pure intellectual understanding (Verstand). (Quoting here from the Stanford Encyclopedia of Philosophy, s.v. Wilhelm Dilthey.) In which case understanding is proper to what Dilthey called the human sciences (arts and humanities), and it shouldn’t be asked of science or scientists.

I like thinking about Snow’s and Sokal’s “rude questions” because there’s a sense in which a person doesn’t understand (properly infer) in a field without knowing its most basic ideas. But lots of fascinating, fruitful conversations can happen between people who don’t understand (interpret, as in Verstehen) quite what they’re saying.

Dan Weiskopf: The last point here is particularly important, Jim, so I’ll just note its obvious resonances with Peter Galison’s conception, in “Image and Logic”, of “trading zones” within distinct scientific subcultures. Galison’s description of how theorists and experimentalists managed to collaborate on local projects despite not having much in the way of common activities, language, or habits of thought might provide a more structured way of thinking about the conditions under which science-art discussions can become mutually productive.

Some quotes for those that don’t know the context of Galison’s model. This is from a later essay, “Trading with the Enemy”, on the way that ideas from one discipline (radio engineering) get stripped down for exchange with another (electrodynamics theory):

“Trade focuses on coordinated, local actions, enabled by the thinness of interpretation rather than the thickness of consensus. Thin description is precisely what makes it possible for the experimentalist and the theorist to communicate, albeit in a register that by no means captures the full world of either, let alone both.”

Further: “it is possible to share a local understanding of an entity without sharing the full apparatus of meanings, symbols, and values in which each of us might embed it.”

Of course in the exchange of concrete goods the benefits to both parties are clear. Similarly in exchanges between separate scientific subdisciplines: what each side takes from the other, no matter how stripped-down, can always be repurposed for their own enterprise. The question then is whether art-science exchanges are similarly mutual, with engagement and benefits flowing equally on both sides, or whether they’re somehow less egalitarian. Sharp differences in power, standing, institutional support, and interest on either side might mean that these partnerships

are doomed to be unstable one-offs (more like brief, boozy encounters) rather than reliable partnerships.

Taney Roniger: This seems to rather nicely delineate the two epistemologies in question here, where *Verstand* would be the kind of knowing science traffics in and *Verstehen* the home ground of art. I suppose it could be argued that both kinds of understanding are operative in both fields, but it seems safe to say each specializes in, or makes it its business to pursue, the one and not the other. I see your point about the value of Snow's argument. I just don't think it's realistic to expect anyone in the humanities to learn — much less understand in either sense — all the foundational concepts of science. That's a high bar, but I think we can do better than relying solely on those rare gems that arise from drunken conversations. I asked Werner, the particle physicist on our panel, what he thinks would help those of us on this side of the two cultures better understand what's essential to science. We'll see what he has to say.

Werner Sun: Thanks, Jim and Taney, for your insightful comments here! I, too, often think about these two types of understanding, but I don't necessarily see one of them as being more relevant to science and the other to art. Even in science, there is a difference between knowing the facts intellectually and knowing them deep down in your gut. And I do think there is a cultural/social element to the second kind. Even Einstein needed help from others to make his breakthroughs.

Typically, what happens is: you learn some facts from a paper or a textbook, and you work out some example calculations to test your understanding of the ideas. But at this point, you don't usually appreciate all the implications of what you have just learned, and you don't have a sense of how these facts fit into the big picture. In my experience, the best way to **truly** understand a scientific/technical idea (*Verstehen*) is to communicate it to someone else. By explaining what you know intellectually and then having that knowledge reflected back at you, you are able to see it through the eyes of others. And this collective experience of that idea allows it to connect to other ideas, and it starts to take root.

Having written all that, I am now more receptive to Jim's definitions above of art and science (which I must admit I viewed skeptically at first). But I would add the proviso that, ideally, the sum total of all the conversations about art and science should be undergirded by understandings of the first kind.

Dan Weiskopf: Here's a brief pass at the question, at least concerning science (and bearing in mind that the history of trying to answer the demarcation question is a dismal and unpromising one).

The sciences are those practices that:

1. Respond to experience in a way that is systematic and organized (regimented by experimental and observational methods)
2. Aim at constructing explanations of phenomena, generating predictions, and controlling and intervening in events
3. Produce ever more comprehensive and refined representations of the world (including theories, models, simulations, atlases, catalogues, etc.)
4. Use distinctive tools and methods, particularly experimental systems, instruments, and other devices of measurement and their corresponding mathematical/statistical formalisms
5. Are organized materially, socially, and institutionally to enable collective sharing and dissemination of results across distributed labs, as well as fractionation of expertise within research groups

These five factors are, roughly, the cognitive, epistemic, representational, methodological, and institutional dimensions that characterize (most) modern sciences. The same scheme is fairly readily adapted to thinking about artistic practice.

Taney Roniger: Thanks for that very comprehensive list, Dan, which I think establishes some helpful parameters. If defining science is perilous, defining art is notoriously more so, but I think it's worth doing — not with the pretense of some kind of claim to finality, but just as a helpful point of departure. In that spirit, I want to offer a very concise definition given by Sian Ede, author of, among other things, *Art and Science*:

Art is "...a reflection of human experience in its complexity [which] emanates from an inventive individual with an unusual and sideways view on things, communicating with vigorous visual acuity and daring, its intellectual content, like that of poetry, conveyed through hints and ambiguities."

What I like about this definition is its emphasis on human experience in its complexity and the "sideways" means by which it is expressed (i.e., through hints and ambiguities). Both these points set it against what we reflexively think of when we think of science (i.e., its third-person objectivity and its exclusive use of discursive reason). But with a view toward moving beyond the usual platitudes, we might find some fertile ground for cross-over on exactly these points. The idea of third person objectivity (what Donna Haraway calls "the god trick") has been sufficiently debunked; perhaps we'll see something of the kind with the myth of science as reason incarnate.

More on How Art and Science Know . . .

Stephen Nowlin

Science, of course, investigates and knows about many things but let's just take one category, astronomy. It's likely that most of the planet's current human population knows through education or at least general cultural awareness that the Earth orbits the Sun and the Moon goes around the Earth. And my guess is that (just speculation here, and despite sporadic droplets of broader knowledge many now encounter through contemporary sources like *Discovery* or *Science* channels, *Facebook* posts, *CNN* headlines, or fading *Sagan-Cosmos* memories), . . . that this simple Copernican Sun/Moon/Earth relationship is about the extent to which a majority of modern humans care or incorporate knowledge of astronomy or astrophysics into their personal existential identities. It seems remarkable to me that an earlier Earth and mythology-centered ontological framework inherited from a multi-millennial past has been so minimally disturbed by the thorough and revolutionary debunking it has experienced during the past one hundred-plus years of astronomical and astrophysical discovery. Throw in Darwinian biology and that's easily six generations of exposure to radical new knowledge that fatally punctures history's persistent and errant memes — yet still they linger and even dominate to cause untold confusion and its consequences.

In the discussion of how knowledge is embodied and communicated differently via science vs. art, I think it is worth recognizing that intellectual pedagogy does not seem to have been very effective when it comes to the task of prying people away from their inherited beliefs and enabling them to change paradigms and perspectives. For that challenge, I think emotion rather than intellect prevails — an emotional epiphany being a more likely successful agent of change than an intellectual disclosure, even when the latter possesses strong supportive evidence. People hang on to their stubborn attachments tenaciously in spite of well-articulated arguments to the contrary, but will relinquish them to emotional enlightenment and declare the experience to have been “profound.” So art has a significant potential role to play in exposing the poetic dimensions of science (which science itself is abysmal at accomplishing) — and which, it is important to emphasize, is not a practice of so-called Scientism or propagandistic marketing, or NewAge fuzzies, but simply recognition that in the scientific rational pursuit and puzzlement over how Nature works, there are deep untapped sensations of transcendent emotion to be found, pondered, and exposed. We, the lucky finders of beauty where it wasn't meant to be.

Taney Roniger: This is a really convincing (and moving) argument for the potentially profound role art might have in the transformation of our culture. I couldn't agree more about the failure of reason to convince. (One could argue that reason is what got us into this mess in the first place, this mess being our ecological crisis. How, then, can we expect it to get us out?) The real changes happen on the level of the unconscious, which is why I find art such a powerful force. On this issue I'm fond of citing George Lakoff's claim that 98% of human thought is unconscious. If that's where we do most of our thinking, any language

that can shoot straight there is bound to be the most effective. Perhaps others will chime in on this idea that you've elsewhere referred to as a new "secular poetics." There seems to be so much fertile ground there for an art-science exchange.

Werner Sun: This is beautifully stated, and I could not agree more. (See one of my comments to Taney's "Moderator's Welcome"). Do you have any favorite examples of science being communicated with emotional resonance and integrity?

Linda Francis: I agree as well with one exception: Taney, that reason has gotten us in trouble: I don't think so - the politics of self-interest and monetary gain have gotten us into trouble.

Taney Roniger: Well, I'm looking a little further back than the spectacular debacle that is unregulated capitalism. For me, it all started in the Enlightenment, when the dreams of reason promised nothing short of salvation. As laudable as its intentions *may* been, the mechanical worldview ushered in then has had some really pernicious consequences, and it remains, all these years later, thoroughly entrenched.

Stephen Nowlin: Werner, a few come immediately to mind. There is the classic moment we all remember in Kubrick's 2001 in which an early prehistoric Hominid has the epiphany to use a deceased animal's thigh bone as a tool, throws it into the sky, and as the camera follows the lofting bone the film cuts to a 20th century satellite floating in the darkness of Earth orbit. Stunning, chilling, the thread connecting space exploration to primitive tool-making, anthropology and evolution to the discoveries of orbital physics, all packed into a single film splice.

Also, in a recent art-science exhibition I included a clip of the first ten minutes of Hungarian filmmaker Bela Tarr's Werckmeister Harmonies, in which a somewhat inebriated group of bar patrons act out the physics and poetics of a solar eclipse — poignant, humanizing. <https://m.youtube.com/watch?v=GRnaC9GhdjA> .

Or a different kind of experience, an installation from 1993 that I included in a survey of San Francisco electronic wizard/artist Jim Campbell, his homage to Werner Heisenberg's Uncertainty Principle. You enter a room with a spot-lit pedestal topped with a transparent acrylic lid, inside of which there sits a small Buddha statue atop some paper with writing. Entering the room you see it clearly, albeit from a distance that thwarts detail — but as you approach for a better look and the closer you get, the contents progressively disappear into a thick fog and thus prevent the precision associated with detailed inspection. Still it is nonetheless strikingly beautiful, even while not fully understood and disobedient to the expectations of observation. All this realized in an immersive, self-guided experience.

http://jimcampbell.tv/portfolio/installations/shadow_for_heisenberg/

Or for that matter, how about Charles Ives' "The Unanswered Question?"

Lorrie Fredette: In some broad way, are we suggesting artists can be gentrifiers of science?

Stephen Nowlin: I get what you mean, but gentrify doesn't sound quite right to me. I might say poeticize, instead, although it's maybe just semantics. But I don't think it's so much about beautifying science as it is liberating it from those shackles designed to keep science culturally restrained and in its proper place as a merely practical, mechanical world view — a how without any why, facts but no meaning. To find its poetic is to create chaos for the stereotype that science has no soul — and that is tremendously subversive in theocratic countries as well as semi-theocratic cultures such as the U.S. and many others.

1.5: There is no sci-art

Linda Francis

Science can be the subject of art, just as reason can be a method or operation in making art and then in understanding it. It can be style. But the appellation “sci-art” is a brand, a useful commodification just as the embrace of science in the popular media is a necessary sale to the public in a world which is increasingly underpinned by the sciences. The allure to artists: the gorgeous imagery, structure, form of the macro/micro revealed in photographs and stories of escape from society's more clearly repulsive spectacle. It opens onto the usual discussions of aesthetics in terms of questions of beauty, truth, the ideal, resonance, et al.

M. Ricciardi (reader): The topic is worthy of debate, but the assertion here of the non-existence of “sci-art” is tenuous — perhaps because of its (seemingly) narrow defining. Sci-art isn't just about beautiful images taken from, or captured with, scientific imaging tools; sci-art is equally about utilizing scientific principles, processes, and mechanisms to explore, or reveal, possible artistic values and meanings (and document these, as in the creation of sci-art works) given the pervasiveness of Science in our lives. Further, it may also attempt to re-appropriate scientific artifacts (e.g., data visualizations), placing these in new or odd contexts, so as to reveal other purposes, perspectives and meanings not normally associated with these artifacts. They even may be utilized to construct a narrative (fictive or real or a hybrid of both) that reveals a socio-political dimension, as with sci-art that raises ethical/moral questions about the direction of certain scientific disciplines, like molecular biology and genetic engineering). Sci-art is.

Response to Session I

Jeanne Brasile

In thinking about the idea of a ‘convergence’ between art and science, I see this not so much as a union of two disciplines, but rather, a meeting of the minds. Sci-art is a trend, a catchy name to describe something that artists have been doing quietly for some time

without an official title. If you think back, Sci-art has pretty much always been ‘a thing.’ Georges Seurat was studied in the science of optics. Robert Smithson was interested in the geometric properties of molecules and crystalline structures. Kenneth Snelson worked with the forces of physics and was inspired by atomic structures.

We like to name and organize things, it’s a human tendency built of our desire to make meaning and understand. Sci-art is another way of compartmentalizing an array of artistic and scientific approaches that are innate, and needed no name until rather recently – when marketing intervened and fads, then later memes, became the dominant culture. We get intensely interested in ‘things’ for a short amount of time. Then we move to the next obsession. Sci-art is now having its moment as a meme, but I suspect it will continue to be a way of relating to the world even when it’s no longer cool to be a Sci-artist.

Isaac Asimov said “Any increase in knowledge anywhere helps pave the way for an increase in knowledge everywhere.” Perhaps that is where the complementary relationship begins. Not that art and science will meld, but perhaps they can share ideas, methodologies, ways of thinking and seeing that stem from the other side. While artists and scientists surely have commonalities that many of us have elaborated on and to which we can agree, the essence of an artist is to create freely and generally without restriction. There are exceptions, such as artists working on commissions and those who are pressured by collectors or gallerists to create in a certain way, but that too is a choice and not a mandate as to working conditions. Artists are generally self-employed and can dictate their own work flows, benchmarks of success, investigations, etc. Scientists are usually in the employment of an institution and must have demonstrable results to show at the end of a trial, study, experiment, project or investigation.

Using the example of science-fi, it’s clear that science fiction is a literary genre. Nobody construes sci-fi as actual science with literary underpinnings. It’s clearly literature but it is definitely informed by science while not being held to the scientific truth of laws, or even theories. Science fiction can be pure imagination and that is where the artistic can play a part in the relationship between art and science. Art can offer a way of seeing and thinking outside normative scientific methods. The artist potentially benefits from this relationship by having access to tools, materials, technology, methodologies, fact-checking and raw materials to which they would not normally. For the artist, the relationship is more pragmatic. I think for the scientist, it could be a pragmatic relationship, that artists might help them solve problems through different ways of approaching a challenge, but ultimately, I think scientists kind of think artists are sexy and like many other people, they may like basking in the residue of this appeal that artists may bestow on them.

Taney Roniger: I’m glad you brought up the comparison to sci-fi, Jeanne. I think it’s such an important point, because that model seems particularly promising to me where sci-art is concerned. Some of the most probing and philosophically trenchant films I know of fall into this category (Tarkovsky’s *Stalker* and *Solaris*, Ursula K. Le Guin’s *The Lathe of Heaven*), although calling them “sci-fi” seems

slightly unfair for some reason. At its best, the genre can ask the big questions that need to be asked — where are we going as a species? What kind of Faustian bargain have we before us? — in a way that stirs us deeply without being overly didactic. So far, very little sci-art has reached this level of probity. It seems to me that if this is where we want to go, we have to abandon certain pretenses, the first of which is that we're somehow doing “real” science. This is why I'm particularly keen to see more of what Dan Weiskopf has delineated as sci-art in “critique mode.”

Jeanne Brasile: I agree that Sci-art's potential (and perhaps when it is functioning at its highest level) is when it does not attempt to replicate or undertake the scientific in a literal manner. Its value is in its desire to simply ask questions, or posit possible meanings. The value of artists is that they are encouraged to daydream about matters that are incomprehensible. I also agree with Stephen that being in the center of this phenomenon, it's way too early to tell what the future of Sci-art will be. This will require the distance of time to sort out its relevance in the long term, but I do believe that Sci-art (whatever it may be called in the future) will continue to endure.

Stephen Nowlin: I agree with Jeanne that Sci-Art will continue to be a way of relating to the world even as it morphs into the future, and I think it's an important topic to try and unpack. For the moment, Sci-Art criticized as a kind of fad or fashion, temporary obsession, etc, is something to which it is vulnerable, and one which may be helped by discussions such as these that provide some historical perspective.

One lens through which to view that history begins in the mid-nineteenth century and the gradual metamorphosis of representational painting into abstraction and non-objectivity by the early decades of the twentieth century. It is not accurate to declare the period to have begun a permanent decline in representation and its symbolisms, since to this day representational art persists in abundance. But I think it is accurate to say that the introduction of abstraction created not just a new vocabulary of forms, but added a new ontological paradigm that competes still with the older one, a path for art that, it bears mentioning, paralleled the emergence of a radical new scientific worldview during the same mid-1800s period (Darwin, Pasteur, Planck, Einstein, etc).

Up to that time, traditional cosmologies were dominated by fictional/supernatural beliefs about how the world was ordered, and they were given form in the pictorial/fictional space of representational painting. One might claim that to the degree science of the period challenged such traditional models of reality, the traditional authority of pictorial space as an adequate place for art to symbolically represent a changing paradigm, became suspect — and art responded by transforming paintings from being windows through which one peered into fictional/pictorial worlds, to paintings being actual real objects in the same space that art's creators and onlookers themselves occupied. Abstraction closed the

window of painting, and by the time Mondrian, Malevich and others had turned paintings into objects on a wall rather than windows to look through, art can be interpreted as having declared aesthetic experience and its commentaries could, or should, exist in the same world as the one that science was studying. Metaphorically, this switch from pictorial to real can be claimed to have echoed the way in which scientific discoveries of the same period challenged the authority of the fictional/supernatural and substituted the real/natural as explanations for ourselves and the universe.

During the course of the 20th century, one art movement after another reinforced the paradigm of art as real object, from the New York School, Abstract Expressionism, Minimalism, Earthworks, Art and Technology, Media Art, Installation art, to Interactive art in which the spectators themselves are active forms of the experience — and I propose that all of these can be seen as having embodied the trend-to-real originated in the 19th century as foundation for an eventual emergence of Sci-Art. Although it may likely someday acquire a different name or a further evolved consciousness, Sci-Art is I think a part of this longer continuum, is just emerging, and is not in any way a fad.

Questions for Jim Elkins (and link to Saturday's lecture)

Taney Roniger

Since those of you who attended our opening event may have had questions for Jim after his lecture, I want to let you know that he'll be with us here until tomorrow morning and then back briefly early next week. Whether you were with us on Saturday or not, you may want to take this opportunity to engage him on his views about art and science. Here's a link to his lecture at CUE:

<https://youtu.be/o62nyrpcMk0>

(Use the comments section at the bottom of this post.)

Response to Taney's post On the Question of Audience

Daniel Hill

I used to like to make a thought experiment of trying to imagine the edge of any material object as magnification is slowly and steadily increased. Physics has shown that any solid object is mostly empty space, so at some point in magnification, the boundary between the thing and no-thing would become difficult to determine. Since thinking about the line between art and science can feel like wading into quicksand with no possible outcome, I like to think in terms of perspective. One thing we can be sure of is that our tenures on this planet are exceedingly brief. The universe exists more without humanity than with us. The vast majority of species that have existed on this planet have gone extinct. Until the 1920's the universe was only as big as the Milky Way Galaxy

until Edwin Hubble made his breakthrough discovery. Now with the dark matter/dark energy problem, the fact that all the matter humanity has ever studied only constitutes 4% of the known matter in the universe, we actually know less proportionally than ever before. If we look at our history we see that the models we have created to explain the universe and our place in it have very frequently been wrong, but a zeitgeist of arrogance kept us from making the realization. Stephen Hawking talks about this Model Dependent Realism in his book *The Grand Design* saying it serves us well to assume that whatever models we construct are likely to be wrong and will need to be amended or scrapped altogether at some point. Paradigm shifts, if they do indeed occur, come from the places we least expect. This does not mean that a connection between art and science will usher in a paradigm shift, only that a more collectively open mind might help us to advance a bit quicker in identifying where our models are wrong.

It is stuck in my mind how just a week ago I was in downtown Manhattan trying to excite students on the importance of art, but the students were distracted by the steady loud thrum of helicopters and the wail of sirens. Just a few blocks away, eight people lay dead from an unimaginable act of a sick mind. Some part of our model is definitely flawed. There is a sense of urgency.

As someone who has devoted my life to art, I know art has the power to serve individuals and society in a way that is far from being utilized. It would seem that to hedge our bets would be smart in hopes that something may come from an apparently barren realm. Compared with other current avenues, the pursuit of art and science seems a harmless bet. The question remains: if some form of art and science moves forward, will it be more decorative data or the catalyst of human transformation? In my opinion, education is the absolute priority.

Response to Stephen Nowlin's List of Successful Sci-Art Works

Werner Sun

Responding to: <http://strangeattractors.cueartfoundation.com/more-on-how-art-and-science-know/#comment-66>

Stephen, thank you for your list of successful sci-art works (link above). Each of them is unique and wonderful, and they certainly incorporate scientific ideas in surprising ways. But what's interesting is that, if I had encountered any one on its own, I would probably not have identified it as sci-art per se (except the Jim Campbell, and only then because of its title). Even the Bela Tarr film, which makes the most explicit use of science, strikes me simply as superb filmmaking.

Why has the "sci-" prefix primarily been applied to visual art (your one musical example notwithstanding)? Why wouldn't we refer to a poem about the solar eclipse as sci-poetry? [As a concrete example of science in poetry, I would offer [James Richardson's "Essay on Wood"](#).] A related question: how has sci-fi seemingly transcended its prefix?

I think a common thread in all these works is that they wear their science lightly. They take the science as a given, as a pre-existing part of our common vocabulary. They respect their audiences, and they do not seek to instruct.

Response to Suzanne Anker's question about "sci-art"

Taney Roniger

Suzanne asks: "There is much discussion that references the term 'sci-art.' Where does this term come from? What is its origin?"

My understanding is that the term first appeared in popular parlance around the year 2000 in relation to the Wellcome Trust's trailblazing sci-art program that ran from 1996 to 2006. Apparently it had been coined in the 1960s by an American artist and scientist named Bern Porter, but didn't really catch on at the time.

I find it a somewhat problematic term. Others have been proposed (e.g., art-sci, art-science), but the main idea is the same. I often find myself wishing we could replace it with something else — something a bit less misleading — since language is notorious for perpetuating misconceptions. Perhaps someone will want to take a stab at that here?

Dan Weiskopf: I tried to trace the term's origin and this is what I concluded as well. Incidentally, the Wellcome Trust's Sciart program published an evaluation in 2009 that's worth a look in the context of these conversations. Just look past the usual jargon of outcomes, qualitative indicators, forms of capital, and so on: https://wellcome.ac.uk/sites/default/files/wtx057228_0.pdf

Taney Roniger: Thanks for posting the link to the Wellcome document, Dan. Having read about the project over the summer, my impression was that a lot of the artists involved felt dissatisfied with how the scientists they worked with perceived them and, consequently, the work that was produced. A lot of them felt they'd been invited to make art *in the service of science* — i.e., as part of some kind of PR initiative geared toward making science more friendly and accessible to the general public. This is of course thoroughly consistent with some of the other art-science collaborations cited in this forum. (Jim Elkins has suggested that the problem is irreparable. Most scientists just aren't interested in understanding art in any depth.) That said, many artists don't seem to have a problem with serving as the handmaidens to science. Witness the recent New York Times article that was widely circulated (and lauded) among artists:

https://www.nytimes.com/2017/09/12/t-magazine/art/artist-residency-science.html?_r=0

(Perhaps it's telling that the article appeared in the Style section?)

Michael Ricciardi (reader): Perhaps the debate of the meaning or purpose of ‘sci-art’ results from the placing of ‘sci’ before the term ‘art’. That said, I have no problem with the term as is. Further, in no way have I ever felt that this meant “Art in the service of Science”... Consider the 2015 exhibition at the Hall of Science Museum in NYC (which I participated in) called ‘Science Inspires Art – The Brain’

[<http://web.archive.org/web/20160330064431/http://www.asci.org/artikel1369.html>]. The exhibition of some 40+ works included several works that were both humorous and /or questioning of cognitive (“brain”) science, and a few that appropriated the theme to explore personal issues such as mental illness. All of the works chose to explore a rather diverse field of topics or perspectives in regards to “the brain”; nothing that I saw there could be considered “Art in service to Science” I am not saying that such art does not exist, nor, that some sci-art exhibitions promote this approach (if only as an unconscious bias)... only that this is not what sci-art is (for more on my view of sci-art, see my comment under the topic ‘There is No Sci-Art’ on this blog).

Also: I would quibble a bit with the claim (above): “Most scientists just aren’t interested in understanding art in any depth”

Many scientists are in fact artists of some type (e.g., musicians, poets, painters, photographers) and many come from liberal arts (college) backgrounds before they chose to pursue their science degrees (so they do have some background in the humanities).

This view may unintentionally reinforce C. P. Snow’s “two cultures” dichotomy... when the truth is more fuzzy than that, and, increasingly, scientists (especially neuro-scientists like Dr. Anjan Chatterjee who co-curated The Brain exhibit) are seeing the tremendous value in exploring the aesthetic/poetic (and “epistemologic”) aspects of the sciences.

What is becoming even more clear (and crucial) is the need for collaborations between artists and scientists to do two main things: communicate science more effectively to the public (given the current rejection of science by the extreme political Right and Left wings), and, to “bridge” the gap between what science is doing and what the public believes or understands about this activity (including addressing ethical concerns and future courses of societies in which science operates most forcefully). This collaborative approach may be all the more important given the advent of Artificial Intelligence and robotic automation that seems to be taking over our society.

Perhaps, if Art is “in the service of anything”... it is in the service of society, the public good... which ain’t such a bad thing, y’know?

Gianluca Bianchino: Hi Michael, I think you make a great point about art working in service of society. However, there is some difficulty by the larger

public in understanding the value of art past its economic merits and the general idea that it is humanity's prime discipline for "creativity". I keep linking the problem of not understanding art to a persistently archaic educational system that seems to be designed to generate workers rather thinkers, or "critical thinkers" for that matter.

It is true that scientists do like art and they often have an art hobby but it seems more so, in its habitual inclination, focused on an appreciation of skill. Some scientists do make the effort to cross over and force themselves to understand art from a philosophical perspective. When in conversation with astronomers about potential projects and collaborations they do seem to grasp my artistic gibberish, but with an almost sense of surprise, as if they weren't expecting art to go there, as in past representation or a common use of symbolism. Interestingly enough, Einstein apparently was very much a fan of the arts but strictly in the classical tradition, both music and painting. When confronted about Cubism he didn't think much of it, despite some attempts during his time to link Cubism to the theory of relativity. The theory of Cubism to Relativity is quite fascinating to me, and if at all far fetched it still makes a great argument about Cubism being significantly more in tune with the emerging science of its time, Relativity in particular, than any other movement, especially in how the cubist picture generates a quasi tangible experience of time on the two dimensional surface. A few years ago I became very curious about the flawed perception of Cubism even by the art community which often views it as a kind of default shattered mirror effect, and less so for its deeper dimensional implications. Perhaps Picasso painted too many vases!...I'm not sure, but that story told me that it was not going to be simple to get scientists to truly grasp the abstract arts past any initial aesthetic allure. On the contrary what's interesting is that artists do get science when it comes to its deeper quest. For some artists (like myself) the challenge is getting past the language of mathematics, but when science is discussed and presented in more philosophical terms most artists understand where that experiment or scientific theory is headed. So perhaps while scientist might be interested in art as an attitude it's rather clear that art looks to science for a deeper understanding of nature.

Gianluca Bianchino: Hi Suzanne, good question. I didn't know the answer so I began an internet search and so far, while my search is not conclusive, the evidence points to an old British publishing company called Sci-Art Publishers, out of Cambridge. From what I can see some books date as far back as 1927 and cover topics such as science fiction, Freudian psychoanalysis, and secularist philosophy overall. Nothing so far about the visual arts, at least as far as the book covers show. It could be a question of collective consciousness. The term may have been in the air waiting to be forged by different entities not necessarily aware of themselves? As a child I thought about the image of a melting clock several times, then I went to art school and found out a famous artist had already done that. Bummer!

Comment from reader Michael Ricciardi

Taney Roniger

We've received an impassioned comment from one of our readers challenging some of the statements that have been made here. In my great appreciation for the push-back, I'm reposting his comment here for anyone who might be interested in responding. Thanks for offering your perspective, Michael!

Michael Ricciardi/ Perhaps the debate over the meaning or purpose of 'sci-art' results from the placing of 'sci' before the term 'art'. That said, I have no problem with the term as is. Further, in no way have I ever felt that this meant "Art in the service of Science"... Consider the 2015 exhibition at the Hall of Science Museum in NYC (which I participated in) called 'Science Inspires Art – The Brain' [<http://web.archive.org/web/20160330064431/http://www.asci.org/artikel1369.html>]. The exhibition of some 40+ works included several works that were both humorous and /or questioning of cognitive ("brain") science, and a few that appropriated the theme to explore personal issues such as mental illness. All of the works chose to explore a rather diverse field of topics or perspectives in regards to "the brain"; nothing that I saw there could be considered "Art in service to Science" I am not saying that such art does not exist, nor, that some sci-art exhibitions promote this approach (if only as an unconscious bias)...only that this is not what sci-art is (for more on my view of sci-art, see my comment under the topic 'There is No Sci-Art' on this blog).

Also: I would quibble a bit with the claim (above): "Most scientists just aren't interested in understanding art in any depth"

Many scientists are in fact artists of some type (e.g., musicians, poets, painters, photographers) and many come from liberal arts (college) backgrounds before they chose to pursue their science degrees (so they do have some background in the humanities).

This view may unintentionally reinforce C. P. Snow's "two cultures" dichotomy...when the truth is more fuzzy than that, and, increasingly, scientists (especially neuro-scientists like Dr. Anjan Chatterjee who co-curated The Brain exhibit) are seeing the tremendous value in exploring the aesthetic/poetic (and "epistemologic") aspects of the sciences.

What is becoming even more clear (and crucial) is the need for collaborations between artists and scientists to do two main things: communicate science more effectively to the public (given the current rejection of science by the extreme political Right and Left wings), and, to "bridge" the gap between what science is doing and what the public believes or understands about this activity (including addressing ethical concerns and future courses of societies in which science operates most forcefully). This collaborative approach may be all the more important given the advent of Artificial Intelligence and robotic automation that seems to be taking over our society.

Perhaps, if Art is "in the service of anything"...it is in the service of society, the public good...which ain't such a bad thing, y'know?

Taney Roniger: For some reason I'm having trouble with the link that takes you to the show itself. I can open the review, but I'd really like to see some images.

Taney Roniger: Michael, let me first say that I absolutely love that last bit of your post. Hear, hear! I am all for more art in the service of society.

And while I can't legitimately opine on the show you mention (I still can't open the link), I can nevertheless make a few general points.

First, I'm always happy to hear about scientists who are interested in art. I acknowledge that they do exist, but it seems pretty clear they constitute a tiny minority. (This may be changing, and I hope it is, but right now I feel okay standing firm in that statement.) That said, I'm often disappointed when I discover that scientists who claim to have a more than superficial interest in art betray an understanding that is in fact rather superficial — or at best ill-informed. Take, for example, Erik Kandel, the neuroscientist at Columbia. As I'm sure you well know, he's written extensively on the art-science nexus, most recently in his book *Reductionism in Art and Brain Science*. While I applaud the effort to link the two different reductionisms, his knowledge about art betrays some disturbing holes. From what I can tell, he seems to think art was an all-male enterprise that ended somewhere around 1960. If he's so interested in abstraction, you might think he'd have noticed that there's plenty of it being made today that's both fantastic and challenging — quite a bit of it being made by (gasp!) women. (And while I did enjoy reading his descriptions of brain processes, I find his thesis somewhat wanting, but this is another subject.) Similar betrayals of ignorance can be found in other popular sci-art books penned by scientists (e.g., Arthur I. Miller's *Colliding Worlds*, Leonard Shlain's *Art and Physics*). Don't get me wrong — I'm sure these are all brilliant people. But my feeling is that anyone who's spent his entire career immersed in science simply doesn't have the time for an in-depth study of art. So if the scientist you cite is in fact deeply knowledgeable about art, he's a member of a very exclusive club, and I applaud him for it.

But here is perhaps a more interesting thing to discuss. As an artist whose work has been shown under the name of sci-art, I've thought long and hard about the issue of "content" — and not without a certain amount of unease. The thing that troubles me is that I'm not so sure beautiful paintings of neurons amount to anything more than beautiful paintings of neurons. I'm not knocking beauty (I'm actually a fan). And I'm not knocking the pedagogical value of imagery that reveals the hidden structures of the world (we're all especially fascinated by our own interiors — witness the fantastic success of mega-shows such as *Body Worlds*). But does it have the complexity and profundity you expect from great art? I'm somewhat dubious. It seems to me that if a work of sci-art is to meet the normal criteria for substantive art, it has to do more than show me what

something looks like. I don't have the answers, and I don't pretend to. But I think it's worth asking ourselves some of these difficult questions, even if it makes us uncomfortable. I'm immensely grateful for your contributions here, Michael – this is exactly why we're here!

Chris Arabadjis: I think there is a difference between being “interested in understanding art at any [appreciable] depth” and being willing to discuss one's relationship to it. Not to cement the differences in perspective between science and art, but I believe it's important to recognize the difficulty. It's much easier when speaking with one's partner to address someone else's relationship than to address one's own. In the same way, a scientist and an artist who have traditionally operated under different ground rules must look beyond their own practices. How does a scientist who must adhere rigorously to the scientific method open up to the possibility of learning from art?

Taney Roniger: I'm quite sympathetic to the problem, Chris! It's very difficult for anyone to reach beyond their cognitive habits and natural temperament to do *anything*. But this doesn't mean it can't be done. I guess what I find puzzling is the presumptuousness of certain scientists when it comes to this issue; as I said somewhere earlier, it's one thing to be interested in something foreign and to walk that shaky bridge, but quite another to presume to speak authoritatively on the subject. I've always been interested in neuroscience, for example. But as much as I know — and it's got to be terribly little! — I wouldn't dare write a book about it claiming to be some kind of authority. Maybe it's just me, but if I were going to write that book I'd get a neuroscientist on board as my stalwart co-author.

A couple of other loose ideas

Elaine Reynolds

People on the thread talk about science as a way of thinking and I agree. However, in my view science is carried out less like the traditional scientific method we all learned about in high school and more like an exploration. It is often a flawed enterprise. For example, the current connectome project, which seeks to map structural and functional connections in the brain, is not a hypothesis driven project; it is a collection of data points that can be explored for pattern and purpose. This was also true of the much maligned human genome project. Bias and interpretation is a huge part of science. The idea of scientists as objective viewers of reality is a farce. Unconscious bias creeps in to perturb objectivity. Results are fit together like a jigsaw puzzle and puzzle pieces rarely fit together neatly. As I said [at our opening event], my advisor taught me to really dig into the pieces that don't fit into that puzzle, but I am not sure how common that is. Data is interpreted, including which data to keep and what analysis to pursue and so on. I see scientists often searching for support of their own ideas, rather than the truth. And science is in the midst of a “reproducibility crisis” since many experiments especially in psychology can't be reproduced. The only way science makes progress is through

collective action that swamps out the bias and mistakes. I often say that scientific data leans toward the truth.

As science moves towards trying to understand systems, it uses modeling as a way to understand complexity. So in this way, science becomes like art in the sense of modeling reality rather than exploring reality directly. If art models reality, can science use art to create models of complex systems?

And I think we could talk all day about the role of the rational and emotional in science communication. I think our culture is driven by emotion and fear, so maybe it's no wonder that scientific thought and evidence are taking a back seat. Maybe scientists should start using emotional rhetoric rather than data as they talk about climate change. Maybe art could help science describe the world we are becoming.

Taney Roniger: Elaine, I find your take on things particularly exciting, because as a scientist you see so clearly (and have articulated so strongly) where science has reached a wall, and where it could really use art's help. For our readers here, I wonder if you could say a few words about the problem of reductionism — about how that tradition within science, as successful as it has been, has proved inadequate when it comes to the problem of consciousness (or emergence in general). I know a lot of artists are interested in the phenomenon of emergence, and you seem to suggest that we're uniquely qualified to help in this regard. So far, however, much of the work I see that engages the subject contents itself with the visualization of emergent properties (typically in abstract, pattern-oriented work), and I find myself wondering if there's something we can pursue *beyond* visualization. Your talk on Saturday piqued the interest of many; it might be nice to share some of that with our reading audience.

Elaine Reynolds: Thanks, Taney for the opportunity to speak on Saturday and for facilitating the engaging conversation of that evening and here online. I believe science has been dissecting reality for so long that most scientists are not trained in thinking about systems as a whole. It's as if they have taken the car apart and can't put it back together. They can't figure out how the parts create the mechanical object, and the problem of how the car becomes more than a means of transport is beyond scientific thought. We know how individual neurons work and all the molecular details of their function and we are currently characterizing how all the neurons in the brain are connected to each other. We are beginning to understand how circuits form the informational basis of processing in the brain. But we have a significant understanding gap when it comes to how this processing leads to behavior or cognitive functions that we observe at the systems level. I believe partnerships between artists and scientists could help tackle these problems because they have different training and perspectives. An example of an artist who I believe is making a significant contribution in this way is Ellen Levy (a recent interview is here <http://www.artcritical.com/2017/05/30/joyce->

[beckenstein-with-ellen-k-levy/](#)). Her work on complex systems creates analogies and juxtapositions that are useful in thinking about the neurological processes like attention and information flow. This is more than just using science as an inspiration for work or the output of processes, but imagine how the processes themselves might work.

Lorrie Fredette: A few random questions and thoughts:

When the focus of the art shifts to the output of processes, is it still art? Is it an example of visualization, factual or abstracted?

Could we consider the realization of a work of art and/or the modeling of current data at a “resting point”? Data is ever changing and many artists consider their work at a stopping point to be intervened at a later time while others may deem it a finished piece.

Elaine Reynolds: I am not a person who is comfortable defining art. I think the collection of data hits a resting point much like a piece does. But I think science never feels finished to me. Do artists finish exploring an idea in a piece and then go on to explore an idea further in another piece? That feels like what I do in science.

Werner Sun: Good points, Lorrie and Elaine! It’s a cliché, but for me, both science and art are more about processes than outcomes. In art, every piece spawns another. In science, every answer leads to another question.

Werner Sun: Thank you, Elaine! I will respond more fully to your intriguing ideas in a separate post, but as a footnote here, I just want to bring up a minor quibble. On the subject of the reproducibility crisis and bias, I agree that science is practiced by humans, and that humans are flawed. But this is not a static condition, and there are many subcultures in science. In my own field of experimental particle physics, we have (in the last two decades) become hyper-aware of our own biases, and we now take blind analyses extremely seriously. We have also adopted a very high bar for claiming discoveries — the so-called 5-sigma threshold, which means the chance of an observation being caused by ordinary processes (the so-called p-value) must be less than 1 in *3.5 million*. In contrast, the published results that spurred the reproducibility crisis only had p-values of less than 1 in *20* (i.e. they were 175000 times more likely than 5-sigma result to be later refuted, which they inevitably were). My point is that not all of science is going through a reproducibility crisis, and it seems to me that steps are being taken to address the problems.

Elaine Reynolds: Your quibble is acknowledged and accepted. I did not know about the steps that physics has been taking to improve the rigor of that discipline. As you said, the difference in probabilities that are being accepted by your field and mine are astounding on their own. Rarely do biologist or neuroscientists do

tests under blind conditions. I also find that design of experiments and application of statistics is problematic in biomedical science. Interestingly, I use papers published in top journal as exercises for my students to use in critical analysis. But it's good to hear that this problem doesn't occur in all fields of science. I guess my main point here was to point out that science is not a rigid set of practices. I felt like some commenters were contrasting science as a discipline filled with reason and I wanted to point out the flaws and interpretation in the practice of science. Tell me if I am wrong but in physics as well as other sciences, one experiment or paper rarely shows anything on its own. Findings have to amass and be confirmed. And this helps sort through any flaws in individual experiments.

Werner Sun: Thanks, Elaine! Yes, statistics is a dry but necessary subject... And yes, science is not rigid at all. You're right that the right answer is sometimes slow to emerge (for example, take the pentaquark confusion: <https://www.symmetrymagazine.org/article/september-2006/the-rise-and-fall-of-the-pentaquark>). But also sometimes not (like the recent observations of gravity waves). Both of these are unusual cases (on opposite ends of the spectrum) in physics.

Chris Arabadjis: Thanks all for providing so many points of clarity. I liked reading about Ellen Levy's work and her relationship to the work of individual scientists. Elaine, it sounds like your view is that artists and scientists can both inspire each other and interpret what they are learning from the other. Question: should science with its quest for precise statements (least ambiguity) and art with its penchant for layered meaning (including ambivalence) change their respective modes of communication? Lorrie's question about visualization and Werner's reminder that each is a process makes me wonder about the different steps in reporting results: artists exhibit a body of work and scientists write papers. Each must satisfy their field's respective gatekeepers: gallery curators and peer review editors respectively. Do these institutions need to change in order to promote the possibility of more dialogue? And if so, does anyone have suggestions about how?

Werner Sun: A provocative comment, Chris. I think the markets would have to shift drastically. In academia, there has been an upsurge in interdisciplinary initiatives. But these initiatives tend to insist on superficial "deliverables". There is meager incentive for (and high barriers to) engaging in the unseen hard work of honestly exchanging ideas. Changing that reward structure would take (institutional) courage to fund the process even when there are no tangible outcomes.

Luis Schettino: I would like to stress the idea that the fact of interpretation in Science is particularly relevant to this discussion. In order for a person to 'notice' something it has to be perceived as salient from the background of all other things being sensed. Scientists' biases (their previous knowledge, their methods, etc.)

render them able to notice just a fraction of all that could be noticed. Artists, with their different set of expectations, may be able to perceive and express another fraction. The collaboration of Art and Science, in part, could take the form of a reciprocal re-focusing of attention if we let it. That is, if a vigorous field of Art/Science practitioners reaches a critical mass.

Werner Sun: This is an excellent point, Luis. When analyzing data, scientists must decide what is signal and what is noise. The signal is the star of any published result. In contrast, artists might be able to find beauty in the noise. More generally, the act of measuring any object must promote some of its qualities over others — if one only measures the height of a box, one ignores its length and width, color and mass, material and... Hence postmodernism's rejection of reductionism. But this winnowing of reality occurs even with information we gather involuntarily through our senses — sensing is measuring, after all. So, one can never completely know an object through measurements, but one can imagine it through art.

SESSION II

Taney Roniger

Moving into the second session today, I've a strong feeling we're just getting warmed up. There have been so many thoughtful and provocative posts and comments here that many people have asked if the dialogue will be archived. I'm happy to say that indeed it will. In what exact form remains to be determined, but my hope is for some kind of print publication. I'll be sure to keep everyone posted.

While the opening session sought to clarify some of the language surrounding sci-art, Session II will encourage us to undertake some introspection as we examine the underlying attitudes, assumptions, and motives of the movement. Doing so will set us up nicely for the exploration of the various sci-art practices to follow. My hope for the next two days is that we'll hear from some of our readers who've had a chance to reflect on the art-science nexus. Below are the questions we'll be addressing:

SESSION II

A Look Within:

Examining Implicit Attitudes, Motives, and Assumptions

2.1 What is it about contemporary science that makes it so inviting of art/science comparisons and so ripe— if it is—for interdisciplinary collaborations?

2.2 What are, and have been, the power dynamics between the two fields, and how might these be shifting with the convergence in question?

2.3 How does sci-art relate to the larger trajectory of postmodernism and its as-yet-undefined aftermath?

2.4 Given that one of art's most hallowed roles has been as a vehicle for transcendence, how does sci-art position itself with respect to this tradition?

2.5 How does sci-art relate to the larger cultural movement toward what E.O. Wilson calls consilience, or the unification of human knowledge?

Response to 2:1

Lorrie Fredette:

Re: "What is it about contemporary science that makes it so inviting of art/science comparisons?" I have a few general thoughts. The first is our ability to access enormous amounts of information via the internet as well as the promotion of news, articles, stories via social media. Step in a bookstore and National Geographic Magazine covers are glossy images of the new brain, the study of the brain and the teen brain. Organizations work hard to get their messages out and do so via these platforms creating headlines of interest to rise above the fray. One of the more important avenue of accessibility is via the NPR program RADIO LAB!! Don't forget Science Friday, too. These programs alone have made science inviting. They have created unique ways to draw people who might not otherwise be interested in science. The accessibility has made science "sexy" when presented in trendy formats. I'm not knocking it at all. Bring it on! Add to the this list t.v., movie and cable t.v. programs like C.S.I., ER, Gray's Anatomy, Six Feet Under and other cult like science tilted programming and BOOM we have a considered focus on the sciences. (By the way, my interest in science came about via the NYX Tuesday science section.)

The proliferation of scientific investigations in mainstream media draws many of us to the wonder of science. Asking "What if?" is a shared question and the beginning of the adventure.

Taney Roniger: It's a great point, Lorrie — there's just so much of it around right now. And I don't know anyone who would argue that that's not a good thing in a political climate that has science under threat of irrelevance (even if all we ever get is popularized versions of scientific goings-on). But I suspect the attraction goes beyond this. My guess is it has something to do with 2.2.

Response to Werner: Science Museum vs. Art Gallery, and other stuff . . .

Stephen Nowlin

Regarding some cited works of Sci-Art, Werner Sun comments that ". . . if I had encountered any one on its own, I would probably not have identified it as sci-art per se. . ." (<http://bit.ly/wernercomment>)

Werner, thanks for your thoughtful comment, which raises really intriguing issues. First, on a broader subject being discussed, my two-cents is that I don't really think "Sci-Art" rises to the definition of a brand — it's rather more like a way-finding sign. It suffices, only. Personally, it kind-of covers what I do and maybe that's as much as we can expect of a big umbrella word. In any event, I think that what we do is not done in order to justify or fit into what it ends up getting labeled. The best we can do is agitate and incite for the moment in which our efforts might make meaning.

Given your comment quoted above, I'm curious to know how you feel about objects displayed in a science museum vs. those displayed in an art gallery. Could they be interchangeable, should they be? I often appropriate raw scientific artifacts and put them on display unedited, to behave like works of art in the gallery next to artists' works that may or may not look like science at all. I like the confusion and tension it creates. I curated an exhibit I called UNCERTAINTY, and I made two videos documenting the installation — one with didactic text clarifying all the works' relationship to science, the other with no didactic text. The exhibit itself purposely had no didactic text to bias visitors. I'd love to hear any thoughts vis-a-vis the videos' respective Sci-Art factors if anyone has the time and inclination to view them. I guess the question is — does Sci-Art need to look like Sci-Art, to be Sci-Art? Does Sci-Art describe objects, or context?

UNCERTAINTY w/out annotation — <https://vimeo.com/205276101>

UNCERTAINTY w/annotation — <https://vimeo.com/207343937>

Just what is it that makes today's science so different, so appealing?

Dan Weiskopf

I'll offer a few fairly wild speculations as to why *now* might be an especially propitious time for artists to take a special interest in science. (With the caveat that there may not be anything special about *now* except that we're living in it.)

Five reasons why contemporary science might make a particularly appealing artistic subject:

1. *The gaze of data.* Arguably one of the signature traits of modern science is the analysis of massive datasets. At the same time, we have learned to see our own everyday actions as raw material constantly transformed into data to be mined by advertisers. Big data is both an ineliminable tool for scientific discovery and a potential threat to privacy and liberty. Data is a modern lingua franca. Thus we get art that reuses, transforms, and perverts data of all sorts. Nathalie Miebach is a paradigm here. (On the history of data's insinuation into our visual practices, see Orit Halpern, "Beautiful Data: A History of Vision and Reason since 1945".)

2. *The pixelated image*. The rise of cheap, powerful digital visualization technology is another common factor. Physical, chemical, and biological processes can be dynamically rendered in ways that are immediately captivating to the eye, if not always essential to the actual practice of science. These computational simulations and images constitute a pre-made set of materials for artists to play with (or subvert).

3. *The vanishing self*. Science has become a default mode for contemporary self-understanding, and even self-fashioning. Genetics and neuroscience have, at least in the popular imagination, started to lay out an account of the most fundamental characteristics of human beings: our “innate” biological code, and the physical underpinnings of thought and consciousness. This activates worries about reductionism and the erosion of the self under the intrusive scientific gaze (as well as more nuanced and celebratory reactions—see Suzanne Anker and Dorothy Nelkin’s survey in “The Molecular Gaze”).

4. *Monsters and nightmares*. On the flip side, there are also historically unparalleled threats to the continued existence of life on the planet. Mass extinctions might arise from runaway genetic engineering, climate change, or industrial pollution. A significant body of sci-art depicts technoscience, its translational applications, and their consequences as something alien and threatening, tapping into a range of old and familiar anxieties.

5. *The distant and sublime*. Advances in astronomical imaging and nanoimaging have made it possible to detect events in the macro and microworlds that defy the ordinary scale of human experience and perception. Contemplating these inherently unvisualizable orders of nature provides hooks for concepts like the sublime. Cf. Linda Francis’s earlier comment on the gorgeousness of these scales of reality relative to the griminess of our own; also see Ofer Gal & Raz Chen-Morris, “Baroque Science”, for the 17th century origins of these concerns.

I’ll try to bring some order to this list. The first two items involve an overlap in technology and media between scientists and artists. They also draw on a more general shared awareness of how our lives are inextricably enmeshed in networked computational systems—the emergence of what I’ve called elsewhere the “data self”. These cases, in which specific tools, modeling techniques, and visualizations migrate back and forth between science and the arts, can fairly be thought of as specific to here and now.

The last three turn on the fact that contemporary scientific discoveries and their applications can readily be incorporated into familiar art-historical themes. These have to do with human identity and personhood, with apocalyptic anxieties, and with an attitude of awe at the natural world and the limits of human perception and expression. None of these are specific to now, but at the moment they may be evoked in distinctive ways.

I’m not sure that any of these count as explanations *per se*, but they do seem to be patterns. Other items might be adduced as well, e.g., the cultural and economic power that science, in some of its guises, wields relative to the artworld. For an institutional

account of the conditions that make bioart in particular a viable form right now, see Robert E. Mitchell's "Bioart and the Vitality of Media".

Taney Roniger: I agree with all your speculations, Dan, and you've given us a fantastic list of sources to pursue. Your caveat is important too, however. As much as both science and technology have changed in the last half century (and duly noting the unprecedented rate at which that change has taken place), the arts have a long history of fascination with both. And how could they not? Science is such a tremendous cultural force — and one has, at least since 1945, presented as a threat to our very survival.

I'd argue that the thing that *has* changed is art's self-image in relation to the larger culture. The failure of modernism, with all its soaring idealism and promises of salvation, hit art hard. Beneath all the cynicism and irony that set in with postmodernism it's hard not to detect a really deep sadness compounded by a pervasive sense of insecurity about art's agency as a cultural force. Science having taken on this soteriological promise, I often wonder if art's reach in its direction might be an attempt to get some of that back by way of association. I'm not sure how I feel about this. On the one hand I think science has much to offer art, but the power dynamic is such that the relationship feels suspect. What I'd rather see is art reclaiming its sense of purpose on its own, and only then moving out into the world confidently bearing what it has to offer.

Dan Weiskopf: I'm sympathetic with the idea that art, like other cultural practices (e.g., parts of philosophy and literary theory) might be open to the charge of scientism. This also helps to clarify the link between your questions 2.3 and 2.4, about transcendence and the aftermath of postmodernism (if it has one).

But I'm curious to know more about what art's reclaiming its purpose might involve. One way of approaching this question (possibly not what you intended) is as a permutation of Krauss's invective against the post-medium condition. Roughly, the argument is that in abandoning the notion of specific media, we also abandon aesthetic autonomy for an inescapable complicity with structures of social and economic power. Seen in this light, "interdisciplinarity" in artistic practice might appear as just a more contemporary gloss on "intermedia", and one that shares its fatal shortcomings. (Haven't we already noted the "discursive chaos" and "heterogeneity of activities" that go with art-science pairings?) There's something Kraussian as well in your comments on the poverty of post-studio practice—Krauss herself was an early opponent of institutional critique, after all.

Pulling these threads together, then, a plea for art's renewed and distinctive purpose can be sharpened into a case for purity of medium, and against works that disperse art's force by yoking it to external sources of authority. I'm not ascribing this argument to you, obviously, but I think there are at least hints of it in what you've said.

Taney Roniger: How to reclaim art's distinctive purpose so it can make a genuinely meaningful and original contribution to culture: this is exactly the issue for me, and I don't yet have a solid answer. I want to explore it here, and will be returning to this thread later today, but for now I can say with conviction that I have absolutely no allegiance to medium specificity, Greenbergian formalism, or anything related thereto. That whole agenda seems woefully retrograde to me, and I think we should move on from it. If we imagine there are two poles here, with the absolute autonomy of art on the one side and a transdisciplinary, discursive/didactic, agenda-oriented paradigm on the other, it's somewhere in that vast region in between that I think the way forward lies.

Werner Sun: Dan, this is a perceptive list and a useful framework for dissecting the art/science relationship. You seem to be implying that sci-art, regardless of the intentions with which it was made, reflects a desire to reclaim ownership of one's self and regain control of one's environment (or cultural authority, as Taney argues), and it is therefore inherently critical of science. And this critical stance leads naturally to discursive art.

Am I misrepresenting you? If not, then is it possible, under the right conditions, for sci-art to celebrate science and still be non-discursive (as Stephen Nowlin has suggested)?

Dan Weiskopf: Hi, Werner. I wouldn't say that critique is inherent to artistic treatment of science, although on the other hand I admit that I have a reflexive suspicion of art that "celebrates" science. I think that celebration is an uninterrogated goal that too easily degenerates into spectacle. But there are clearly artists who are more interested in what I would call exploratory or phenomenological projects rather than critical ones. They aim to engage in a kind of play with scientific concepts, or to evoke experiences suggestive of encounters with inhuman natural phenomena. My final comments on the sublime were meant to gesture towards this sort of work, which is particularly common in art that draws on physics and cosmology.

Discursiveness is a separate issue, although it raises questions that I gather we'll discuss in the next phase of the conference. There is no necessary link between the degree of a work's discursiveness and its critical stance; artworks that critique genetic modification or that evoke the horror of climate change can do so nondiscursively. But my starting position is that it's extremely hard (maybe impossible) to embody the content of scientific theory in artworks, and that the fragments of theoretical content that are present are almost always being misused. This isn't a negative judgment, I should add, but a descriptive claim about how the surrounding context of an artwork transforms the meanings of everything that it contains.

Werner Sun: Thanks for elaborating, Dan. This discussion of discursiveness and its alternatives touches on a key question about sci-art for me. I agree that one can be critical (or celebratory) without being discursive, but as you point out, it seems particularly challenging when scientific ideas are involved (which is not to say it can't be done, obviously). Science derives its rhetorical force from building constantly on long trains of thought. It's true that new discoveries might arise from an accident in the lab or an irrational flash of insight (*deus ex machina*). But in order to gain acceptance, these discoveries must, in the end, mesh with the parade of findings that have stood the test of time and that might stretch back for centuries. So for the most part, scientific ideas follow a discursive path, and they depend on their context for meaning (like any good story). So, I think the challenge for sci-art is to engage with that whole backstory of science (i.e. the whys behind the what) and not just a snapshot from the present day.

Taney Roniger: Returning to the issue of how art might reclaim its distinctive purpose as it moves out into the world, I offer the following thoughts (in no way formalized, and still very speculative at this point). For me, the power of art lies in its capacity to embody and transmit tacit knowledge – the kind we're not consciously aware of but which nonetheless constitutes most of our knowledge. Obviously this is not to say that in art there's no conscious content. (When we look at a Turner painting we see a ship and an ocean and the various manifestations of turbulent weather. But as anyone with any understanding of art knows, ships, oceans, and turbulent weather are by no means the real content of the painting, the more substantive stuff being all that slips in through the back door, as it were, and lodges deep in your psyche.) One problem with much sci-art, as I see it, is that it showcases the work's conscious content so forcibly that we become less receptive to any of the more subtle meanings it might have to offer. It's essentially the non-verbal equivalent of telling people what to think. You look at it, you think about what you're supposed to think about, and you walk away – thoroughly dissatisfied, and certainly unchanged.

So the question for our times becomes how can art actively address some of the pressing problems we face so that it's both seen and taken seriously without forfeiting this power outlined above. The answer I'm going to give sounds too easy, but here it is: Work with whatever subject matter you seek to address, but knead it, complicate it, finesse, compress, and distill it — and then deliver it as poetry. Use the conscious content as the ruse it always was, and let the real stuff do its work as it comes in that other door. The problem is essentially one of anxiety; in our (very laudable) effort to make a difference in the world, we artists have become insecure about the tremendous power of poetics.

Response to Taney via Dan

Linda Francis

I certainly agree with Dan Weiskopf's well taken points and enjoy his caveat - as if we could know. And Taney: that this romance has been going on through history and your observation: "Beneath all the cynicism and irony that set in with postmodernism it's hard not to detect a really deep sadness compounded by a pervasive sense of insecurity about art's agency as a cultural force." Witnessing the demoralization of young art students in the face of postmodernism was tough. I realized that you cannot take a young developing cohort and tell them that their ideals and aspirations are fictions without derailing their development. Perhaps science/art is an escape from the wreckage, propelling the self into the comfortable zone of the outlier — Dan's point #5. And subtext: "The Matrix".

Dan Weiskopf: Hi Linda, your point that "[p]erhaps science/art is an escape from the wreckage, propelling the self into the comfortable zone of the outlier" is an apt observation. I think this is also behind Taney's question about transcendence. At least some work seems to draw on scientific imagery precisely in order to suggest a vision of transcendence (of humanity, its perspective, its limits, etc.). If one thinks of art as being traditionally linked with a search for transcendence, then science-based art is not a departure from this tradition but just another

Linda Francis: Agreed Dan, and in thinking about conditions necessary for "transcendence" on more mundane fronts, we are thrown back to the question of whether it is possible for art and science to find a common language since it is necessary in some respects for artists to position themselves at a certain remove from their own practice, the larger culture and accepted rules. At the same time, underlying formal structure is one of the ways to identify art and use to apprehend it. In that regard I would ask if those structures mimic the organization of the brain and if we can find analogs in scientific thought and then be able to communicate on equal structural footing. The questions of category broached by Stephen Nowlin inherent in the sense and context of his moving and beautiful exhibitions I would relate more to the idea of data in your point #1, how it is used and what kind of knowledge it creates.

Daniel Hill: "Beneath all the cynicism and irony that set in with postmodernism it's hard not to detect a really deep sadness compounded by a pervasive sense of insecurity about art's agency as a cultural force." -and- "Perhaps science/art is an escape from the wreckage, propelling the self into the comfortable zone of the outlier"

Just wanted to chime in here that I totally concur with these statements. I certainly feel this was the case for me in art school and this drove me (secretly) toward science as being the conceptual underpinning to my work. Really appreciate these sentences Taney and Linda as well as the lists made by Dan!

Taney Roniger: Yeah, when I was in art school it wasn't so much the conceptual allure of science that first drew me to it (although that was certainly attractive), but rather the discourse surrounding it. The language of critical theory, then in its

heyday, was thoroughly unappealing to me. Most of it struck me as bloated and pretentious, especially when parroted by my fellow art students, who, when pressed, couldn't tell you the first thing about what any of it meant. The whole thing seemed like little more than a game whose point wasn't to communicate but rather to impress. It was a really lonely time. After school I'd walk down to the Barnes and Noble Scholarly Annex on Fifth Avenue and set up camp in the science section till well into the evening. There I discovered that not only do people in the sciences write to communicate, but that they often do so with tremendous eloquence and passion. And, crucially, they are interested in truth, which had of course become a dirty word in an art world newly awash with cultural relativism. And much to my surprise, I also discovered that there were profound resonances between certain aspects of the practice of science and what I was discovering about making art. I'll never forget the first time I read Jacques Hadamard's *The Psychology of Invention in the Mathematical Field*, or G.H. Hardy's *A Mathematician's Apology*, or anything by Einstein, Carl Sagan, or Stephen J. Gould (I could go on and on). Next to these, the irony and cynicism I was steeped in at school seemed not just deadening but also, well, cowardly. Even if ultimate truth proves beyond our grasp, there's something so noble and beautiful about its pursuit.

There is also, of course, the more pernicious side of science (e.g., the deleterious effects of its mechanistic worldview, its occasional abuse of claims to value-neutrality to advance morally suspect agendas, etc. – this list could also go on). But for me this would only come later. All of this is to say that one of the things I applaud about the sci-art movement is its rejection of both the extreme forms of relativism birthed by postmodernism and, thank heaven, its language.

Werner Sun: Science as a vehicle for transcendence — this is a fascinating insight. Thanks to everyone for sharing your personal motivations!

My own story goes in the opposite direction. Although I was good at some aspects of science, the social and material cultures can be impersonal and lacking in visual appeal. Instead, I found the transcendence I longed for in the arts (first in music, then in visual art). Here was a type of beauty that could stay with me for days and years, that I felt somatically and not just intellectually. I guess the grass is always greener on the other side....

Linda Francis: Werner's observation that the arts offered him "...a type of beauty.. that [he] felt somatically and not just intellectually" nails it if we think/feel that the artist has the means to embody science.

Reply to M. Ricciardi:
Linda Francis

There is no argument here regarding the many possibilities for art and science together, there is only my dismay at a catch-word that has the effect of limiting the dialogue, characterizing the work in a superficial manner, and leaving the enterprise vulnerable to the usual swings of the marketplace.

Reply to Elaine and Taney
Linda Francis

The problem is language. We have more or less agreed upon it. So do we parse the structure of scientific method and then do we measure art by it? Or Taney, apropos of “reason” – How do we have a meta- discussion of meaning in the language of art or science - It strikes me that there is no other way but to reason together, or alternately, produce work together that is critical in and of the genre in which it is operating. It brings us back to the necessity of fluency in each language. Perhaps the example that Elaine uses re: scientific thought and evidence taking a back seat to – knowledge? In any case, I think there is some problem in what art is doing with itself too. Is it able to discover new things or is it hampered by its own conventions? How can we use it? I recently forced a chapter of the Audubon Society to cease its abuse of its mandate to conserve birds, habitat and wildlife. I didn’t choose to take action through art because I couldn’t effect the outcome in the real world with those tools. I did use what science I could to make the case but in the long run it was just as useless. I sadly had to resort to legal means and matters of property rights. We want to make contributions, we think art and science are civilizing forces, but how to make them do work together in this culture?

Elaine Reynolds: Linda, I really enjoyed these comments and questions. I like your idea of reasoning together.

Linda Francis: Elaine, I sense in your comments a kindred impatience with the state of your discipline (forgive the presumption). But I think too that this is the time to be more pragmatic about using the tremendous resources and interest that is flourishing.

Session 1 Still Lives! (Response to Elaine)
Werner Sun

First of all: Elaine, many thanks for bringing a fresh perspective to this conversation! I very much enjoyed your talk on Saturday. I wanted to react to the comments in your post and also synthesize a few threads from elsewhere in Session I.

I wholeheartedly agree that the scientific method in practice is much messier than the way it is taught in schools. I made a similar point in one of my [earlier comments](#). When I

said that science is a way of thinking, I was referring to scientists' underlying attitudes and worldviews, not any specific procedure for doing science.

Similarly, returning to a previous thread, the “core concerns” that I suggested we should unpack also reside on this fundamental level. Dan Weiskopf nicely characterized the practices of science. And Taney cited a definition of art from Sian Ede. But I'd also like to hear some answers to these questions: what are the deeply held beliefs implicit in our work as artists and scientists, and what makes us believe these things?

For example, physicists might say they believe that the universe can be modeled mathematically (even if we don't have a complete description yet), and the reason for this belief is the spectacular track record that physics has enjoyed so far. This does not preclude the possibility that there might be an ultimate limit to our knowledge, but we seem to be far from hitting that limit (if it exists), so why throw in the towel now?

How would others here — artists, scientists — answer these questions? I am genuinely curious about this!

I think your (Elaine's) broader point is wonderfully provocative (and perhaps makes the question of core concerns a moot one): that artists may have already intuited (through trial and error) how the brain processes stimuli, and that scientists might look to this technical know-how to address certain “hard questions” (including consciousness). It implies that artists, in the very act of grappling with ambiguity, have produced a kind of knowledge that can be leveraged concretely. This idea echoes the notion that many others here (Anker, Elkins, Nowlin, Weiskopf) have advanced about the value of the drunken conversation, that the conversants need not understand each other fully, or that sci-art need not know where it's going, for there to be some benefit.

Going one step further (though still within sci-art's co-production regime) is Daniel Kohn's suggestion that sci-art could explore the tension between different types of knowledge, which I find intriguing because this tension can take place even within a single person. Strictly speaking, scientific knowledge can be encapsulated in information-theoretic terms as the reduction of a large dataset with many degrees of freedom to a more compact model with fewer degrees of freedom (or free parameters). But then, these models are necessarily beheld by humans, for whom the knowledge itself (as it might be written on a chalkboard) is complemented by the experience of knowing (the jolt of finally understanding what's on that chalkboard). This unique personal component is not easily quantified but appears to be universal. In the fullness of time, as neuroscience progresses, this personal knowledge might eventually become amenable to measurement/description. But until then, one only has to look within oneself for a sci-art subject.

Taney Roniger: Werner, I'm so glad you're pressing the issue of “core concerns,” and I do hope others will answer the call. I think it's important because here is where the distinctions between artists and scientists are most telling — and

also, for this reason, where we might find a genuinely productive basis for partnership.

You say that physicists, for example, might have as their core belief that the universe can be mathematically modeled, that it is ultimately both knowable and “mappable.” This amounts to nothing less than a metaphysic, and one that, it seems to me, most artists would balk at. I should speak only for myself here, but I thought it significant that when our conversation on Saturday turned to the subject of mystery, Elaine [for readers just joining: a biologist and neuroscientist] was quite clear on her position: “I want to know!” The artists, on the other hand, thought otherwise; to us mystery is sacrosanct, and the specter of its annihilation signals nothing less than the end of art. This, too, is a worldview. I’m curious to hear how other artists feel about this, but in my worldview the universe is ultimately unknowable, and this is exactly what gives it its profound beauty. I just don’t think we’re wired to know the universe, humble creatures that we are. I’ll end with Karsten Harries on this: Every attempt to “think the infinite” is bound to suffer a shipwreck. The best we can do is know that we can’t know, and that alone puts us one step beyond our ignorance. (paraphrase)

Werner Sun: I think you probably speak for many artists, Taney, and eloquently so. What about the second half of the question — what makes you believe the universe is ultimately unknowable? How would you explain that to a scientist?

Daniel Hill: Perhaps as an artist I am an anomaly, but mystery is not sacrosanct for me. It is a motivator for sure- especially that there is still so much more to know- but ultimately, I want to know too!

If I had to have a core concern, I suppose it comes in the form of the question “why?” I continue to make work largely driven by curiosity and asking “what happens if...?” I would not attempt to answer if we are capable of knowing the universe. (I would prefer to leave that door ajar.)

For me, what matters most is the process and practice of discovery and invention. The art is almost secondary, for if the drive to discover and invent is taken away, then there is no art. It would appear this can be a common factor between artists and scientists. Is this desire for discovery innate or acquired?

Werner Sun: The process and practice of discovery and invention — yes, I place great value on these, too. I like to think that the drive to discover is an innate trait because I can imagine how it might have improved our chances of survival as a species.

I am of two minds about mystery itself. The questions we can ask concretely, I feel a need to seek answers for. But the questions that can't even be formulated — these evoke a certain amount of awe.

Response to Daniel Hill on epistemological chasm as unbridgeable

Leonard Shapiro

[Daniel Hill says:] “But the epistemological differences between the two make a true convergence unlikely in our lifetimes and perhaps never.”

Despite the epistemological constructs that separate art and science, one can still build a bridge and forge practical links (on an individual basis i.e. literally in the work that one does), between art and science. I teach an observation method that involves touch and drawing to medical students and medical practitioners in order for them to dramatically improve their ability to observe the 3D form of the human anatomy. I see the work that I do as having made a small bridge between art and science, but a bridge all the same. More of these practical examples can happen.

Daniel Hill: Thank you for your comment Leonard. I looked up the HVO&D method you developed and agree that you have forged a small bridge towards a connection and congratulate you on that. I feel also that I am making a small step toward some sort of connection in my work, but that bridge is personal one, using select ideas, concepts, methods, and the quality of thinking of science to serve as the primary motivator and conceptual underpinning for my work. (If I were to rely on the art world for these same resources, I might have given up art long ago!) Ultimately, since I am an advocate of pursuing some sort of connection between art and science, I agree with you. I would also agree that moving forward in incremental steps is a prudent, logical method. But I do think that the epistemological differences may be enough that if it were possible for a true union - which implies balance- it might take generations. There is a Max Planck paraphrase that says, “Science advances one funeral at a time”- which suggests that even in the advancement of purely scientific ideas, the old guard must pass to give way to the ideas of the next generation. The notion that art could serve science in a way that would be scientifically useful would seem further off, although not impossible, as James Elkins pointed out in his lecture. This is the train of thought that produced the statement you referred to.

Leonard Shapiro: Thanks Daniel for engaging with me on this. Could it be that (in those practical instances) where art and science find a union, that it becomes apparent that there was no ‘division’ between them in the first instance, and that they actually complement each other?

I give the example of making scrambled eggs. Is it an artistic practice? Is it a scientific practice? Or are both art and science present as equal partners in this process? A person who follows a recipe from a cookbook follows a description of a method as does someone who replicates a scientific formula with its method in order to manufacture a drug (although the ‘recipe’ to make the drug is far more precise as it needs to be). So, in the case of making scrambled eggs, let’s imagine that we are scientifically observing, measuring and recording someone making it, with the same degree of exactitude that someone would record a science experiment such that they can replicate it. We find that making scrambled eggs is highly calculated; it is a science. If one were to measure the method/recipe to scientific standards and with scientific instruments, such that it could be perfectly replicated, it might be recorded as follows: break 3 eggs into a glass bowl measuring A x B. The eggs should be precisely 16.2 degrees centigrade. Whisk for 135 seconds with a xxx whisk. Pour into a pan which has been preheated to 82.4 degrees C and in which 23.4 grams of butter has been melted. And so on. It is a science and it is an art. So, what is that ‘something’ at the intersection that holds science and art as common to this recipe for scrambled eggs as well as for the making of a drug? Is it human creativity; that ability in us that is able to grapple with what we know about heat, eggs, butter, amount of whisking (or chemicals and their effects) and devise many different types of scrambled eggs (or different variations of a drug) by varying the method and ingredients?

Taney Roniger: I’m glad to see you two pursuing, if I may, the “complementary hypothesis.” Much of what we’ve heard from the scientists on the panel seems to support what you’re getting at. Both Werner and Elaine have emphasized the exploratory aspect of their processes, wherein the “scientific method” as we laypeople learned it in school isn’t exactly the operative agent. (I loved hearing from Werner that he and his colleagues don’t much think about it at all.) Much of it, it seems to me, comes down to pure heuristics, which is exactly how I’d describe the artistic process. I wonder if we can get Sinead to chime in here, since what she’s doing is very similar to your work, Leonard.

Daniel Hill: I’ve been thinking how to respond to this and had this thought: if we assume that making scrambled eggs is both an art and a science, what if a robot makes the eggs? (This is possible now.) Would it still be an art? I ask this as someone who makes art guided in some part by rules in a system, but have learned the most interesting part of my system are the human mistakes or the unforeseen glitches of the system. Art is a human activity, at least as of now, but is this because it cannot be fully described by an algorithm? A well funded team has created the “Next Rembrandt” with algorithms and 3D printing, but is this art? <https://www.youtube.com/watch?v=luygOYZ1Ngo>

Leonard Shapiro: At the outset, let me say that robotics is not my field so please be as critical of my response as you need to be.

A robot would be programmed with the intelligent input of a human or a number of humans. When the robot makes decisions and then acts on these decisions based on its programming, it is acting within the parameters of its programming and therefore within the parameters and limitations of the human intelligence that it now contains. I am sure the robot can be programmed to randomly adjust some of its decisions. For example, to add a pinch more salt or whisk the egg more slowly or more quickly (which will introduce less or more air into the egg mixture). The parameters of 'how much or how little salt' can be pre-programmed; in other words, it would be pre-programmed not to add over a specific amount of salt relative to the number of eggs in the bowl. In this way, a robot can make a number of different variations of scrambled eggs. [As an aside, a good use of this programming would be for us as humans (and for chefs in particular) to taste a number of scrambled egg recipes made by a robot programmed in this way, and then to judge which recipe works best]. However, we still have the robot making decisions and acting within the bounds of its programming, even though it has been programmed to make variations on any of its decisions.

But we are separating robot from human as if we share no robot attributes simply because we are made entirely of flesh and bone (i.e. our bodies are entirely non-mechanical). But as soon as I introduce a machine into my existence I begin existing as an integrated unit with the machine. Even when I use a washing machine, my behavior is changed; if the washing cycle will take 15 minutes, I will have a conversation with someone based on the fact that I have to take out the washing in 15 minutes time. So, my human behavior has become partly determined by my engagement with the (washing) machine. And this is just one machine that is 'attached' to my consciousness and my daily decision making processes. My human mind is the 'computer' operating the machines in my life and my mind is in turn influenced by the abilities of the machines that I use around me. What I arguing is that we are more robotic in our programming than we acknowledge ourselves to be.

What I am doing when I drive a car is applying a number of decisions in order to operate a machine. I am using my brain like a computer. And now we have entirely non-human operated cars, which indicates that the use of my brain when driving a car can be substituted by a computerized program. Of course, a car going from A to B is just that; it is being guided within a set of predictable and very narrow parameters.

Scrambling an egg is very different from driving a car; we expect creativity/artistry to be introduced into the making of a scrambled egg recipe but not in the driving of a car which we expect to be governed within strict parameters.

Can a robot learn?

A human will make a scrambled egg and if they repeat this daily, they can learn ways on how to improve it based on what they did the previous day. They can learn how much or how little salt to add. Can a robot be programmed to learn? Could a robot learn and make adjustments based on what it has learned? Assuming that we had a robot that could be programmed to taste in the same way as a human could (and so it would know what was too salty or not salty enough), and it made a scrambled egg, would it be able to learn the quantity of salt that it needs to add so that the egg does not have too much or too little salt in it? (note that in the case of this robot, we have not programmed it to add an amount of salt within certain parameters as in the previous example).

So, I think that a robot making scrambled eggs would indeed be an art similar to a human making a scrambled egg would be an art. In fact, a well programmed robot would make better scrambled eggs than a novice human cook. And the proof of this would be in the tasting: when tasting the scrambled eggs made by a well programmed robot, a group of chefs who did a ‘blind’ tasting would surely agree that it made better scrambled eggs than a novice cook (who might have added too much salt).

Also, in the programming that I have described for our scrambled egg-making robot, doesn’t it follow that one can write an algorithm for the making of a scrambled based on the way that a particular human makes it? If so, wouldn’t it follow that one can write a number of algorithms based on a number of individuals who made scrambled eggs in their unique way? (I am asking this as a genuine question as a non-robot expert).

PS: I liked the Youtube video on the Rembrandt painting. I would be keen to see the computer paint a Jackson Pollock :). One thing that would be needed is to program in the kind of splashes made from a brush loaded with a paint of a specific viscosity and flicked at the canvas from a specific distance, or dribbled onto the canvas from a tin with a hole of a specific size in the bottom of it.

Neil (reader): Surgery isn’t science, and HV&OD isn’t art.

Response to Stephen: Science Museum vs. Art Gallery, and other stuff . . .

Werner Sun

Stephen, “sci-art” as a way-finding sign is such a refreshing way of approaching the term. It does shift one’s perspective when thought of that way. I am reminded of the “shut up and calculate” approach to physics, which has certainly had its successes.

I suppose I am ambivalent about the term “sci-art” because it tends to color my interaction with any given work. It feels as if a certain lens has been placed in front of my eyes. Perhaps that is my problem and not yours.

And thank you for sharing your videos with us. Congratulations on such a sensitively curated exhibition! Incidentally, I was member of the CMS collaboration at the time of the Higgs boson discovery, and I am still involved in CMS research.

Regarding the display of scientific artifacts in an art gallery or art in a scientific setting, I have no problem with this practice in principle, but it’s not easy to pull off well. Too often have I seen heavy-handedness in such endeavors. In contrast, you have handled the challenge in a sophisticated manner by avoiding didacticism, allowing viewers to form their own associations. I hate being told what to think; I would much rather be tricked into it....

I am also impressed by the sheer quantity of thought embodied by the show itself. The works are all crisply executed, and you have assembled them into a cohesive whole, in a way that honors the underlying science (because they are presented without comment, not as symbols of “science”). The objects intended as art use scientific ideas as seeds for embellishment, not as literal sources of “content”. When science artifacts are presented as art, it is done with reverence (it seems) and not with an educational mission. And the juxtaposition of the two types of objects is pleasantly disorienting, as you say. I respond to all of these little touches.

The two videos seem to work on the viewer differently, but with equal impact. Without annotation, each piece in the exhibition comes across as a mysterious object of contemplation, without being clear whether it is an artifact of science or art or both. With annotation, my intellectual curiosity is satisfied, and this knowledge balances the sheer beauty of the work. So, the first video is dominated by a sense of stillness, and the second video sets up a push and pull between head and heart. Both seem to succeed at being sci-art, as well as art.

Stephen Nowlin: Werner, thank you for taking the time to view the videos and formulate your thoughtful reactions. While the exhibit itself was purposefully absent didactic information except for the most rudimentary credit labels, the video I made first was the annotated version, which I then rejected and re-edited to make the strictly visual version. I am myself somewhat undecided about the limits of didactic information in a visual art exhibition if one wants to preserve and favor the personal immersive experience. It is tempting to augment the objects with explanations of their scientific significance, but in doing so the objects risk becoming like illustrations padlocked to a text rather than works of resonant art with pliable meanings — ie, more like a science museum exhibit than an art gallery exhibit. I tend heavily toward the latter, and each art-science exhibition I curate is a test of sorts, an experiment in finding the right experiential/contextual ratio.

Werner Sun: Stephen, thank you for the background information. It is interesting that you made the annotated version first. The science museum effect is indeed the bane of sci-art (in my opinion), but you have managed to avoid it somehow, even with annotations. Perhaps if the annotated version were the *only* version available, I might have a slightly different reaction.... I struggle with my own didactic impulses as well.

Response to Linda (and, obliquely, to Werner)

Taney Roniger

Linda, your question about what art can do and whether it's being hampered by its own conventions resonates with me very deeply. I've been thinking a lot about the so-called "post-studio" movement that seems to be gaining momentum, and while I applaud the effort art's making to move out into the world I also wonder if it isn't in danger of losing the very thing that makes it worth bringing out there to begin with. This "thing," as I see it, is none other than non-discursive thought, by which I mean the kind of thinking that happens beneath the plane of reason in that rich underworld that is the unconscious. This is what art embodies and the means by which it (very powerfully) communicates. What I see happening is that in its reach toward greater cultural influence, art is becoming more like other modes of discourse (which is to say more discursive), and since these other modes of discourse don't seem to be getting us anywhere in solving our pressing crises, why perpetuate more of the same? I'm a fervent believer in the power of poetry, precisely because it bypasses reason and shoots straight into the body, that unacknowledged locus of most of our cognition. To me, art is embodied poetry.

None of this is to suggest that I'm in any way anti-reason. God knows we need it, just as she knows it's become something of an endangered species. (One wonders a bit why, if she really exists, she doesn't step up and do something about this.) But reason alone is inadequate. It needs to be augmented by something *other* – some other kind of language that can access the deeper regions of the psyche/soma. So sure, we have to *speak* to each other in the conventional language, but the whole point of an art-science relationship is that we also *make* things, and then behold them, and then speak some more – even if our language falls far short of what we got from the experience.

Joseph Nechvatal (reader): This is breaking in Philly – and worth a look, I think:

The University of the Arts Ph.D. in Creative Work phdprogram@uarts.edu is offering a low residency degree for advanced interdisciplinary research in the arts, humanities, sciences, and social sciences

All Ph.D. programs require a dissertation that makes "an original contribution to knowledge." Yet after steeping the candidate in the existing literature and methods, they offer no guidance on how to move beyond them. So as George

Bernard Shaw famously wrote “progress depends on the unreasonable man” who changes rather than accepts established practices. At the University of the Arts, our Ph.D. is about fundamentally changing the way our students think. We intend to use a deep immersion in the intuitive practices of the arts to seed a more creative working practice in students who come already prepared with the conventional methods and knowledge of whatever fields they work in. We seek students who have already achieved a professional mastery in some discipline and we prepare them to go to another level. We show them how to be open to finding that moment when ideas that didn’t seem to have anything to do with one another suddenly come together to ask or answer a question, create a solution to a problem, produce a new invention. The complexity of problem solving in the arts differs from scientific method in their deliberate embrace of intuition and can teach a practitioner in any field — in science, in medicine, in business, engineering, in the social sciences, and also in the arts – to think more creatively. Business entrepreneurs need to “think out of the box”; musicians need to do more than master the score; the statistical odds of a scientist winning a Nobel Prize triples if he or she has an avocational practice in the arts.

The underlying idea of this reimagining of the Ph.D. is to infuse any discipline with protocols of creative work. Our Ph.D. students begin with exposure to a variety of interdisciplinary approaches to research in a different fields during five days of seminars. The readings prepare the ground for an openness to the immersion in artistic process that will follow. Then we throw them into a creativity “bootcamp” which repeatedly challenges them to bring coherence to their experience over an intensive, week long immersion in artistic modes of thinking. While doing the immersion week they also workshop the frame of their thesis project, aiming for a truly interdisciplinary perspective, more radical than what would normally emerge from existing Ph.D. programs. We will construct a tailor-made committee of respected advisors in the various relevant fields specifically selected for the individual’s project. Coupled with rigorous research, the creative working processes founded in an immersion in art practices will make our students stand out as leaders and innovators in a field that they help to define. We’re looking for M.D.s, practicing lawyers, professionals working in corporations, governments, foundations, or in the arts who have ideas that they wish to pursue beyond the limits of where they are professionally now.

Although the Ph.D. is increasingly the gateway for high level careers outside academia, most universities require it for full academic rank. We intend to prepare our graduates for a more creative approach to whatever path they take and expect industries as well as the academy to set a premium on our degree. By redefining the underlying approach to their practice, our graduates return to the work world equipped with deep expertise in an area they define and in which they are strongly invested, while also deeply embracing the creative process. They gain singular expertise and their future work will fit them better for a career that lines up with their real interests. As our graduates succeed in public life, this University of the

Arts degree will also further a broader understanding of the centrality of the arts in all education, at every level.

Linda Francis: Yes yes. I am glad to be an “artist” and specifically, a thinker and an embodier. Poetry: At this point in my life, I am understanding the wisdom of poetry in its ability to encapsulate and at the same time forever restructure itself in one’s conscious yet unconscious mind. Many times I can only respond to a work of art or science with inchoate laughter/recognition and call it poetry. James talks about ambiguity and its current draw. Perhaps it is the small place left for optimism to reside.

Taney Roniger: Joseph, that sounds hugely ambitious and very promising — at least in theory. What do you think of the idea? As someone who pursued something of an interdisciplinary PhD yourself (correct me if I’m wrong), what’s your take on prospects for art’s advancement through programs such as this?

SESSION III

Taney Roniger

While many of the threads we started last Sunday are still going strong, today I want to propose another set that promises to be equally catalytic. Moving from theory to practice, our third session gets down to the meat and bones of the matter: How exactly is sci-art being made, and with purposes in mind? I’ll be especially curious to hear people’s perspectives on one of the most nagging issues of the genre: Is scientific *imagery* sufficient to invoke scientific *content*?

Modes of Engagement:

Exploring the Nature of Art’s Involvement with Science

Fri. Nov. 10 – Sun. Nov. 12, 2017

3.1 With what angles of approach are the various sci-art genres engaging with science? Does sci-art aim to celebrate, popularize, “problematize,” or challenge science? Can it do all four at once?

3.2 How is scientific content embodied in works of art?

3.3 What is the relationship between scientific imagery and scientific content? Does the former necessarily imply the latter?

3.4 With the rise of transdisciplinary practices, we’re hearing more about “art as research.” What does it mean to engage in art as research? (Similarly, more talk is heard of “art as knowledge production.” What is the nature of the knowledge art produces?)

3.5 Are there modes of sci-art engagement that seem particularly problematic, and if so how might the issues be addressed and/or circumvented? Are there modes of engagement that seem particularly promising?

Simon Penny (reader): Imho, this is a very important set of questions, and certainly not new.

> Is scientific imagery sufficient to invoke scientific content?

What underlies this question is a deeper question of whether what we're about is simply 'invoking.' We ought to ask: What might science want with art? And what might art(ists) want from science?

With very few exceptions, the role for artists as perceived by scientists is that of illustrator. Generations of sci-art artists have rankled, and argued for a more conceptually substantial role. Sometimes, but rarely this happens – usually due to the fact that the 'artists' are already dual-qualified. This means, they already have a foot in each camp, which, by and large, is not the case for scientists involved, who tend to have a naive understanding of (contemporary) art. (That is not to say that many artists have a naive understanding of contemporary science). There is no good reason why professional scientists should provide a place at their table for an artist, until the value of such interaction is demonstrated to them.

By clinging to these exclusive professional categories we in fact create the problem we're trying to solve. (That is not to say that trans/anti/non disciplinarity is as easy as just saying it, it certainly isn't.)

One answer to the second question is that, as engaged activist citizens, (some) artists, are motivated by subjects for which 'science' has become the gatekeeper. Most of the wide variety of environmental issues fall into this category.

So what use might science have for art? That is more difficult to answer, as (we know) there are as many different ideas of what an artist does and what the uses of art are, as there are artists walking the streets. The illustrator/communicator role remains valid. At the other end of the production pipeline, a less obvious but more valuable role is to provide extradisciplinary interrogation. As I've been told many times in such contexts, I ask the difficult questions.

Scientific research agendas and projects **can** suffer from being "paradigmatically bound", by unquestioned axiomatic assumptions, and **sometimes** the artist's training as a transdisciplinary asker of 'out of the box' questions, and offerer of external perspectives **can** be productive. If in no other way than expanding the field of reference of the inquiry, or involving specialists from other fields that at the outset may not have seemed relevant. This is better

than finding out too late that important questions had not been asked or important perspectives had not been considered.

SP

Taney Roniger: Thanks for joining the discussion, Simon. “What might science want from art?” is indeed the million dollar question here (which I’ll get to in a minute). My question about invocation is really a veiled challenge to/criticism of a lot of the sci-art I see in New York. The kind of work I’m talking about presents itself as being in some way “about science,” or as being some kind of critical engagement with scientific concepts, which it ostensibly achieves through its use of scientific imagery, scientific instruments, or other things associated with science (we see a lot of test tubes and beakers about). But to me, most of this work is not about science at all; if anything, it’s about an attempt to acquire intellectual gravitas by its association with science. This doesn’t make for terribly interesting art, and it certainly isn’t science. (It’s as if the artists find it sufficient to present things that look “sciency” without any careful consideration for either of the deeper dimensions of meaning we expect of art or what the images and apparatus actually mean to science.) That said, this issue admittedly begs a larger question that can be asked of any work of art: How does meaning get embodied in *anything*?

The question of what use science might have for art is one we’ve been exploring in various ways and from various angles since Session I. The art as science illustration model is the most common approach, yes. But more and more these days we’re seeing art as data visualization – often with some spectacularly exciting visual effects. But this, to me, is equally problematic, because like the illustration model it puts art in the service of science, which is not really an equal partnership (although it must be said that a lot of artists are fine with this, for reasons I suspect related to what I stated above). Some of the scientists on our panel here (Elaine Reynolds, Luis Schettino) have suggested that perhaps what science really needs art for isn’t so much in its visual products but rather the way of thinking and understanding in which visual artists are expert.

Luis Schettino: What might scientists want from artists? Simon’s last suggestion is something that my artist collaborators and I have been working on for some time. Not in an explicit way, but through our interactions and ‘drunken conversations’. I find it exhilarating to step out of the boundaries imposed by mainstream Science to ask questions that could very well be the seeds of new lines of research. Having said that, it is important to realize that this enterprise is rather young and it will need some time to produce ideas/concepts that work equally well in both Science and Art (probably not the exact same concepts, but forms of them).

Taney Roniger: Luis, in your experience, how many of your scientific colleagues have expressed an openness to the kind of work you’re doing? I imagine many of

them might look on it with some suspicion; how do you explain to them the value it may hold (if you do at all)? Elaine mentioned during our live conversation on Saturday that for many scientists, art (and particularly sci-art) is the object of much ridicule. Given the kind of work that gets hyped in the mainstream media, I understand entirely. I wonder if you have any thoughts about what we artists can do to correct this impression that we're all a bunch of, say, Damien Hirsts?

Luis Schettino: I suppose the answer would depend on which group of scientists we are talking about. Most of those involved in basic motor control would consider these notions to be too complex to even consider them an appropriate subject of research. However, last year the international conference of the Neural Control of Movement society finished with an interesting discussion of the possibility of studying artistic behavior. I will say that most of those scientists who presented data were not terribly convincing in their treatment of art. And obviously, studying artistic behavior is not exactly the kind of interaction of Science and Art we are talking about in this symposium. But I felt that at least there appears to be interest in the intersection of the fields. In the case of Cognitive Neuroscience I would say that there is a lot more interest and a more nuanced understanding of Art on the part of at least a few of the researchers.

Is scientific imagery sufficient to invoke scientific content?

Linda Francis

Invoke scientific content, yes, but produce content not necessarily, unless we ask the same questions of both disciplines, “what is reality” notwithstanding. If we focus on one specific question maybe, and then agree to discuss each discipline’s findings in relation to the other. That might work. Perhaps a more narrow version of consilience, as Taney cited in the last session. Thinking about what Dan began in a reply to Werner regarding discursion reminds me of a particularly interesting conceit in art that is labeled “recursion”: In one sense, artists are creating works that have to prove themselves as objects or facts. Enter recursivity- discursively speaking, our own Mandelbrot-ian referents. Apropos of that, fractals have been able to describe Russian nesting dolls *and* molecular biology.

Response to Taney and Daniel

Linda Francis

So Taney and Daniel and all: because of your experiences, and mine although of a different generation, you can understand why I am wary of the sci-art label. In my generation as in all of them it seems, there holds sway some form of suffocatingly exclusive rhetoric.

Taney Roniger: I understand your wariness completely, Linda. If it were up to me I'd say we drop the term entirely. But I suppose it does serve as a sort of shorthand for "art that engages science through any number of means, media, and materials whose intentions fall within broad spectrum of attitudes from the critical to the celebratory," which is, admittedly, a bit of a mouthful.

Daniel Hill: Linda, I am assuming that you are referencing the possibility that Sci-art (for lack of a better term) could take over as the dogma of the day to suck the life out of some future generation of students like postmodernism did to your past students? If this is what you mean, I do not think that Sciart will do this anytime soon. In order for Sciart to become the main dogma, it would have to show more success within the art world itself, which we have not yet seen. I think Taney pointed out somewhere that the current Sciart scene is very much outside the gallery system. But if we can accept that a connection of science and art would have at some basic level the pursuit of an external truth, then I see this as an improvement over the concerns of the post-modern sort.

Linda Francis: Daniel, I am not at all thinking that Sci-art could destroy any student cohort mostly because as I have stated before, I see science as a possible subject for artists and not an all encompassing consideration. But, in thinking of that, I was writing another entry on a similar front just as I got your comment about how science is an expression of the ethos of certain times, and that we currently as a society are being exposed to it unrelentingly by the ubiquity of computer use and the injection of science into so many of the ordinary parts of life.

Session III – Data or No Data?

Gianluca Bianchino

Currently Sci-Art appears to be partial to the popularization and celebration of the subject and less on the much needed self-critique, thus I thank this forum for engaging with the question.

Given the current troubling political climate, strongly influenced by conservative zealots in tandem with a stubborn petrochemical economy, a claim could be made that Sci-Art is an institutional critique just by its mere existence and popularization where both conceptual and formal scrutiny may be seen as inconvenient at the moment. Similarly to the relationship between Sci-Art and current politics, identity politics in art may be experiencing a concomitant lack of scrutiny. Identity politics in art is flourishing within a now vast and undefined counter culture movement primarily aligned against the Trump administration. Perhaps in a few years, if the political tension is ameliorated, especially here in the US by a different election result we may be able to look back at the art produced in the age of Trump-about Trump related matters and analyze more carefully which works truly merit long lasting attention versus the load of sheer reactionary art. Sci-Art though does not have to wait for a xenophobic administration to pass in order to

develop self-reflection because the political correctness is not as sensitive as compared to identity politics in art, though there are a multitude of similarly ethical issues in science, stem cell research being a salient example.

The recurring trouble I encounter with most Sci-Art is its addiction to data and how that dependency dictates the outcome of many sci-art works. Sci-artists working within the plastic arts such as painting and sculpture, in their willingness to interpret data, develop practices that simulate digital processes particularly in algorithmic methods to spit out an image. Though at times interesting for the most part this is where I find the issue of self-reflection within the Sci-Art community hits a wall. The dependency on data, or scientific theory, takes over the engagement with process and materials. In this paradigm I wonder if we are giving up true artistic discovery in exchange for a “sciency” experience. This could be a double edge sword exciting on one hand, the science engagement, and perplexing on the other, the potentially limited artistic discovery aimed at raising questions rather than answers. In art if we lose the question we lose the field.

Jeanne Brasile/Response to Taney and Gianluca:

Response to Taney and Gianluca

Jeanne Brasile

Perhaps there is a larger crisis in the arts as Gianluca and Taney have pointed out in their recent posts. Taney’s response to Simon yesterday afternoon noted an “attempt to acquire intellectual gravitas” by tapping into science. While Gianluca notes above “Sci-Art appears to be partial to the popularization and celebration of the subject and less on the much needed self-critique.” Perhaps this is not so much a challenge with relations between the fields of art and science, but a legitimate crisis in the arts. What does it mean to be an artist or what importance does art have in a world where we are seemingly on the brink of no return with climate change, disease, explosive population growth – and all the other doomsday predictions?

What does it mean to be an artist when the market crowds out even the most talented in a limited market where collectors and galleries win, but artists are left holding the bag? Perhaps this is not a debate about science and art, but a one sided debate about the legitimacy and importance of the arts in an age where we’re so busy surviving, the arts are seen as inconsequential. In aligning itself with the weight of the sciences – perhaps art is attempting to reclaim agency?

Taney Roniger: Wonderful, Jeanne. I could not agree more that art’s deeply felt loss of cultural agency amounts to a crisis. None of us knows what to do, and the sense of despair is palpable. I’m entirely sympathetic with the general thrust that has us moving out of the studio and into the world, but it pains me to see sci-art denuded of all the things we most value about art just because it’s desperate to regain legitimacy. One thing I do like about it, however, is its rejection of the mainstream gallery system. One thing we can say for sure about sci-art is that it’s not about money. For that alone I respect it immensely.

Jeanne Brasile: Art is certainly not the only field having a moment of crisis. Journalism, manufacturing, science, agriculture – and pretty much every other discipline, profession, job and industry are facing profound change and even, demise. It's not clear what will survive and in what form when everything shakes out. Art's fetishized emphasis on the pecuniary is not a unique symptom of the creative sector. It's a broader cultural phenomenon that occurred concomitantly with profound leaps in technology and science. Perhaps this point goes back Session II and "the larger trajectory of post-moderism and its yet-undefined aftermath."?

Taney Roniger: You're so right, Jeanne, that the crisis we're feeling is not art's alone. It is certainly something we share with every other domain of culture, all of us inextricably bound together in what is essentially a global calamity. I guess the thing that sets art apart, though, is the longstanding perception that it was always superfluous to begin with — something one enjoys on Sundays after the serious work of living is done. But yes, we're all in this together, and all indications point to a future in which each discipline will have to be radically restructured if it is to survive.

Taney Roniger: Gianluca, in the first part of your post, are you suggesting that sci-art might be in some sense a form of protest against the anti-intellectualism and anti-science attitudes prevalent in today's politics? This is interesting. It's funny, because much of this discussion has focused on what I call science's cultural authority, but here we're reminded that it, like art, is under considerable threat. But here again we run into the question of audience; if sci-art's audience is mostly artists and scientists, we have a preaching-to-the-choir situation at hand. And if the target audience is not artists and scientists but the general public, then we're up against the inscrutability issue again, in which case both have to be diluted for the work to be even approachable.

Gianluca Bianchino: Taney, to some extent yes, it can be a form of protest toward today's anti-science and anti-intellectualism in politics, although I don't think it consciously evolved that way. I though became interested in the subject for those reasons when in the late 90s – early 2000s the attention of the public in space exploration especially had reached an all time low. The condition made me wonder if our collective sense of curiosity and wonder, which had characterized the post war generations, had suddenly dimmed. I realized a few years later that I was not alone in asking a lot of those questions. In fact a mainstream question I often encountered went something like this: "why spend money on space exploration when we have the war in Iraq to deal with?". My answer to that question was "Well who told you to bomb an innocent country (as in a country not proven guilty of the 9/11 attacks)!!! and let's put that trillions back into space (or universal healthcare for that matter).

Your argument concerning the limitations of the Sci-Art audience is a very valid one (in fact I recall speaking about it in terms of economy, in that it might be difficult in the current art market for most scientist to invest in the very Sci-Art they like). However, to Sci-Art's credit I think the persistence and proliferation of this dialog will reach a broader audience eventually through public works, popular residencies such as CERN, academic programs interested in the dialog and see it fit for their student populations, and eventually museum exhibits that might start taking place ten or twenty years from now celebrating the enthusiasm behind this movement, with or without the critique that we are forwarding.

As for the authority aspect, that's also really interesting but the responsibility resides with art and less with science. Art seems to always need a muse dealing with the larger question of existence. Religion used to fill that role, and in some ways it enforced it because it was for centuries an authoritative power and an economic center of gravity for art. Now science has become that new muse but with a lesser degree of authority compared to religion because we share intellectual research but not much of the financial wealth. In that sense it may be liberating for Sci-Art (and art in general) to be acting in an alternative market by rejecting the mainstream one. Thanks for pointing that out. I hadn't thought about that way. That is great food for thought.

The inscrutability factor I think can be traced to art that is strictly data based, which often can come across as intellectual posturing on behalf of the artist and risks alienating the audience. While it is great to be inspired by science I think it is ultimately more useful and inspiring for the artist to focus on making art and not a pseudo science experiment.

Werner Sun: I want to second Gianluca's call for "engagement with process and materials" precisely because it stands in opposition to anti-intellectualism. The way an artist engages with process and materials is analogous to the way a scientist analyzes data or a journalist uncovers a story — to make lasting work requires an open mind and a willingness to listen to the data. In this age of misinformation and fake news, the ability to interpret information honestly cannot be overvalued. Artists can show the way by developing authentic responses to one's materials, with an eye towards personal truth instead of dogma.

Jeanne Brasile – Session III

Jeanne Brasile

The angles of Sci-art to which I am drawn stem from a fascination with science and popular culture. My generation came of age during the Space Race and the development of shuttles, space stations and space probes. Star Wars, Battlestar Galactica and a legion of movies about space brought astronomy and physics to the forefront of our consciousness. Medicine and Biology were also very salient areas of discovery and popular culture for those coming of age in the 1970s through the 1990s. Though there was a multitude of approaches and themes to explore in Sci-art, what interests me the

most are artists that don't necessarily want to get to truths, but who are using science as a beginning to a conversation that doesn't need to be factual or even have an answer. Sci-art, when it simply ponders larger questions, holds the most sway with me. I look to science for answers. I turn to art for possibilities – and those don't have to be based on any sort of veracity.

The Sci-artists (and for that matter, artists in general) that are most successful in my view, are those that have a curiosity about science that engages them deeply and personally, but merge that interest within a larger framework that can appeal to others. That is, to form a larger dialogue outside of their own interests and engage in a broader conversation with the public. When Sci-artists borrow imagery or data, and don't implicate it beyond simple replication, it is not necessarily art. When Sci-artists borrow processes, information, technology or concepts from science, and then reconstitute it or implicate it differently – that is when Sci-art functions best. In the mid 2000s I began to notice many artists reproducing images from tunneling microscopes, MRI's, telescopes or seismographs – with little or no intervention or change in context. For me, this doesn't resonate. Artists are culture's daydreamers – they are allowed to ponder, explore alternate realities and dream of potentialities. Art, unlike science, is not just permitted – but obligated – to indulge in asking questions that do not have to necessarily be answered.

Transfigurations and exchanges

Dan Weiskopf

I'm going to venture a strong claim: it's impossible for scientific images and other materials to preserve their meaning when they're imported into artworks. Images, simulations, and other visualizations are *working* images: they hone our research projects by operating as evidence, or as devices to reason with. They depend on an array of skilled interpreters, both human and technological. Making them idle by tacking them up for display shifts attention to other properties (their formal character, their allusive potential) that play no role in their working life. Elsewhere I've discussed some examples of how this happens in works that draw on astronomy (see "The Sky and the Edge of Sight").

Of course, it's the prerogative of artists to transform the meanings of anything that they happen to use as raw material—what Danto called "transfiguration". The question is whether materials so transfigured can loop back around and feed into the scientific practices that they originated in. We might think of this possibility as a case of what Lindausefully called recursion.

In this vein, Simon pointedly asks what scientists might take away from exchanges with artists. I suspect that in general, aside from moments of adventitious illumination, the answer is not much. There are relatively few "slots" in the epistemically-oriented activities of planning studies, conducting observations, recruiting participants, preparing samples, writing grants, and calibrating instruments for artworks to make contact. Artworks are ill-suited as tools for scientists to think with.

That's not to say it can't happen. Some artistic explorations might have heuristic value for theorists, or might suggest new phenomena to investigate (on the latter conception, see Domnitch and Gelfand's essay on "art as rigorous phenomenology"). One example of a fairly concrete benefit from these collaborations is in medicine, specifically clinical pain studies. In a number of papers, artist Deborah Padfield and researcher Joanna Zakrzewska describe the creation of depictions of facial expressions of varying degrees of pain to be used by patients in conveying their suffering to doctors. Pain rating scales are notoriously hard to use for this purpose; see a summary in *The Lancet*, and one of several published studies of the procedure's effectiveness. Notice, though, that it's hard to regard these pain rating cards themselves as artworks.

Finally, I'm more dubious of the idea of artists as all-purpose outsider critics, mostly because to ask a question that really reframes a live problem requires being fairly steeped in the technical details of the field. The ways of thinking that artists develop are tied to their tools and materials, their hand skills, and the vast network of art-historical references that they draw on. It isn't clear what "exchange value" these might have for scientists.

Leonard Shapiro: I made this comment elsewhere but I think it applies here too – a short comment about the differences between the 'language of art' and the 'language of science'. It might be obvious and for that reason overlooked: each individual artist uses a visual language specific to them and we the viewer need to get to understand their unique language in order to 'read' and understand their artwork and what they are trying to 'say'. Even fellow artists need to decipher the unique visual language that their fellow artists use. Scientists (and indeed the whole science community) use a universally understood language. As such, scientists understand each other's writings, terminology, visual imagery, annotations etc. immediately. There are descriptive standards which facilitate precise understanding.

Luis Schettino: While I believe the bulk of the collaboration between Art & Science is bound to happen in the creation of ideas during brainstorming, I am not sure there is no possibility of some type of fruitful interaction through the 'loop back'. Scientists engaged with Art may find interesting/useful associations when thinking about the ramifications of what they are experiencing.

I see Dan's point, but I think that the 'epistemically-oriented activities' listed above are part of the methodology of modern science. I would not expect the methods of modern art to be of use in science either. Science and Art intersect in the discovery of ideas and in the cognitive processes leading to them. I am not sure that trying to find commonalities in the methods will be very useful.

Please note that when I say *cognitive processes*, I am including the process of purposeful exploration through doing. This can be any type of interaction with the environment while in Flow, such as writing notes and drawing on a piece of paper or testing a move for a choreography. All creators tend to engage in this type of activity.

Dan Weiskopf: Luis, I think that the cognitive overlap approach you sketch is one that often comes up, and there is probably something to it. At a certain level of generality all “purposeful exploration through doing” (to borrow your nice phrase) shares certain features. Even basic forms of exploration and play can be folded into this scheme, since they involve making moves and seeing how they change both the world and our experience of it.

Without wanting to deny this, though, I worry about how far this gets us either theoretically or practically. Theoretically it remains to be seen whether we can give a substantial analysis of what this common creative capacity actually is. Practically speaking, if the same cognitive processes are already involved in both scientific and artistic practice, what is the benefit of combining them, since presumably they share the same basic mental resources and operations? I think this is why folks like Simon Penny argue that artists actually don’t think quite like scientists, and that it’s precisely the **difference** that is valuable.

Anyway, to be clear, none of this is an argument against taking an anarchic collaborative approach towards discovery. I’m in favor of doing whatever works, in a broad sense. It’s just that I don’t think that our common psychology (if we have one) will help to explain the cases where it turns out to be productive.

Linda Francis: Luis I really like your characterization of the intersection of art and science and think that however that structure may be understood in the service of either or both disciplines is right.

Taney Roniger: While I remain somewhat agnostic on the question of what art has to offer science, I can say that I wholly concur with your “strong claim,” Dan – that scientific content can’t survive the recontextualization as art. But as you suggest in citing Danto’s “transfiguration,” this in itself isn’t the problem. (An example we might consider here is Bernar Venet, the French artist who uses mathematical equations in his work. Even when they’re presented in full and are not rendered palimpsestic, the equations no longer read as the mathematical equations they are in their original context, and they’re not meant to. Instead, they might evoke things like the sublime power of mathematics, or the question of whether mathematics is “discovered” or invented, or the dreams of reason gone awry, or any number of other things we associate with that august cathedral that is mathematics. In this case the equations are entirely metaphorical, and in some of his best work they exude uncanny mystery and considerable poetic power.) The problem with much sci-art is its implicit claim that the science it involves is to be taken at face value, which is to say as actual science. I always feel it’s such a shame when I see this happening, because science as metaphor holds so much potential. Why settle for a kind of crude literalism that smacks of disingenuousness when the material is so loaded with rich poetic potential?

Dan Weiskopf: It's an interesting question how to think about Venet's work. He personally seems to be concerned just with the "look" of equations, formulas, and graphs rather than anything they might mean. For him they are not even symbols, but uninterpreted marks, a new inventory of primitive elements for generating formal compositions that owes little or nothing to traditional styles of mark-making within painting. This accounts for the visually destabilized way they're often presented (at strange angles, cropped, overlaid, etc.), which serves to block any intrusion of sense. Trying to see his paintings in this way requires, for me, actively working to suppress any thoughts I might have about mathematics itself. The interest of the works lies in discovering how long I can sustain that mildly strenuous form of looking.

So in a way I think Venet's work is actively trying not to be about mathematics. However, if I were to push a little bit further, I would say it has natural affinities with the view called formalism in the philosophy of mathematics. Formalists held that mathematics is not "about" abstract mathematical objects—there is no ontology of math. Instead, it is nothing more than it appears to be on the surface: a rule-governed practice of manipulating contentless written shapes. If formalism had a visual realization, this might be it (as long as we can keep sense from leaking through the canvas, anyway).

Response to Jeanne: One Scientist's Perspective

Werner Sun

I would like to echo what Jeanne posted earlier.

Speaking as a scientist, one of the biggest stumbling blocks in my own appreciation of sci-art is not knowing how I am supposed to react to the scientific content. Scientific ideas are often very difficult to explain to laypersons and even other scientists. But for practitioners, every scientific idea holds a specific meaning, and it plays a particular role in the development of a field. The same is true of instruments, data, equations, etc. Every component is a brick in a Jenga tower.

So, when I see scientific material appearing verbatim in a piece of art, without an accompanying sense of exploration or transformation, my gut reaction is that the science is being taken out of context. A Jenga brick has been randomly plucked from the tower, and the edifice of thought surrounding it is being ignored. As an artist, I can recognize that this is not always the intention behind the work, but as a scientist, I must say I have a hard time approaching such work on its own merits.

An exception that proves the rule is the wonderful exhibition that Stephen Nowlin pointed us to. Instead of commenting on the science itself, Stephen's practice poses questions about whether scientific artifacts can be seen as art, or whether art be found in

the science. Note that the science he has chosen to highlight is of such import, and contains such mythic resonances, that it can easily shoulder these inquiries.

The discursiveness of science can be a barrier to its authentic use in art. Similar issues crop up in art based on a historical narrative or a piece of fiction — is it “just” an illustration, or is it “something more”? It seems to me that “something more” is achieved when the artist liberates the work from its ostensible subject. *Guernica* speaks universally in its own language, even though it depicts an actual event. And in Stephen’s example above, his entire exhibition is constructed as a microcosm to house the science, and the objects and displays placed within it are allowed to generate their own associations organically. So, I think if a work of sci-art manages to evoke a richly textured and convincing world unto itself, then the literal meaning of the science on which it is based can take its place as but one layer among many.

On Transfigurations and Exchanges

Linda Francis

Dan mentions the possibility of art’s heuristic value to theorists or that it may be suggestive of new phenomena to investigate. To inspire scientists, as well as of course others, is “not nothing,” to quote Ray Johnson. And to be inspired by them, as I wrote earlier, can be the subject of art. A personal example: I became friendly with a materials scientist who enjoyed coming over to my studio and talking with me about various ideas regarding science in general. We lost touch a couple of years later, when he moved to California to work on a NASA space shuttle whose heat shield failed. One day I received an envelope in the mail from him with a letter-sized xerox of an electron micrograph image and the inscription- “this looks like your work.” It actually did. I was amazed to find that a person whom I thought had no aesthetic grounding would recognize (and remember) the array of forms and see them in his work. Especially in these times recognition of image *is* knowledge, useful maybe not only as data but as the structure of...[post truncated]

The Problem of the Wall Label . . .

Stephen Nowlin

There are, as this symposium shows, many approaches crowded under the Sci-Art umbrella. For the one having to do with exhibiting works of science-based art, the quaint convention of the gallery wall label conceals much deeper issues than its quietly pragmatic utility would suggest. First of all, gallery labels are annoying — tiny little extra rectangles, visual objects in themselves, that dot the wall and exude residue of having hawked one’s craftwork at a peg-board street fair. Worse, though, they trumpet the century outmoded single-channel notion that each work of art is “on display itself” rather than part of a cohesive aesthetic and intellectual whole where only an installation free of

all unnecessary visual flak will suffice. Wall labels in a gallery are like leaving a metronome going during the symphony. But their truly criminal act is when they historicize and decode the work of art, and by so doing padlock it to a particular meaning, a sanctioned history, reducing it to a mere illustration and sidekick of the tiny text object that explains it. The debauchery of the didactic! This theft of an artwork's resonance, its pliability and potential to inflame sensations of transcendence, is especially likely when it comes to Sci-Art. Maintaining the integrity of an artwork as an object that ignites meaning and sensation surreptitiously and experientially, that exerts a kind of alchemy, a gravity that summons diverse associations and interpretations into its orbit, that resonates freely and shepherds onlookers in random meandering paths of meaning — that amazing unique power of art harnessed to the profound mystery and ontological torque of science must not be shackled by too ambitious an attempt to corral the art inside too specific a meaning. Unless your desire is to run a science museum, instead of an art gallery — where you can communicate science with the banality of a high-school textbook, instead of the impassioned spirit of a poet. . .

Werner Sun: I have only one thing to say to this: Bravo!

Taney Roniger: “The debauchery of the didactic”: This sounds like the title of an essay that’s begging to be written. Thanks for this post, Stephen. It’s refreshing to hear that some curators are pushing back against what I see as the increasing infantilization of the audience. (Of course, curators aren’t the only ones complicit in this; most artists I know will seize every opportunity to explain their work before the viewer even has a chance to experience it for herself. I can’t tell you how many times I’ve been to an artist’s studio where the artist has stood between me and the work — both literally and figuratively in every way imaginable. By the time I finally get to look at the damned things I usually find I’m no longer interested.)

Daniel Hill: This reminds me of many years ago when I worked at the Guggenheim as a guard. Bored and standing for hours next to great art, I began an experiment of observing how the masses experience art. I soon noticed a pattern that would often go like this: viewers would stroll in and give an artwork a general glance with a blank expression. This would soon be followed by the inevitable dash for the label. Once a cognitive link and association is made- “Hey that’s a Picasso!”, the face lights up as they step back to bask in this now great work with a newfound sense of admiration. After observing this so many times, I was left asking: why can’t they trust their own innate ability to see and have an experience directly? Is this a product of a lack of art education? I agree that labels are distracting, but wonder if the masses would complain about their absence!

Taney Roniger: It must have been disheartening to see that all day every day, Dan. I do think the dearth of art education in our schools is part of the problem, but I suspect it’s also a function of a much larger and more insidious problem — namely, the lack of critical thinking skills in the population at large. To me,

critical thinking is independent thinking, thinking that pushes beyond all the platitudes we're conditioned to accept as givens. Not engaging in it can be attributed to intellectual laziness, on one level, but on a deeper level it seems to be rooted in fear. It's both much easier *and* more comfortable to think, do, and say things that come pre-endorsed by popular consensus. In other words, it's much easier and more comfortable to always be "right" than to risk having an original thought that might go the other way. Although this has probably always been the case, I imagine it's much worse now with the platitude perpetuator that is the 24-hour news cycle. In any case, I say let the masses complain. If every museum got rid of its wall labels they'd have no choice but to look. At the very least, we might consider it an experiment in the promotion of uncertainty.

Daniel Hill: Good point, Taney. Also an element compounding the issue is illustrated in the Asch Conformity experiments where subjects gave wrong answers despite obviously being wrong in order to conform with the thinking of a group. <https://www.youtube.com/watch?v=67iHGCTkXus> Too bad we can't connect critical thinking and art education in our schools...

Taney Roniger: Wow. The psychology of conformity is really disturbing. The problem seems so deeply rooted that overcoming it on any large scale feels depressingly unlikely. But you're right: it does come down to early education, which can be changed. And one thing we artists can do is encourage rigorous critical thinking in the classes we teach. For reasons cited earlier in the symposium, though, art schools seem particularly mired in conformist tendencies. I'm sure you do it in your classes as well, but one thing I try to encourage in mine is the free expression of weird, outlier opinions. It's hard for students at first, but once they realize they're not going to be censured for saying something nobody else agrees with it becomes easier. (I begin by saying I don't think the Mona Lisa is such a great painting. They all gasp in horror.)

Response to Werner Sun

Leonard Shapiro

The fundamental differences between the 'language of art' and the 'language of science'. It might be obvious and for that reason overlooked: each individual artist uses a visual language specific to them and we the viewer need to get to understand their unique language in order to 'read' and understand their artwork and what they are trying to 'say'. Even fellow artists need to decipher the unique visual language that their fellow artists use.

Scientists (and indeed the whole science community) use a universally understood language. As such, scientists understand each other's writings, terminology, visual imagery, annotations, etc. immediately. There are descriptive standards which facilitate precise understandings and clear, unambiguous communication.

Werner Sun: Thank you for pointing this out, Leonard. I agree that artists and scientists construct their languages with different goals in mind (although they both seek to be understood, in their own ways). Do you find the inscrutability of scientific language (as Taney puts it) to be off-putting? And in your teaching, do you find that scientists are receptive to deciphering unique visual languages?

Leonard Shapiro: Hi Werner, I don't find the language of science off-putting. I find it helpful in my communication with scientists. When I teach anatomists or medical students a multi-sensory observation method, I bother to learn the anatomical names of the various parts of the body. I learn scientific terminology and develop my vocabulary quite naturally as I proceed in the medical science domain.

I find that scientists I know who are interested in art are open to deciphering visual language. However, they might not be open (as I as an artist am not) to deciphering particularly obscure visual language. To be fair, some artists are not yet fluent in their visual language and so their artwork is difficult to 'read'.

Art invoking the authority of Science in order to give 'legitimacy' to non-sense

Leonard Shapiro

I have often seen artworks which include random scientific imagery in order to 'science up' the artwork; to give it a veneer of being a work that is making a comment that is supported by science. This imagery is often unintelligible (to the general public and even to the visually literate) and can even consist of a *fragment* of the original scientific image. In doing this, artists are doing science (and sci-art) a dis-service in that unintelligible sci-art imagery alienates non-scientists even further from approaching and understanding things scientific. And it certainly alienates scientists from art and artists.

Taney Roniger: Exactly, Leonard. It's interesting to hear that you're seeing the same kind of thing there in South Africa. Although I know sci-art has a storied history in the UK, I had assumed its more pretentious manifestations were primarily New York phenomena. Does Cape Town have special sci-art galleries, centers, and magazines like we have here, I wonder?

Leonard Shapiro: Taney, South Africa does not have dedicated sci-art galleries nor magazines. Truth be told, the first time I heard about sci-art was from you via our discussions on Facebook. I think you could call Maropeng a sci-art endeavor where art accurately and artistically reflects the science being communicated. Maropeng is the official visitor center to the Cradle of Humankind. Scientists and artists/designers worked very closely on this project to make it a success. There are well designed interactive exhibits with information that appeals to the very young right through to older school goers. There is also information available for

academics and
archaeologists.<http://www.maropeng.co.za/content/page/maropeng-exhibition-highlights>

Sci-Art as Activism

Taney Roniger

Since we're on the subject of practice, I want to reintroduce a question Eve Laramee brought up early on in this discussion, which was: Is there a place for activism within sci-art? Given Eve's own work as an environmental artist and activist, I think the answer is certainly yes. But I wonder if anyone would care to speculate about some of the complications inherent in this kind of work. It seems to me that when one's explicit intention is to educate or raise awareness, it becomes especially important to get the science involved *right* and to relate it unequivocally. This puts considerable pressure on the artist – and on the art. From what I've seen, much of the work that falls under the activist art rubric suffers from a certain heavy-handed didacticism and a concomitant diminution of aesthetic complexity.

One example that comes to mind is Maya Lin's *What is Missing* project, whose purpose is to raise awareness about species loss and habitat degradation. It can be argued that this project is meant less as a work of art than as a public memorial of sorts, but I've seen parts of it installed in galleries. In the latter context it has struck me as fatally didactic, so little did its embodiment as a work of art do to move me. (Frankly, rather than having to stand there reading the various litanies, I'd much rather have been handed a pamphlet to take home. And I have never, I must confess, been moved by a pamphlet.)

Dan Weiskopf: I'm probably not well-suited to answer this question, since this sort of political awakening is almost the last thing I turn to art for.

Still, if there is a problem here, it's a fairly general one. For instance, I'm sure you've been following the discussion over why climate change has proven to be such an elusive subject for fiction—see, e.g., the interview with Amitav Ghosh in the LARB:

<https://lareviewofbooks.org/article/wheres-the-great-climate-change-novel-a-conversation-with-amitav-ghosh/>

Visual art exhibitions don't seem to fare much better, as this review indicates:

<https://blogs.scientificamerican.com/sa-visual/art-can-highlight-climate-change-but-where-is-the-data/>

Still, they continue to be mounted. Here's the catalogue from one (“Weatherwise/Otherwise”) that's up in Atlanta right now, for instance:

<http://www.daltongallery.org/wp-content/uploads/WWOWOnlineCatalog.pdf>

The simple fact, however, is that none of these have anything like the reach or impact of, for example, David Wallace-Wells' "The Uninhabitable Earth", which faced a severe public backlash for being so negative in its tone that it (allegedly) ran the risk of causing people to give up and disengage rather than stay in the fight. (It's an indicator of my own pessimism about our climate's future that I found it a measured and well-grounded analysis.)

Taney Roniger: Thanks for these links, Dan, which (among other things) introduce an idea that's never occurred to me — namely, that next we might be seeing a new genre dubbed "cli-art"! The interview with Amitav Ghosh articulates the problem very clearly. I respond particularly strongly to this paragraph:

"I think the most important thing is that novelists shouldn't write about climate change. I mean, that's the whole point. As soon as you conceive of your object as something called 'climate change,' your work dissolves. What you have to be writing about is actually your changed reality. This is what novelists have always done. Novelists have written about war, about famine, about all sorts of things. This is the changed reality that we have to try to confront. When we try to think of this thing in terms of a single object, it does in fact become very abstract and dull. But if you look at the actual impacts that are unfolding around us, they're anything but abstract and dull. They're incredibly powerful, overwhelmingly powerful. It's so interesting that Hurricane Katrina resulted in so many important documentaries and nonfiction books. And even Hurricane Sandy has resulted in some good nonfiction work. But where is the fiction? Where's the culture? Bill McKibben pointed to this decades ago, asking where is the culture that reflects our changing reality."

And his citation of *The Grapes of Wrath* as a proto-climate change novel that's also a literary masterpiece is fantastic. All of this seems to point in this direction: "addressing issues" in art cannot be done in the abstract. The issues have to be embedded in a context of particulars (in the case of novels, a narrative about specific people or nonhuman subjects; in the case of visual art, an object or image oriented around the same). It's really a matter of orientation, I guess; while some of the images in the Boston exhibition you link to are intriguing (maybe), the explanatory text in which they're wrapped robs the work of its affective potential. (As soon as I read that something is "about climate change," my eyes glaze over just as Ghosh suggests.)

But the problem of *exactly* how we should be addressing these issues in art is a very difficult one. (What would a successful piece of "cli-art" look like?) So far paintings of melting glaciers have not really cut it.

Lorrie Fredette: The topic of Sci-Art as activism is a trifecta condition. Some of us are participating in the online forum seeking definitions and possibly some clarity on “what” Sci-Art is and isn’t. Attaching activism to the genre, in my opinion, places the majority of work on the doorsteps of science and activism. When thoughtfully presented they stand strong in their communities, having intelligently presented the data, created accessible engagement through dynamic visuals as well as involved activities and, if done well, they have reached outside of their neighborhoods.

One of the projects presented “outside” the gallery possibly fitting under the Sci-Art as Activism umbrella would be Eve Mosher’s High Water Line, <http://highwaterline.org/>

Laura Splan’s Watching Hands, <https://www.cdcfoundation.org/content/watching-hands-artist-laura-splan>, commissioned by the CDC is one of the few projects successfully standing in the Sci-Art Activism blend.

Brandon Ballengée’s The Frameworks of Absence, <https://brandonballengee.com/the-frameworks-of-absence/>, poetically attracts our attention to lost species diagrammatically and the visual effect is a punch in the gut. This particular projects successfully presents in a gallery, art fair (initial showing was at the 2015 Armory Show), science centers, county clerk offices and state parks. It seamlessly translates to each environment a bit like a chameleon.

Would this type of “effortless” presentation be a marker one is seeking of Sci-Art as activism? As Taney asks, are there more successful projects?

Response to Leonard Re: ‘Giving Legitimacy to Nonsense’

Stephen Nowlin

In his critique of “artworks which include random scientific imagery in order to ‘science up’ the artwork” Leonard Shapiro thoughtfully raises a fundamental issue for Sci-Art. The challenge is how to manage an artwork that appropriates scientific imagery for the purpose of evoking emotional reactions and transcendent associations which were not inherent in the imagery’s specific scientific origin, thus proffering for that imagery its legitimate resonance with broader ideas and sensations — and at the same time remaining true to the integrity of the science. When poeticizing or in effect acknowledging the genuinely ‘spiritualizing’ dimensions of science, it is nonetheless easy to slip into complicity (or give the appearance of doing so) with New-Age mysticism, religious pseudo-science, or paranormal and supernatural memes that clearly misinterpret and pervert rather than promote science consciousness. It is in the discourse over how Sci-Art challenges such historically and culturally institutionalized perversions of science, that

the movement is potentially both disruptive and enlightening. The absence of such a rich discourse that reaches into the core of human beliefs about reality, is one of the frustrating aspects of most popular media-based coverage of Sci-Art — coverage which tends to address its novelty but not the deeper ontological implications it raises.

The Sci-Art Moniker and Art's Fight for Relevancy

Daniel Hill

As has been touched on so eloquently elsewhere here, and as evidenced by the absence of Sci-Music or Sci-Poetry, the visual arts appear to be in a desperate position to retain some cultural authority. Whether the alienation of the general public; the toll paid for years of cold, exclusive postmodernist jargon; a blind capitalist system dictating aesthetics via market value; or poor overall art education, the art world seems to be a bit of a mess right now. It is no wonder that Sci-Art would emerge, but the moniker has become synonymous with an illustrative aesthetic which can lose sight of art's fullest, most valuable potential. It is noteworthy that the "Sci" comes first in this name and emphasizes the concern that the art part gets lost. Art has the unique ability to pitch our perspectives outside of our little world enough so that we see the world through new eyes and touch upon the ineffable. This transformative catalyst is needed more now than ever in society. But making good art is not an easy road. It can be extremely difficult and requires years of dedication and sacrifice to find one's personal vision and develop a unique visual lexicon. I fear Sci-Art could offer a tempting, easier route that relies too heavily on the science in place of doing the dirty work. If Sci-Art is to move forward, do we want the type of art that is mainly a scientific pedagogic tool or the catalyst of personal and societal transformation? Can we have both? And if we can, is the latter still called Sci-Art? Perhaps the latter needs no name. Great art does not depend on its description; it simply is just great art. Matthew Ritchie was basically making a form of science inspired art decades ago but it wasn't called SciArt. Maybe this *Other Sci-art* should not be a movement as much as it should be a personal decision on the artists' part. It is my experience as an artist and curator that being able to talk about art within a scientific context does increase an audience's ability to appreciate the work. Maybe this is because it ties a complex visual language to that which is the most compelling concept—the truth, or its pursuit.

Taney Roniger: Daniel, I share all the sentiments you express here, and I particularly appreciate your pointing out the tendency of some "sci-artists" to think they can bypass the hard work it takes to be an artist. From what I see, there seems to be an entire generation of young artists out there who think sticking an image of neural circuitry onto a painting somehow makes the work "smart." I'm not sure where they got this impression (is it the MFA programs? Are they becoming less rigorous?), but it's somewhat painful to those of us who've spent decades laboring to make work complex and substantive enough to be called art. I'm not sure how they're going to be disabused of the notion, especially since they form something of an exclusive club that admits no dissent. But the larger issue, for me, is the impression they're giving the scientists they work with. The

idea that art is easy and fun and that it exists to amuse is already entrenched in their culture; if genuine art-science collaborations is what we're aiming for going forward, we artists must do everything we can to dispel this myth rather than presenting ourselves in such a way as to perpetuate it.

Daniel Hill: “The idea that art is easy and fun and that it exists to amuse is already entrenched in their culture; if genuine art-science collaborations is what we're aiming for going forward, we artists must do everything we can to dispel this myth rather than presenting ourselves in such a way as to perpetuate it.” Very good point- it is an uphill battle and one that exists beyond the sciart realm and into the very fabric of culture. Without the support of an overhaul in art education and the eventual shift in attitude towards the arts in society, artists will continue to have a very tough road indeed. Which is why my thinking endures doubts that science can help recontextualize art and break or expand its current status.

Werner Sun: Daniel, your last two sentences have made me realize something: science might not even be the real subject of sci-art. Perhaps science is being used merely as a *symbol* of “objective” truth, that which was under attack in the science wars and which some artists now seek to revive. In that case, what matters for sci-art is not actual scientific content, but science's mythic aura. Scientific imagery functions here like a religious icon, as a talisman evoking something pure and noble.

Werner Sun: To expand on my comment above: if this is correct, it explains Daniel's and Suzanne's observation that not every artist who uses science gets labeled as a sci-artist. The reason is that only one particular face of science is relevant to sci-art.

Seen in this light, the motivations behind sci-art seem benign and perhaps even utopian.

Daniel Hill: When I first read this comment, it struck me as an “Ah ha!” moment. This an excellent insight and is potentially true in a good percentage of the work. I suppose it is necessary and performs a function. (I am referring to Werner's comment on the objective truth being used as a symbol or talisman.)

Taney Roniger: Agreed, Daniel! It explains a lot, actually.

This takes us back to something that came up earlier: the idea of science as a symbol of transcendence — or as I put it, salvation — which I find really interesting. Perhaps we mean different things by this, Werner, but what I was thinking of with regard to the salvation issue is that as much as modernism's ideals were rooted in the belief that technological progress would deliver us from all our woes, art was also seen as a vehicle for salvation (in this case spiritual

rather than material). So in that era art, science, and technology were felt to be equally noble pursuits, since all three held this soteriological promise. But with art's rejection of its spiritual aspirations as postmodernism took hold (to the point where the word "spiritual" is still considered anathema to many artists), science and technology have become the sole torch-bearers of salvation. My hypothesis is that art longs to recover its spiritual dimension but can no longer believe in it the way it once did, so it's reaching toward science to regain it by association. I'm not suggesting that any of this is conscious – only that some of these implicit longings may underlie sci-art's emergence.

Werner Sun: I think we do mean the same thing, Taney. I'm sorry I didn't put two and two together when you first made your comment. My main speculation here is that the yearning for salvation may actually *explain* the particular quirks of sci-art that several of us have brought up in this symposium. I didn't see the causal relationship until now.

Taney Roniger: Both angles are interesting to consider, though. The main point, which you stated above so astutely, is that sci-art might not be about science at all but rather what it represents to people psychically. I think there's something quite poignant about that. The more I think about this, the more convinced I become that so much sci-art is a case of misapplied literalism.

Daniel Hill: Yes I think you are both referring to the same idea. And the word "spiritual" actually does make me cringe. Perhaps because it is one of those words that has been used so much and with so many differing meanings, that it has actually become meaningless (for me, and I suspect others.) Is it the longing for transcendence, the awareness that transformation is perpetually needed to overcome our ignorance? This speaks to Model Dependent Realism, which I mentioned elsewhere. <http://strangeattractors.cueartfoundation.com/response-to-taneys-post-on-the-question-of-audience/>
If we are aware that we are likely wrong, we are smart to look for ways to transcend ignorance more quickly. This would also apply to our personal models of perception, thinking, and evaluation. If art is to use "spiritual" as a word, it risks being associated with the morass of New Age fluff out there. As is the case for a substitute for Sci Art, I do not have an alternative word.

Daniel Hill: One of the fantastic outcomes of this symposium is the opportunity to observe one's own views under a microscope and sharpen the focus of meaning and intent. My above post could be viewed as critical of the current SciArt movement and I suppose it is. Certainly I have entertained the perspective of a skeptic and can say I understand the criticisms. Ultimately I think the conversation between art and science has enormous potential and only through analysis can it become stronger and more effective. I see that the sentence "If Sci-Art is to move forward, do we want the type of art that is mainly a scientific

pedagogic tool or the catalyst of personal and societal transformation?” is the wrong syntax: it is not an either/or situation.

The enthusiasm is palpable in the SciArt scene and any enthusiasm for art and/or science on any level in our current troubled society is a good thing. This will continue as it performs a necessary function. I only hope that the other that I refer to is not overlooked; that it too, has a much needed function as well; one that has an innate link to our species as a sophisticated language for communicating the ineffable and perhaps a link to our personal and collective realization of, and transcendence of, ignorance.

Taney Roniger: It’s interesting, Daniel, re: the word “spiritual.” I think there’s a significant movement afoot to wrest it from the clutches of New Age woo and restore its former dignity as a respectable word within art. I support that movement. I’d also support coming up with a new word, but nobody seems to be able to do it (least of all myself — same for sci-art!). That said, I think there’s plenty of potential for articulating what a new kind of transcendence might mean — a secular one — that will have nothing to do with everlasting life or the sky god or any of those things we postmoderns can no longer accept. For me, it has simply to do with transcendence of one’s own puny, finite perspective — one’s skin-encapsulated ego — in favor of a deep feeling of connectedness with the whole system in which we’re inextricably embedded. Nothing fluffy about that, right? In fact, it seems to me that that’s exactly the sentiment we science buffs refer to as (for lack of less cliched terms) awe and wonder. But I like your take on it very much too — i.e., transcendence as a ceaseless striving to move beyond our own ignorance. (And let me confess here that I somehow missed your former mention of Model Dependent Realism, and as I head into that link now I realize I may be inclined to change my opinion!)

Daniel Hill: I think again, we are talking about the same idea. I concur wholeheartedly!

Luis Schettino: For me it is very exciting to read this conversation with regards to the possibility of SciArt to produce what R. Otto called the ‘Mysterium tremendum et fascinans’ or ‘the numinous’. Those are other ways to refer to the experience of awe that religions are able to inspire. But, of course, those experiences do not need to be associated with any religious dogma. (In fact, mystics are usually unwelcome by organized religions). I have no doubt that Art and Science are able to produce such emotional states in people as suggested by Taney in our earlier conversations. Can SciArt be the catalyst of personal and societal transformation?, I suppose it’s worth a try!

Response to 3.5

Suzanne Anker

As we continue the conversation, the “sci-art” proposition and its engagement is still not resolved. What is included in this set? Do we separate out the physical sciences from the biological ones? Bio Art may be a sub-set of this conjunction, but does it follow that there is a Physics Art? Geology Art? Mathematics Art? I don’t think so. When artists such as Damien Hirst or Marc Quinn or even Orlan employ dead animals, bodily fluids or molecular substances in their work, they are not referred to as belonging to the “sci-art” genre. What is included in this designation and why? Many artists working with wetware in a laboratory mode are in general either making amateur science or speculative design. Let’s not forget that our discourse is in art, art theory and art history or even cultural studies. Artists in the “sci-art” domain are not equipped to rant about the scientific aspects of their work beyond a layman’s interpretation. They are in fact using science’s data bank to translate those ideas into images, objects or film. There is no conjunction here making artists and scientists twins, separated at birth.

There are several modes of engagement that seem promising. Competitions such as iGEM or the Bio Design Challenge are excellent ways to vet ideas which fall under this rubric. These are rigorous competitions that entail visual presentations, social and educational outreach in addition to innovative collaborative practices.

Dan Weiskopf: “What is included in this designation [sci-art] and why?” My own favorite puzzle case is the surrealists, who drew liberally on Freud’s theories and clinical framework to justify their methods. Psychoanalysis was at least *held* to be a science at the time. I take it that the perverseness of the example just shows how arbitrary the category is. More to come on your latter point regarding applications in another post.

Response

Linda Francis

I certainly concur with Leonard’s post on legitimacy, although it is difficult to know how to judge things that we want to call art of any kind, and within that sci-art. The problem both Taney and Daniel have identified is the problem of relevance or authority in society as a whole. But I ask this question: what do we want from sci art, and how is that similar or different from what we want from art in general. Taney and Suzanne speak about Activism or social relevancy in art. Bio-art when it is positively positioned gives us some excellent and useful ideas in trying to solve various pressing problems we have as a society. However, is the “art” we are attempting to label an art that maybe does not operate in any quotidian sphere, and is there no need for it at this point? I don’t mean to exempt design from art per se, on the contrary, we are in a kind of exploded Bauhaus position.. growing numbers of practitioners in the arts and a concomitant expansion of the aestheticized life. I wonder though what Mondrian would have thought if he saw the drinking glasses MOMA sells with his painting on it or his name on a condo or nightclub.

But, as I said earlier, my experience with effecting a positive outcome regarding conservation was not through art but through political and legal intervention.

Dan Weiskopf: Linda, I endorse this, particularly your last point about the relative (in)effectiveness of art as a vehicle for activism. I've made some related remarks in response to Taney here:

<http://strangeattractors.cueartfoundation.com/sci-art-as-activism/#comment-172>

Margaret Wertheim: Linda I agree with your point about activism. In my work also I have seen that art can be a leveraging mechanism for bringing awareness about issues like climate change and plastic pollution. But does it get anyone to change their behavior? The great power that journalists hold – the only one really – is to raise awareness, and artists can also play a role here, but I think art-as-activism has been over-hyped. Activism requires boots on the ground and the long hard slog of community work, which might be entailed in an artist's practice, but often isn't. A question that I have increasingly is "Can alliances be made between sci-artists (if we want to call it that) and groups doing the hard political work?" Are there ways of supporting such alliances? In my work I've experienced that when my work becomes more politically engaged and activist it becomes harder to fund. Sci-art funding often seems to be allied to an aesthetic that fetishizes "cutting edge science" and the newest terminologies. (I notice some previous comments about the fetishization of jargon.) I am interested in how (and if) sci-art can serve as a mechanism for helping to prise open hierarchies that often get enacted in relation to science.

Taney Roniger: That's an interesting idea, Margaret, about pairing sci-art activists with political activist groups. I wonder what that would look like. I have a filmmaker friend who does some interesting work that might provide a model. One of his projects involved working with the employees at a recycling facility to create a large-scale video work (very large — 50 by 8 feet) that was absolutely beautiful. Part of its success was its subtlety; rather than being a documentary-type film explaining what happens to our waste, it was just a slow sequence of shots showing the enormity of the problem (no voice-over, no explanatory text). I saw it installed at the Museum of the Moving Image, and it was one of the most powerful works I've ever seen — leagues above what one usually sees with activist art. I wonder what would happen if he were to team up with some environmental activists and together bring it out into communities that might be affected by it. (Sadly, very few non-art world types frequent that museum.) (For anyone interested, his name is Pawel Wojtasik, and the work is called Single Stream.)

Linda Francis: Taney, Pawel was my student years ago and we are still in touch! I know the piece you are talking about and I had him show it to a class of

mine at Pratt..I think space, and consequently time really curves back on itself-
Heh heh. (Longer post later..)

Taney Roniger: Pawel and I were at Yale together, Linda. He was doing sculpture then, but his transition to video has made him, in my opinion, one of the best artists around these days! Small world, eh?

Some Thoughts

Matthew Ritchie

The question of what constitutes ‘scientific imagery and scientific content’ as specific terms separate from the representation of other forms of human enquiry is evolving – and therefore often poorly defined or indefinable. Even the term ‘scientist’ only appears in the early nineteenth century, in counterpart to the idea of the ‘artist’, precisely when it becomes clear there are many specific forms of science, just as there are many specific forms of art.

The goals, uses, materials and processes of science and art are not necessarily exclusive, but are often mirrors of each other. In both fields, a premium is placed on freedom of enquiry and instrumentalizing both physical and metaphysical data, all in the service of hypothetically reciprocal (but as often competing) social and theoretical ends. The differences in presentation and interpretation often lie as much in the chosen application of visualization technology and the expected terms of service.

Another way to think about it might be the more recent question of ‘image’ versus ‘file’. Most scientific imagery is produced for professional journals in the form of reductive or essentialized quantitative diagrams – tables, graphs, Muller plots etc; that ostensibly reflect an ‘objectively’ (see Galison & Daston for how this term has changed) procured dossier, or file, of source data, (the inherent scientific content), and the file of data is the nominal work product. In reality, many of these graphs are so graphically essentialized as to be almost useless scientifically – while the contextual information such as spatial co-ordinates, time and duration is easily manipulated to help the simple data visualization conform to the research premise. But the premise remains that the source information is directly accessible and subject to review.

In a few data rich fields, like astronomy, network theory, medicine, biology etc; more complex data visualization methods can produce more highly developed visual forms (or qualitative) images that superficially retain the initial informational topos – but here the contextual information is often stripped away, the essential keys to their scientific sources (such as spatial co-ordinates, time and duration) are removed and the primary file is doubly compressed, from a data table into a fixed image, now far more resistant to future informational decompression and more accessible to aesthetic compression.

Personally I appreciate the visual economy of the former as much as the complexity of the latter forms. But in many cases of the first type, efforts to instrumentalize one kind of knowledge, the primary database or file (assumed to be the ‘science’), with a simple visualization technology table, graph or diagram are assumed to produce an image that is ‘not art’ – primarily due to its ability to be decompressed or be ‘useful’. In many cases of the second type, the combination of a given visualization technology and the secondary database, or re-processed file (still science?) are assumed to more thoroughly instrumentalize the second kind of knowledge, and produce another, tertiary kind – an image (art?).

In art, the mirror premise is that the subjectively (or at least authenticated by of the maker) procured source information, is, like the source data in a science experiment, somehow still directly accessible, either as ‘raw’ content or through material form. In reality, Frederik Stjernfelt’s analysis of the sketch describes how the original terms of any given hypostatic abstraction are progressively obscured as they are aestheticized through a similar three-stage process. This should be no surprise, as *all* information accessible to what Antonio Damasio calls the ‘core-self’ must undergoes a similar three stage compression – to present the information in a form that is accessible through the viewers’ own theory of picture.

There is another, ongoing version of this discussion in the art world between the terms, ‘photograph’, ‘image’ and ‘file’ – all of which also produce ‘pictures’. What we lack is a meaningful grammar to discover any distortions in the translation, or a gauge of the inherent mirror symmetries that might govern this process of aesthetic compression – or how information decompresses into and out of pictures – and so we don’t know how to evaluate the exchange between science and art. Sci-art seems to fall into this space.

So maybe one useful question is, can multiple forms of enquiry, research and knowledge production – whether, intuitive, deductive, scientific or artistic, be engaged and represented simultaneously in a way that allows them to be coherently transposed, decompressed and usefully compared inside a common theory of picture? A promising form to carefully consider might be the diagram, or ‘informational drawing’, which re-emerges in the 17th century as the essential tool of scientific research, and whose ability to concretize process can be clearly distinguished from Foucault’s concept of the ‘table’ or closed disciplinary array, by its ability to both cut across boundaries and to produce pictures of thought structures – or theories of picture.

Can this be done? Over the last few years, I’ve developed my own simple visual grammar of how these theories might interact diagrammatically, that visually unifies certain hitherto diverse approaches in the histories of science, aesthetic theory, network theory and ontological philosophy. This followed on from the premise that the dynamics of a complex system can be described as a walk, or game, drawn on a high-dimensional free energy surface and that more knowledge of the properties of the system can be obtained if one knows the distribution and properties of all the local minima of the surface. Just as there are minima for physical reality (the four constants), there are ontological minima

for the human framing of knowledge and spatio-temporal minima for the useful proliferation of information within physical reality in forms that can be represented in the ontological framing of knowledge. However, most of the time, any system is confined in its deep local minimum as the high transaction costs of moving between ontological and temporal energy minima mean any new form trying to escape has a tendency to fall back to the local informational minima – hence the difficulty of defining a combinatory position between science and art!

Response to Dan on activism

Linda Francis

I do agree, particularly when, as a result of my failure to convince the Audubon Society and a number of associated land trusts with a very well researched and simply reasoned discussion, to actually take some position that would be in accord with their own conservation mandate, I understood in a flash how all is lost on a local level. If one multiplies/enlarges the willful ignorance that was at work, one can see why on a national level we are losing all too.

In regards to your posts and Taney's on Bernar Venet: I totally agree with your view of the work and want to point out that there are some superficial devices- words placed obviously in some of the panels acknowledging the current rhetoric in fashion. eg: on one you will see a phrase in an eye catching position naming Kurt Goedel and on another piece the word "recursive" in larger case letters. One doesn't know if these things are satirizing science or art or using the words because they look clever. To me the work is decorative composition and makes nice wallpaper even if a little strident.

Taney Roniger: You might be right about Bernar Venet, Linda and Dan! Perhaps his example is even better than I'd initially thought, because now we're up against what we might call an issue of responsibility. If Venet's use of mathematical equations isn't about either the equations themselves or mathematics as a whole, then why is he using them? Because they're sort of interesting graphically? This would seem a bit irresponsible on his part, because every viewer of his work will immediately go there — to the *idea* of mathematics — and it's hard to imagine he doesn't recognize this will be the case. But I suppose in the end the artist's intentions are irrelevant; what matters is what the work presents and how viewers respond experientially. Being a fan of the mathematical sublime, I myself can be quite taken by some of the better ones (the ones devoid of candy colors and cheap references to Goedel and whatnot. I'll see if I can find a good image).

Response to 3.4 by Margaret Wertheim

Margaret Wertheim

As someone who trained in physics and mathematics and now works as an artist and a science writer I find that there's a fair bit of confusion in the arts-practice sphere about

what scientific research is, which is creating angst around the idea of what “research” might mean for arts practice. Let me begin with an anecdote:

The other day I was speaking with an artist I respect about mathematics and I mentioned that when getting a PhD in math you have to come up with new equations. He was rather surprised and didn’t understand that new equations are the sine qua non of math research. Equally, in theoretical physics you are expected to come up with new equations to get your research published. There isn’t really an equivalent in art practice because the “validity” of equations is judged by pretty narrow parameters. I want to dispel a myth here: new equations aren’t a rare thing; in the mathematical/physical sciences they are meat and potatoes. It’s like playing chess: a good chess player is expected to find new paths within a set of pre-existing, narrowly defined parameters. The paradoxical art of doing physics and math is coming up with new things while conforming to a huge body of rules. Most artists wouldn’t want to be so constricted, and art would be immensely less rich if we *were* so constrained.

In science one is mostly making incremental additions to a vast body of existing work to which you add small fragments that are judged in pre-set ways. In the arts, we tend to value new visions and leaps of imagination – or at least we claim to. Big imaginative leaps are rare in science research, which in recent decades has been wildly romanticized. Einstein is an exception here, which is why he’s been so mythologized, but he’s un-representational of what science mostly is. Occasionally the rules of science are broken or reinterpreted, and new fields come into being. But that’s unusual. By its nature science is a conservative activity – it *has* to be to function. 90% of a science education is learning what’s gone before; it’s rather like an old-fashioned apprenticeship, and in many ways learning to be a physicist or mathematician has more in common with learning to be a carpenter than training to be an artist. In mathematics and physics, you can’t make a contribution until you’ve mastered a vast body of existing knowledge that will have necessitated working through endless problem sets where the major task is to recapitulate what millions of others have done before you.

New knowledge comes into being through many different modalities and science shouldn’t necessarily be our model for new epistemologies. As feminist artists, post-colonial artists, queer artists; as artists who want to challenge received rules and assert new ones, our model often can’t be scientific research. Of course we can find resonances in our practices within sciences – as a feminist I’m interested in the ways that women’s handicraft embodies mathematical relationships and constitutes a genuine form of mathematical cognition. My practice explores and asserts the value of non-symbolic modes of doing mathematics.

Werner Sun: I completely agree, Margaret. Your anecdote shows that if artists and scientists are to truly understand each other, it’s not enough to simply have high-level conversations about what each field is “about”. Artists and scientists need to get down in the weeds together, working shoulder to shoulder. They have to be exposed each other’s minutiae and dirty laundry because these are the

telltale signs of a field's core concerns, not the glorified accounts we make up after the fact.

Along the lines of your second point about the role of existing knowledge in science, I think reductionism has also been the subject of misunderstandings. (I've been intending to write this up as a post.) Scientific reductionism in practice bears no resemblance to the juggernaut that is demonized by postmodernism. Progress is not a one-way street. The answer to a particular why does not always mean drilling down to ever greater levels of detail; sometimes it comes from stepping back to look at phenomena in aggregate (e.g. Ken Wilson and the renormalization group). More importantly, new descriptions of phenomena do not necessarily displace the old — it depends on the scale. An analogy: you don't have to account for the curvature of the earth when building a house, but you do when launching a satellite. Similarly, we haven't discarded Newton's law of gravity now that we have general relativity. Newton's law remains true and useful in its regime of validity, and general relativity tells us something deep about **why** Newton's law works. These disparate descriptions of the same phenomenon coexist, and they end up validating each other. Indeed, such unexpected convergences contribute to the multivalent nature of scientific knowledge (which could be a point of contact with art), and they are often cited as one aspect of beauty in science.

Neil (reader): “science shouldn't necessarily be our model for new epistemologies.” I presume you mean “epistemes”. But it probably should be. That's the definition of science – it's systematic, domain-specific learning. For science not to be a model for epistemic discovery, we'd have to admit to unsystematic models of learning. But that sounds oxymoronic, 'cause if they're unsystematic then how can they be models?

Taney Roniger: I think the “our” in Margaret's sentence there refers to artists, Neil (or possibly to anyone in search of alternative approaches to knowing). Art is notorious for becoming sclerotic when it's bound by rigid rules and functions best when it's unsystematic, so I think what's being suggested here is that we artists look for models other than science for understanding how we conceive artistic (Or, further, that we should abandon the term “research” altogether, which would be my preference.)

Response to Daniel Hill's question: “what if a robot makes the scrambled eggs? Would it still be an art?”

Leonard Shapiro

At the outset, let me say that robotics is not my field so please be as critical of my response as you need to be.

A robot would be programmed with the intelligent input of a human or a number of humans. When the robot makes decisions and then acts on these decisions based on its programming, it is acting within the parameters of its programming and therefore within the parameters and limitations of the human intelligence that it now contains. I am sure the robot can be programmed to randomly adjust some of its decisions. For example, to add a pinch more salt or whisk the egg more slowly or more quickly (which will introduce less or more air into the egg mixture). The parameters of 'how much or how little salt' can be pre-programmed; in other words, it would be pre-programmed not to add over a specific amount of salt relative to the number of eggs in the bowl. In this way, a robot can make a number of different variations of scrambled eggs. [As an aside, a good use of this programming would be for us as humans (and for chefs in particular) to taste a number of scrambled egg recipes made by a robot programmed in this way, and then to judge which recipe works best]. However, we still have the robot making decisions and acting within the bounds of its programming, even though it has been programmed to make variations on any of its decisions.

But we are separating robot from human as if we share no robot attributes simply because we are made entirely of flesh and bone (i.e. our bodies are entirely non-mechanical). But as soon as I introduce a machine into my existence I begin existing as an integrated unit with the machine. Even when I use a washing machine, my behavior is changed; if the washing cycle will take 15 minutes, I will have a conversation with someone based on the fact that I have to take out the washing in 15 minutes time. So, my human behavior has become partly determined by my engagement with the (washing) machine. And this is just one machine that is 'attached' to my consciousness and my daily decision making processes. My human mind is the 'computer' operating the machines in my life and my mind is in turn influenced by the abilities of the machines that I use around me. What I am arguing is that we are more robotic in our programming than we acknowledge ourselves to be.

What I am doing when I drive a car is applying a number of decisions in order to operate a machine. I am using my brain like a computer. And now we have entirely non-human operated cars, which indicates that the use of my brain when driving a car can be substituted by a computerized program. Of course, a car going from A to B is just that; it is being guided within a set of predictable and very narrow parameters. Scrambling an egg is very different from driving a car; we expect creativity/artistry to be introduced into the making of a scrambled egg recipe but not in the driving of a car which we expect to be governed within strict parameters.

Can a robot learn?

A human will make a scrambled egg and if they repeat this daily, they can learn ways on how to improve it based on what they did the previous day. They can learn how much or how little salt to add. Can a robot be programmed to learn? Could a robot learn and make adjustments based on what it has learned? Assuming that we had a robot that could be

programmed to taste in the same way as a human could (and so it would know what was too salty or not salty enough), and it made a scrambled egg, would it be able to learn the quantity of salt that it needs to add so that the egg does not have too much or too little salt in it? (note that in the case of this robot, we have not programmed it to add an amount of salt within certain parameters as in the previous example).

So, I think that a robot making scrambled eggs would indeed be an art similar to a human making a scrambled egg would be an art. In fact, a well programmed robot would make better scrambled eggs than a novice human cook. And the proof of this would be in the tasting: when tasting the scrambled eggs made by a well programmed robot, a group of chefs who did a 'blind' tasting would surely agree that it made better scrambled eggs than a novice cook (who might have added too much salt).

Also, in the programming that I have described for our scrambled egg-making robot, doesn't it follow that one can write an algorithm for the making of a scrambled based on the way that a particular human makes it? If so, wouldn't it follow that one can write a number of algorithms based on a number of individuals who made scrambled eggs in their unique way? (I am asking this as a genuine question as a non-robot expert).

ps. I liked the Youtube video on the Rembrandt painting. I would be keen to see the computer paint a Jackson Pollock :). One thing that would be needed is to program in the kind of splashes made from a brush loaded with a paint of a specific viscosity and flicked at the canvas from a specific distance, or dribbled onto the canvas from a tin with a hole of a specific size in the bottom of it.

Margaret Wertheim: A quick response to the question about robot learning: Yes robots can be programmed to learn. That's what's going on now with AI's and neural networks. Neural networks are increasingly learning ways to do things that their human creators no longer understand. Indeed there's an emerging field of computer science devoted to learning how the programs have learned. We are already at the point where the programs have evolved knowledge strategies well beyond the capacities of their makers. A nice example is computers that have learned to be far better chess players than any humans; but what's nicer is that human-machine chess teams working together are better still. So there's a new kind of chess-playing entity called a "centaur" which is a team of humans working with a computer. The "centaurs" can beat any human, so they play against one other.

Daniel Hill: Simultaneously fascinating and terrifying Margaret! I would venture it is a reasonable assumption that we will see "Centaur" art making entities in the not so distant future? (Maybe they already exist?)

SESSION IV

Taney Roniger

The flurry of activity we saw here over the weekend has left us with much to ponder and discuss! While we continue to explore some of those questions, I want to issue the final set of prompts that will take us through Wednesday. Because we've covered so much material in so little time, and because so many of our panelists' responses call for further discussion, we've decided to leave the conference site live through the end of the year. This will give everyone the opportunity to continue the dialogue and, should there be the desire, to respond to each other's essays that will appear soon in *The Brooklyn Rail*.

Moving Forward:

Establishing Visions for the Future

Mon. Nov. 13 – Tues. Nov. 14, 2017

4.1 What, if anything, does sci-art have to offer the broader culture?

4.2 Does the sci-art movement have a role to play in the 21st century imperative of saving the planet? In what specific ways can sci-art contribute to solving the most urgent problems we face?

4.3 If the mechanistic worldview of the 20th century is what brought us to the current ecological crisis, can sci-art serve as an agent of promotion for a more holistic and sustainable metaphysic?

4.4 How might art and science evolve *independently* to shape culture in more positive ways? Would each be more effective on its own?

4.5 Given the current political climate, what can both fields do to resist the increasing threat of marginalization?

4.6 One of the most ambitious claims made by sci-art proponents is that some day in the near future art and science will be indistinguishable. In light of this claim, what lies beyond sci-art? Where are we going?

Sci-Art Fictions

Werner Sun

Leonardo da Vinci is often cited as the original sci-artist and a paragon to be emulated because of his mastery of both art and science. But I wonder if Leonardo is a false idol, given how much both fields have evolved since his time. Science in the 1400's was a far more speculative affair than it is today, not having been exposed to the instruments or

mathematics or Enlightenment ethos that solidified its current cultural authority. And I suspect that most artists in the 1400's viewed their craft in a utilitarian manner and not as the vehicle for transcendence that so many of us insist upon. In other words, the idealized art/science unity in the Renaissance may simply be a romantic myth that has little bearing on art and science as they are now. Perhaps today's art and science were never meant to be as one.

Having made that claim, I should also guard against presentism and acknowledge that art and science are surely still evolving. In the future, art and science might leverage the cognitive similarities that Luis has noted in unforeseen ways, undergoing foundational shifts that position them more in alignment with each other. Indeed, before Maxwell, who would have thought that electricity and magnetism were one and the same? [Of course, art and science might instead draw even farther apart.]

Daniel has brought up one such vision: computer-generated Rembrandt paintings. He asks whether this is art. What if future generations say yes?

Elaine has suggested a different kind of partnership, where scientists, when they hit roadblocks, might look to artists' tacit knowledge to guide them towards the right questions. What if art becomes the oracle for science?

Matthew posits that the indigestible raw images of both art and science undergo successive levels of manipulation and abstraction, and in so doing, approach a middle ground accessible by practitioners in both fields as well as the general public. What if informational diagrams become the lingua franca of civilization?

Stephen has advocated for sci-art as an agent of change that endows science with the emotional resonance required to replace discredited myths of old.

All of these game-changing possibilities would make for interesting thought experiments (which is perhaps another definition of sci-art). Who wants to play?

Gianluca Bianchino: Werner, I like the idea of Sci-Art as thought experiment, somehow that feels right. Also, I agree that the future may play a favorable role toward the acceptance of Sci-Art as a culture unto itself. The true beneficiaries of that culture will be determined most likely by that future. Hopefully the cumulative critique emerging from this symposium will influence it for the better in some way. I'm particularly intrigued by the idea that the future may also accept computer-generated Rembrandt paintings as art. I don't like the idea but I'm accustomed to accepting, or having to work with, ideas that never resonated with me as art. So at the moment I propose that we ask not if that work is considered art, because many things are considered art, but whether it holds a poetic language...or dimension.

Werner Sun: Agreed, Gianluca. Maybe calling things “art” that are not yet accepted as art tends to shut down discussion. I think it’s especially important to consider ideas that we don’t like. Many of the technologies and ideas we depend on today faced resistance when they first appeared (writing displacing the oral tradition, the heliocentric model of planetary motion displacing the geocentric model).

Stephen Nowlin: Werner — adding to this thought experiment: In the future might science replace religion as the means by which humans pursue an emotional relationship to their existence?

Werner Sun: Indeed, Stephen! Do you have a sense of how this might work in practice? Your own exhibitions are certainly exemplary in this regard.

FYI, Stephen, I have edited my post to include a reference to your ideas, which I should have mentioned in the first place.

Reply

Linda Francis

I like the idea of sci-art as a thought experiment and advocate for those experiments between disparate disciplines in general. I would underline the experimental ethos to try to avoid a priori assumptions/ conclusions.

Re: science and religion, I really enjoyed George Lucas’ sly comment in THX 1138.

Werner Sun: Thanks, Linda! Yes, letting go of preconceived notions is extraordinarily difficult. But if anyone can do it, it’s artists and scientists — that’s what we’ve been trained to do!

Taney Roniger: Hear, hear to more thought experiments, Werner! On this subject, Matthew’s work with diagrams – which I think he considers a vast thought experiment — interests me very much. Since art’s poetic dimension has been a recurrent theme here over the course of the conference – its power, and indeed its necessity in the world – it might be worth exploring the poetic aspects of the diagram. Part of what makes the diagram so appealing to me as a unique kind of language is its economy of means — the distillation, the condensed expression, of the logical relations that are its content. The diagram, then, can be seen as a kind of visual poetry in which form and content are absolutely inseparable.

Elsewhere, Matthew has made reference to Edgar Allan Poe and his ideas about the imagination as a form of logical thinking (see his *Descent into the*

Maelstrom). All of this is to suggest that logic may not be so foreign to art as it is supposed to be, nor poetry so foreign to logic as it's thought to be. And Margaret Wertheim's practice makes a beautiful case for the poetic and aesthetic dimensions of science that are all but absent from conventional science discourse. So perhaps there's some fertile ground here for new epistemologies that we're only just beginning to explore.

And crucially, one of Matthew's most trenchant points is that diagrams don't just reflect cognition; they also shape it (as of course does any powerful form of art). Thinking about Matthew's work, my mind keeps returning to the film *Arrival*, directed by Denis Villeneuve (released in 2016). It was by no means a perfect film, but what made it interesting to me was the aliens' language. Based on the Sapir-Whorf hypothesis in linguistics – the claim that the structure of one's language determines the nature of one's thoughts and behavior – their language was exclusively visual and manifested itself in exquisitely beautiful glyph-like forms that issued, vapor-like, from the aliens' pods. Non-linear by nature (the patterns were to be apprehended all at once rather than sequentially), it was essentially a holistic language that reflected minds capable of transcending time. Okay, this is sci-fi – but the connection between visual structure and mode of cognition resonated very deeply for me, as I imagine it would for any visual artist. Is this not what every visual artist aspires to ultimately – that in embodying a distinct kind of cognition, our work will penetrate other minds and expand the parameters of their thinking and behavior in unexpected ways?

Luis Schettino: I would like to touch on the idea of Science or Art (or Sci-Art) as a possible substitute for Religion. I have thought about this from time to time and I think there are at least a couple of characteristics of Sci-Art that would commend it as a plausible replacement. First, there is ritual: a fusion of Art and Science can formulate the type of sensory experiences that suggest to the individual that he/she is experiencing Sacred Time/Space. After all, that is what religions have done for centuries with song, rhythm, drugs, incense and other paraphernalia. Second, there is meaning. Scientists have been mentioning for years that there is no better source for wonder than what we already know about the Universe. Our problem has been that we haven't been great at communicating why we think that is the case, an issue that has been mentioned here a few times. Having said the former, there is one issue that religion does well that secular approaches can't seem to get right, and that is community or congregation. Faith-based belief seems to be especially efficient at bringing people together. Is that something that could be replicated through Sci/Art means?

Taney Roniger: I must say that the possible convergence of art, science, and religion has been one of the most exciting aspects of this conversation for me. And Luis makes a good point about the necessity for some form of communal experience if this is where we're heading. Luis, did you see the video Stephen posted of the show he curated called *Uncertainty*? Watching the unannotated

version certainly evoked religious sentiments for me. If experienced communally — preferably in silence — this kind of exhibition could rise to the level of a new form of secular communal transcendence. (You can find the video here: <https://vimeo.com/205276101>)

Luis Schettino: Thank you for re-posting the link to Uncertainty, Taney. I had not yet seen it. I agree that watching the video or experiencing the actual pieces in a group would help induce some form of emotional communion, but joining in a set of actions, in a ritualized behavior, would be more effective. Perhaps that is where we lose some of the secular public, by asking them to join a ritual it raises in them a red flag against crowd behavior, which is a reasonable response. So the question is, how do you convince people in the skeptic to cynical spectrum to join in a ritual?

Thoughts on the Future of Art and Science

Jeanne Brasile

I think art and science both have much to offer one another. One example that resonated with me recently was how scientists and engineers at MIT are using origami to overcome the difficulties of space travel – specifically using designs for solar arrays based on intricate folds to maximize energy use. Similarly, physicist Robert J. Lang is also an origami master who similarly employs the use of folding to solve complex engineering problems at NASA’s jet propulsion laboratory. I see that the future is not necessarily about a convergence of art and science, but how art and science can be used cooperatively to overcome challenges in both fields. It is in the area of innovation – the ability to think, see and tap into knowledge outside your area of expertise – that will enable us to make gains beyond that which can be approached by working within the limited parameters of a single discipline. Nature is infinitely interdisciplinary and as we work on more complex problems, we need to emulate nature’s multifarious characteristics to form appropriate solutions.

Taney Roniger: I’m glad you brought up the so-called origami revolution, Jeanne. I agree that this is one of the most promising points of intersection between art and science around right now (although for accuracy’s sake this should really go under the more inclusive rubric Art/Nature/Science/Technology). Part of what’s so striking here is that the art being drawn upon is not illustrative (the bane, it seems, of most sci-art interactions) but rather *structural.* I know a lot of artists today who are exploring the structural principles of nature, so this movement could potentially expand beyond origami. I’m also reminded of one other field whose practitioners excel in the area of structure, and this is architecture. When I think of architects like Christopher Alexander – father of “the pattern language” whose nature-oriented approach has been widely influential in the field of design – I wonder if the sci-art movement can more

actively pursue contact with that field. Linda has mentioned something about this – an initiative at Pratt, perhaps?

Jeanne Brasile: Taney – Thanks for introducing me to Christopher Alexander – I was not familiar with his work. My entree to this subject is via artists/writers like Jack Burnham (Real Time Systems, Systems Esthetics) who, beginning in the 60's, was interested in understanding patterns based on systems that could be applied to art – patterns that were borrowed not only from science – but the disciplines of sociology, economics, chemistry, biology, engineering and physics. This represented in his mind a paradigm shift from art as object based, to art as system based.

Gianluca Bianchino: I agree with Jeanne that nature is infinitely interdisciplinary and it is very possible that nature has some disciplines it hasn't shared with us yet. It makes me wonder if collaborations between disciplines will unveil practices even more profound than art and poetry. If I were to make a prediction based on the cumulative discourse of the better Sci-Fi works of literature that I've read, I would say that it is inevitable for our survival in this Universe to eventually tap into dimensions beyond the four we are accustomed to, those being the three dimensions of space and one of time. If we are to become multi-dimensional one day then we may discover an abstract language even more profound than art. Not that the convergence of art and science will necessarily take us there but at the moment the dialog seems logical, and even more logical is our critique of it.

Werner Sun: Thanks for this, Jeanne. Your observation that “Nature is infinitely interdisciplinary” has been haunting me. We as humans build so many different “ways of knowing” — including science and art — and they all have their own internal logic (whether or not we accept their premises). But meanwhile, Nature just sits there in all its complexity, simply existing. Is it any wonder, then, that we need so many different descriptions of Nature, some of which might contradict each other, but nonetheless simultaneously true?

Jeanne Brasile: Werner – your reply is incredibly eloquent and I like your personification of Nature. I do believe Nature has its “internal logic”, but at this point we cannot fully understand the language, let alone the logic. Perhaps our fascination with art and science is a means to bring us closer to Nature's and logic and parlances. For example, we're just beginning to understand how plants communicate and work with other species to defend themselves. How can a plant speak to a bee to get pollinated, or a bug protect itself from a fungus? Nature is definitely interdisciplinary, but also multi-lingual.

“Nature is Infinitely Interdisciplinary”

Linda Francis

Jeanne's post is certainly spot on. I think we sort of obliquely spoke about "knowledge" and didn't really continue the discussion James began in regards to it. Matthew graphed the migration of modes of thinking from one position to another in history. I agree with Margaret that the toughest part of the picture, even with this cascade of science into the culture's consciousness, is in trying to work together to affect real-world applications that are most often linked to politics. Suzanne cited two programs that were applying pragmatic solutions to big political problems in a kind of entrepreneurial frame. But I am most concerned/ worried about the development of AI and how that could be used. How can artists, who are taught that art does not editorialize, position themselves as arbiters of what is good?

Taney Roniger: Very good question, Linda, about art's ethical dimensions. Does art have an ethical imperative in times of crisis like our own? I'd like to think that it does. Pawel's work is exemplary in this respect — perhaps we can think of more projects like his in which the art is not compromised but the "message" (such a dirty word in art!) is clear?

Response to Werner's Thought Experiments — Will Science Replace Religion?

Stephen Nowlin

Regarding Werner's [call for thought experiments](#) on the future of the science-art enterprise, and my query on how science might someday replace religion. Werner asks "*Do you have a sense of how this might work in practice?*"

Good, modest little question, Werner — kinda like asking for simple operating instructions on how to transform all of human history! But an excellent experimental thought challenge. So everyone please forgive me at the outset for the hubris of even imagining how such a massive change might actually happen . . .

A first humble step might be to stop casting the argument in terms of religion vs. science, and engage it as supernatural-world vs. natural-world. This makes it an academic pursuit rather than one pointedly antagonistic to belief. Then get over the [NOMA](#) hurdle, discard it and recognize that ontologically religion and science essentially account for the same deep-seated human desire — an emotional relationship to one's existence, escorted through by a sense of the profound and meaningful.

Whether we recognize it or not, the path of this central and unavoidable discourse which will ultimately lead to a battle for the ascendancy of one paradigm or the other, began at least (and has continued culturally at the creeping pace of continental drift) in the 15th and 16th centuries when early science shook the church to its foundation by locating the Sun at the center of the known universe. This now well-worn story of science history was culturally cataclysmic at the time, and I propose the fault-line was further expanded in the aftershocks of late 19th and early 20th century artists locating transcendent aesthetics in the contemplation of real objects, rather than in art's traditional fictional *depiction* of

objects. As metaphor, those transcendent sensations in response to actual real objects referenced how new scientific knowledge of the real was prying us loose from the glue of ancient inherited fictions — i.e. advancing from the supernatural to the natural is analogous to moving from the pictorial to the real.

Sci-art continues that vector of change in all its permutations, and is what over time can transform the stereotype of science as a mechanical pragmatic-only world view into an emotionally resonant and profoundly symbolic one as well — and thus further history's incursion by science into the ontological archetypes traditionally claimed as rewards of religion only.

BTW — No, science/natural cannot replace religion/supernatural's eternal life and reuniting of loved ones in heaven — it will have to bravely prevail without those myths. But science may conceivably someday shatter the authority of such seeming absolutes as aging and death . . .

Translational research and everyday aesthetics

Dan Weiskopf

The examples of science-art interactions discussed so far have mostly identified science with basic research and its products (theories, data, images, etc.). But science is heterogeneous, and the emphasis on theory neglects other forms it can take. Beyond the classical division between theorists and experimentalists, we also need to add modelers and simulation-builders, who craft and manipulate computational analogs of real-world systems. Perhaps most significant for thinking about science-art collaborations, though, is the comparatively new field of translational research.

Translational science aims not at creating theories or models, but at concrete making. As the slogan has it, the goal is to move “from bench to bedside”, producing useful products and therapies derived from discoveries in basic science. Synthetic biology is the paradigmatic translational field. Its experiments are not geared towards exploring a domain of phenomena or seeking confirmation of a hypothesis, but towards discovering ways of synthesizing new drugs, organisms, materials, and technologies. To the extent that translational science can be understood as producing knowledge, its most direct product is *practical knowledge* about designing and creating highly tailored living systems. While it typically centers on biomedical applications, the expanded field of translational science includes wider community applications in addition to clinical ones. Needless to say, it's also hoped that all of these will have lucrative commercial potential.

As Suzanne mentioned, a paradigm for cooperative creation between translational scientists and artists and designers is the Biodesign Challenge. A few of its highlighted projects include biomorphic architecture, Suzanne Lee's “biocouture” (bacterially-derived textile products), and cheaply grown water filtration systems. These products of

translational science are meant to be lived with: inhabited, used, worn, touched and manipulated, even ingested (as in the case of new synthesized foodstuffs). They need to be not just functional, but also desired. Some aspects of the role that design thinking plays in synthetic biology are explored in the volume “[Synthetic Aesthetics](#)” and other work by Alexandra Daisy Ginsberg.

Artists whose main goal is producing gallery-bound objects of distant contemplation may not see this as involving art at all. In a narrow and somewhat proprietary sense, this is probably right. But so what? The artworld as it exists now is arguably a historical oddity, and one whose continued existence is not guaranteed. As the recent surge of writing on everyday aesthetics has made clear, aesthetic experience overflows the boundaries of art *per se*. The made world that we inhabit is permeated by aesthetic qualities that are, to most people, more present and relevant than the hothouse flowers of the artworld.

Having said all that, my main objection to this argument is that it sketches a role that isn't obviously limited to science. All design involves understanding and extending the potential ways that novel materials can be shaped and transformed, hence the artistic contribution here may not involve anything that engages *specifically* with the project of translational research as opposed to any other way of making things for use. On this general topic, Glenn Parson's recent book on [the philosophy of design](#) is worth a look, as is the site [Design Research Failures](#).

Linda Francis: Dan, on the “hothouse flowers of the artworld”: In that they have become rarefied arguments of style, and in that they for the most part mimic the proclivities of the people (maybe 10%) who trade in them, I understand your pointing to the glory of capitalist enterprise- when it is working for “good”. As much as it is exciting to develop ideas that are “useful” as I have said before, I am loath to give up the image of art's larger critical function. It is possible that the conflation of the aesthetics of art with design will obviate art in every realm, including its most spiritual sense, and I dont know where to look to make claims for it on the grounds of art of any hybrid or “pure ” state. Something I loved and observed in India that I often think of as art: The custom of the sadhu who walks from village to village, standing in its midst shouting out profanity, reviling prominent people and in general creating a totally upsetting atmosphere for a time before going on their way to other locales. What is interesting to me about this practice is that it is accepted ostensibly by all and yet defines itself outside normal social and political parameters. I guess it may be a form of religion but more, one of ethics.

Taney Roniger: Linda, you say: “As much as it is exciting to develop ideas that are “useful,” as I have said before, I am loath to give up the image of art's larger critical function. It is possible that the conflation of the aesthetics of art with design will obviate art in every realm, including its most spiritual sense...” This is an interesting point. But I wonder if something that's useful — i.e., design — can't also be critical or spiritual. I'm imagining things along the lines of, say,

conceptual artist Jonathon Keats's "Temple of Science." ([Temple of Science](#)). Actually, now that I think about it, Keats is somebody I should have mentioned long ago. He's someone who works at the (crowded) intersection of "experimental philosophy," art, design, science, and technology (and with the temple, albeit with tongue in cheek, religion). His new project is something called the Metroscope, which is essentially a set of small public parks shaped like whatever city they inhabit in which thousands of lights will display patterns of the city's activity (how many toilets are being flushed, how many lights are on, how many cars are clogging the streets) to nightly visitors. While data visualization has become ubiquitous in our time, engaging in it as a shared, intentional activity — and one in which people could contribute their own visualizations — might make it the transformative experience it must be both to galvanize change and to be moving *as art.*

Dan Weiskopf: Hi Linda: on the question of usefulness, I'd just point to the claims of architecture, ceramics, textiles, and other crafts to be fusions of aesthetic quality and practical utility. Whether one wants to think of crafted objects as artworks (not obviously the right thing to say, in my view), the two properties don't drive each other out. Craft's history is at least as long as art's, so the prospect of design usurping art's status within the realm of the aesthetic doesn't seem likely to me.

As you noted, there's a certain notion of art as being like the sadhu, an itinerant critical troublemaker subservient to nothing except its own transcendent spiritual and moral vision. I can certainly see the appeal. (Philosophy, too, can be like this, with its endless Socrates-fixation.) This enfant terrible role should be firmly historicized, and it isn't anything like a universal, but it also doesn't seem in any danger of dying out, if only because being a strident critic can be an effective way of securing status and attention (for some appropriately situated individuals, at least).

SESSION V

Taney Roniger

Heading into our final day here, I have to say that eleven days now feels woefully inadequate for the kind of dialogue we've been having! So many of the issues raised here beg for further exploration, while others equally rich in potential have gone all but untouched. That said, we'll be keeping this forum live through the end of the year should anyone want to further pursue any of the ideas discussed. I'd also welcome posts with notices about other sci-art goings-on here in New York or elsewhere — it would be wonderful to get to know more of the sci-art community!

With an eye toward assessing the shape of the dialogue moving forward, Session V offers an opportunity for panelists and readers to weigh in on how you'd like to see it progress. I look forward to hearing your ideas.

Conclusions

Wed. No. 15, 2017

5.1 If you were to respond to the questions in Session I now, after ten days of dialogue, would your responses be any different? Have any of your attitudes and assumptions about the sci-art movement changed as a consequence of this discussion?

5.2 If we were to further the dialogue – either here or elsewhere – where would you like to see it go? Are there any voices that have been conspicuously absent, and if so, how might we go about getting them involved?

The Poetic Space

Gianluca Bianchino

As I go about my career making works in dialogue with science, and therefore participating in Sci-Art to some extent, I still believe the category itself is potentially unnecessary for it is the result of defining a trend and less so a movement in art. We are in a strange age that orbits the very edge of Postmodernism, echoing the long undefined boundary of the solar system the Voyager spacecrafts are traveling through. Before these spacecrafts securely reach another system will they be traveling through a forever undefined border? Perhaps we are currently making our way through an ambiguous region of our own as artists whose trends and categories are driven more by fierce market forces than intellectual rigor. What will be the next definable phase in art and will that bring back movements as opposed to fashions? That being said I still believe that Sci-Art will persist in growth while continuing to act as a branch of art more than science; this I think is due primarily to the question of its audience, still undetermined or perpetually in flux. Will Sci-Art generate an affordable market to scientists if they shall be its principal audience? Some good things have been said in this symposium about its capacity to evolve outside of mainstream markets. It's almost as if Sci-Art is squatting on unclaimed real estate. What happens when the developers come? Run!

Sci-Art will continue to grow as a trend, and potentially a movement in the near future particularly if it engages in further challenging the political climate in service of innovation and energy efficient technology. However, I honestly don't think that art and science will merge into one discipline without there always being art for art's sake lurking in the background, inconveniently stressing self reflections upon Sci-Art as one would hope it does upon other branches of culture. Art's primordial interests in abstraction, with or without scientific inquiry, will continue to prevail and bring about

new aesthetics of its own. This very independent artistic space is the true nursery of poetic sensibility in visual language. It is a fundamental organism of human thought that will always find a way to carve itself a new path within the “creative” hemisphere. While abstract art will always persist, Sci-Art has to worry about longevity and possibly extinction.

Taney Roniger: “This very independent artistic space is the true nursery of poetic sensibility in visual language.” Beautifully stated, Gianluca, and I couldn’t agree more. Except that we might differ on what “this very independent space” might be. I’m not sure “pure art” (art cloistered away from the real world, an autonomous entity existing for its own sake – if this is even possible!) is the real seedbed of creativity. To me, it seems that to be creative in any meaningful sense, art must be engaged with the world – both deeply observant of its changes and challenges and fiercely responsive to them. By this I’m not referring to activist practices of any kind; I just mean “situated” practices that engage the human condition in whatever state it happens to be in at any given time. I see “this independent space” as the one you underscored in your first paragraph – that precarious place on the margins of culture where we’re all just hoping for another day before the developers arrive. Art’s capitulation to the market has cost it its soul, and I’d hate to see that happen to any more mature instantiation of this thing we’re calling “sci-art.” To be critical in any sense, we must remain countercultural — which is to say willing to live without the endorsement of the dominant culture. This is what I’d like to see sci-art do moving forward: Reclaim art’s hallowed role as an agent of perturbation. Which is not to say all of us need to go around shouting; sometimes – and now seems like one of them – the most countercultural thing you can do is sit still and think. But do it out in the world, you know? ...where people will notice.

Gianluca Bianchino: Taney, Yes. I think what I meant by art for art’s sake is not art completely disengaged from the world but neither one so bound to a compartmental category, or a dominant culture for that matter where it risks turning itself into a sheep following a heard. Abstract thinking of the best kind ultimately springs from participating in the world and can feed ideas back to that world.

Taney Roniger: Ah, I see! You meant art as ART rather than art burdened by a hyphen and all it portends. Then yes, we are absolutely on the same page. Personally, I think we’d all be better served if we dropped the term sci-art and just called it art.

Gianluca Bianchino: Yes art as Art! Apparently these days that’s the hardest thing to do. And thank you also for helping in clarifying that thought. I very much like the idea of art (abstract or figurative) “situated” in a context relevant to the world.

Linda Francis: I have come away from this symposium understanding just how much currency science has developed in art at this time. When I first started out in the 70's it wasn't much in fashion but it was being discussed among that segment of us that realized its importance and wanted to use it. Minimalism, positivist of necessity, employed a cold factual approach that aimed to foil interpretation. So the next generation worked with exactly how meaning could arise from reduction and abstraction. Now I have seen many more direct quotations of science being used almost as figural representation in art. I have also learned something of bio-art, am sure that is an important development but would rather that it was called applied science, which a substantial proportion of it seems to be. Gianluca's characterization of his work as "in dialogue with science" is well stated.

Gianluca Bianchino: Linda, Thank you. It has not been easy to reach that characterization, for the work is always in flux and bound to process and discovery of new materials and techniques as opposed to any preconceived theory. It's interesting to know that minimalism is also tied to a scientific methodology without the work necessarily resulting in a science-like aesthetic.

Stephen Nowlin: Yes, I agree as well — thank you both for those cogent thoughts. Sci-Art should be ART first, situated in an agitated puzzlement over how science means and disturbs in current human culture.

But I don't see it as a trend or typical movement — rather, as a 500 year-old continuum with a present inevitability that I expect will persist along evolutionary timescales . . .

i.e., I think it's here to stay.

Gianluca Bianchino: Stephen, I believe in the 500-year-old continuum as well and it will be interesting to see its evolution both within and outside of the definition of Sci-Art. I think one of the aims of this discussion has been to develop a communal sensitivity to unmask the works that are mere science aesthetic, or nothing more than simulations of science experiments, versus works (or artistic practices) rooted in a deeper poetic dialog. If this atypical movement is here to stay, this distinction is important.

Comment from Suzanne Anker

Suzanne Anker

Taney, thank you very much for your efforts in helping to clarify some of the intersections between art and science. As there is not one kind of science or one kind of art, more specific definitions and re-definitions are in order. One aspect not covered in the discussion is the notion of epistemic things, a term greatly referenced by Hans-Jorg Rheinberger in his writings. He refers to epistemic things as concepts in experimental

systems. That said, perhaps we can view art as an experimental system and begin to outline its attributes.

Conclusions and Acknowledgements

Taney Roniger

When we began this dialogue eleven days ago, one of my main objectives was to impose some sobriety on what James Elkins has memorably – now perhaps indelibly — called the drunken conversation between art and science. Establishing clarity and eradicating misunderstandings, I was convinced, was the only way sci-art could mature as a genre. How quickly I was disabused of this notion! Indeed, if there's one thing that's been made clear to me over the course of this symposium, it's that working with only partial understandings can be wonderfully generative, and that by taking little stabs at sense from numerous different angles we can generate ideas and questions wholly unforeseen at the outset. Such has been my experience here, and I can honestly say I've learned not just *more* than I'd hoped for, but more about things quite other than I'd anticipated.

We've covered so much ground here, and from such a variety of different perspectives, that a quick summary would do the material no justice. But one thing about which we all seem to agree is that art, like so many other fields, is in crisis, and that its reach toward other disciplines represents an earnest effort toward a renewed sense of purpose. Whether you're a sci-art enthusiast or one of its skeptics, I think we can all find this move sympathetic and laudable. And whether sci-art grows as a genre or dissolves altogether, it seems fairly certain that art will look very different than it does now some decades out.

Acknowledgements:

First and foremost, I want to thank all of you for all the rich insights, reflections, and speculations you've shared here. So many of you poured more time into this conference than I could have ever expected, and for that I'm deeply grateful. I'd also like to give a huge thanks to the wonderful staff at CUE – Corina Larkin, Shona Masarin-Hurst, and Eva Ellmore – for all the work they've done over the last six months to make this happen. Without them, we'd have been conferring in my barn upstate, and I can say with some confidence that this arrangement was far more comfortable. And finally, I want to thank Werner Sun and Daniel Hill, my partners in crime, without whose tireless support and keen insights this conference would have been much the poorer.

I look forward to seeing many of you on Friday!

(And I can't help but add: Who ever thought we'd end up at religion?)

Werner Sun: I won't be able to make it to the mixer on Friday, so I want to thank everyone who participated in this giant discussion for giving me so many new thoughts and perspectives to ponder. The question of how art and science might be connected has been vexing me for some time, and it is immensely gratifying to share ideas with others who are also deeply concerned/curious about the same things. I do hope this conversation continues because I feel that we have just scratched the surface, as Taney said.

Many thanks to everyone at CUE — Corina, Shona, Eva — for your generous hospitality both in your physical home and online.

And of course: Taney, THANK YOU for the tremendous amount of time and effort you have dedicated to this project. This has been such a rewarding experience for me, and you have posed the questions that desperately needed to be asked!

Taney Roniger: Thanks so much, Werner – much appreciated! I'm officially out of here now but will be checking every few days. We'll miss you tomorrow night!

One More Thought Experiment

Werner Sun

Inspired by what [Dan](#) and [Suzanne](#) said about the boundaries of sci-art:

We have been focusing on science-based art, but it might be interesting to consider the implications of the converse — art-based science — by which I mean the study of art objects using scientific techniques. There are many examples: violin makers systematically quantify how violins produce their distinctive sound (also [this](#)), physicists have [deduced what Jackson Pollock knew about paint](#), and at the lab where I work, [x-rays have revealed hidden layers in a Picasso painting](#). Some artists are uncomfortable with such work because they feel this reductionist approach diminishes the human element and dispels the mystery in art. I wonder why it has to be either-or. Why can't have it both ways?

In physics, we often study phenomena that admit multiple (sometimes mutually exclusive) descriptions — light is both wave and particle. Or, a volume of fluid can be viewed both from afar in terms of macroscopic quantities (like density or viscosity) or up close as microscopic particles. We might be moved by the how the fluid dances and flows, and this beauty is not negated by having a low-level picture of how things work.

Maybe it can be the same for science and art. Maybe the physics of paint can coexist with the painting. Maybe it is possible to both know and not-know at the same time.

Drunken conversation or exquisite corpse?

Dan Weiskopf

At the outset of our discussion, encounters between science and art were framed by James Elkins' seductive image of the drunken conversation. A conversation may meander, lose its way and double back, but no matter how confused things become, it is still held together by the cooperative norms that prescribe mutual intelligibility as a goal for all parties. These norms, even if allowed to lapse in practice, always hold out the prospect of achieving a hazy form of comity.

Attempts to bring scientific and artistic practices fully into engagement within the same project, though, seem to me darker and less cogent than this, an apophenic pile-up of meanings more akin to an exquisite corpse. The surrealist parlor game prizes anti-legibility: since neither party can see anything more than the outermost borders of the other's image, communication is impossible. Each side lays down marks autonomously, as dictated by its own vision and its own internal rules. Neither participant has a clear or complete view of the other's efforts, so the resulting depictions tend to the fantastic and monstrous, always falling short of making sense.

This contest of representations is irresolvable, I think, because the aims, means, evaluative standards, governing discourse, institutional frameworks, and historical consciousness of contemporary art and science are hopelessly at odds. As this discussion has illustrated, artists are interested in the tools, concepts, and products of science insofar as they are evocative vehicles for poetic expression (in Gianluca's terms), mystery and transcendence (in Taney's), or social and political critique (in Linda's), not for their epistemic or explanatory value.

To return to another opening theme, the situation might be different if there were a common grid of knowledge within which both could be aligned. This remains far from clear, though, as shown by the persisting confusions over "artistic research". Art-making can be exploratory, playful, perhaps even experimental in the sense of being open to unpredictable outcomes, but its implicit standards of success are always reflexive and historical. Building and testing scientific models, by contrast, turns on assessing their fit with complex webs of evidence. Notions like argument, evidence, and confirmation, when used in their original senses, have no obvious application to visual artworks. (In the same way, "novels of ideas" are never *themselves* logical arguments).

It may not matter, though, whether artistic practices involve understanding the core scientific concepts, in the sense of being able to do the correct things with them. Mutual understanding may never have been the point. I'll conclude with a more carnal speculation: fundamentally, what art wants from science is to *eat* it.