Preface

The conference “Simplicity: Ideals of Practice in Mathematics & the Arts” took place at the Graduate Center of the City University of New York during April 3–5, 2013. In 2007, Juliette Kennedy co-organized a symposium on mathematics and aesthetics at Utrecht University in the Netherlands and curated an accompanying art exhibition, *Logic Unfettered: European and American Abstraction Now*, at Mondriaanhuis: Museum for Constructive and Concrete Art in Amersfoort. The symposium, which she organized with Rosalie Iemhoff and Albert Visser, featured talks by mathematicians, philosophers, art historians, and a physicist, and for the exhibition Kennedy selected works of ten artists, including Fred Sandback’s *Broadway Boogie Woogie (Sculptural Study, Twenty-part Vertical Construction)*, 1991/2011. It was a very successful combination; those artists who were present attended the talks, and then all participants gathered together for the opening of the show. It was an ideal opportunity for interactions and exchanges of ideas. Kennedy proposed that the three of us organize a similar conference in New York City, taking advantage of the inexhaustible New York art scene and focusing this time on the idea of simplicity. One motivation for the conference theme was Hilbert’s recently discovered 24th problem.

At the second International Congress of Mathematicians in Paris in 1900, David Hilbert, one of the most influential mathematicians of the twentieth century, gave an address in which he presented a list of unsolved problems. He chose ten of them for his address and then presented the full list of 23 problems in the published version of his lecture. In 2000, Rüdiger Thiele discovered another problem in Hilbert’s mathematical notebooks. Although his notes do not define it as precisely as the published problems, leaving some room for interpretation, in essence, the 24th problem was to find criteria for simplicity in mathematical proofs.[1]

In his contribution to this volume, Étienne Ghys writes “My job is to state and then prove theorems.” This may be the simplest description of our profession.

[1]Rüdiger Thiele, “Hilbert’s Twenty-Fourth Problem,” *The American Mathematical Monthly* 110, no. 1 (January 2003): 1–24. We include an excerpt from Thiele’s translation just before this Preface.

Indeed, stating and proving theorems occupied mathematicians from the time of the Pythagorean school. It was Hilbert's profound insight that this activity itself can become the subject of mathematical investigation. Later, in the 1920s, Hilbert formulated a program whose aim was to formalize all of mathematics. The first step was to establish a fixed set of basic facts that would serve as an axiomatic base and to specify the rules of deducing mathematical theorems as formal consequences of the axioms. Formalized this way, proofs became sequences of strings of characters in which new strings are derived from previous ones by mechanical rules following principles of logic. Once this is done, whole new areas of mathematical exploration open up. In particular, for a given theorem proved from a specific set of axioms, one can ask about the simplest such proof. How does one measure the simplicity of a proof? One can count the number of characters in the proof or count the number of applications of certain kinds of rules. One can ask about the smallest number of axiomatic premises that the proof uses, and one can categorize those premises with regard to their level of abstraction. All of this can be done, and indeed is done, in the discipline known as proof theory. Moreover, software is available to answer many such questions about the complexity of formalized proofs. Hilbert would have been very happy to see this.

While we know how to formalize mathematics, when we do mathematics there are almost no holds barred. We think by analogy, we draw rough diagrams, we speculate, we generalize, and most of all we try to *understand*. The final product is always a theorem or, even better, a theory, i.e., an organized collection of results in a specific area of mathematics. One could argue however that the real goal of mathematics is not just to accumulate useful facts but rather to unravel the reasons behind them. This process of unraveling is often perceived as one of simplification, whether or not the facts in question satisfy any formal criteria of simplicity. "For me, the search for simplicity is almost synonymous with the search for structure," Dusa McDuff stated in the talk transcribed for this volume.

That mathematicians attribute aesthetic qualities to theorems or proofs is well known. The question that interests us here is to what extent aesthetic sensibilities inform mathematical practice itself. When one looks at various aspects of mathematics from this perspective, it is hard not to notice analogies with other areas of creative endeavor—in particular, the arts.

The drive toward formal simplicity in 20th century Western art shares some of the values that motivated Hilbert: a desire for uniformity of means, necessity, and rigor. Examples include serialism in music, abstraction in painting, Bauhaus architecture and design, and conceptual and minimal art, among others. Thus, the serialist composer Anton Webern describes his 1911 *Bagatelles for String Quartet*, Op. 9 as

> perhaps the shortest music so far—here I had the feeling, 'When all twelve notes have gone by, the piece is over'. . . in short, a rule of law emerged; until all twelve notes have occurred, none of them may occur again.[2]

[2]Anton Webern, *The Path to the New Music*, as quoted in Arnold Whittall, *The Cambridge Introduction to Serialism* (Cambridge, UK: Cambridge University Press, 2008), 6.

Another expression of the role of simplicity in art making comes from visual artist Sol LeWitt's "Paragraphs on Conceptual Art" (1967):

> To work with a plan that is pre-set is one way of avoiding subjectivity... This eliminates the arbitrary, the capricious, and the subjective as much as possible... When an artist uses a multiple modular method he usually chooses a simple and readily available form. The form itself is of very limited importance; it becomes the grammar for the total work.... Using complex basic forms only disrupts the unity of the whole.[3]

In some cases, artists seeking "simple and readily available form" have, like LeWitt, turned to mathematical forms, such as the cube or the grid, but generally, we find that a more profound connection between art and mathematics than any formal similarity is a similarity in method. For this reason the conference emphasized ideals of *practice*.

We advertised the conference as "Lectures by and conversations among twenty-six mathematicians, artists, art historians, philosophers, and architects, accompanied by a program of artist's films." Additionally, the artist Kate Shepherd installed *String Drawings* in the conference lobby. These works were pinned directly onto the linen-covered wall panels of the lobby (see page 205).

If the conference was a success, it was not only because of the quality of presentations but also due to the open and lively atmosphere at talks, panel discussions, and during breaks. A very accurate description of the conference appears in Allyn Jackson's report in the *Notices of the American Mathematical Society*, which she kindly permitted us to reprint in this volume.

Initially, there was the idea to organize a gallery exhibition to run parallel to the conference, continuing the pattern set by the Holland events. But, for reasons primarily having to do with securing a gallery space during the conference week, this did not happen. The constraint of presenting art within a conference auditorium and lobby led us to the idea of a film program. A potential offered by having an *in situ* arts program that we hoped for was its integration with conference talks, panels, and discussion.

We screened eight films by artists Andy Goldsworthy, David Hammons, Richard Serra, Andy Warhol, and William Wegman. All the films were non-narrative art films made by artists known primarily for their work in other media. Each was selected for the simplicity and directness with which it operates on our conception of art, in the sense of Joseph Kosuth:

> a work of art is a kind of proposition presented within the context of art as a comment on art... what art has in common with logic and mathematics is that it is a tautology; i.e., the "art idea" (or "work") and art are the same....[4]

[3] Sol LeWitt, "Paragraphs on Conceptual Art," *Artforum* 5, no. 10 (1967): 79–83.

[4] Joseph Kosuth, "Art After Philosophy (1969)," in *Art After Philosophy and After: Collected Writings, 1966–1990* by Joseph Kosuth (Cambridge, MA: MIT Press, 1991), 13–32.

One could try to put in words their visual propositions, but we might just comment that a common subject of these films is that of *looking*. Stills from several of the films appear as illustrations separating contributed essays.

The full program of the conference, including abstracts of all talks, details of the arts program, and notes from the panel discussions, appears in the appendix after Jackson's article. The events were ordered so that each day of the conference took into account a range of perspectives on the central theme of simplicity. The articles in this collection follow a similar pattern. We hope that the diverse selection of voices and opinions will serve as engaging reading as well as new material for further discussions.

We add to our preface a selection of quotes, one from each contributor to the volume. When read together the quotes are themselves a portrait of the conference in miniature, and they show the breadth of topics and the array of questions that simplicity as an ideal of practice in mathematics and the arts helps to bring out.

New York, NY, USA — Roman Kossak
Bronxville, NY, USA — Philip Ording
October 2016

Quotes

> Today I want to express this very naïve idea for mathematicians that we should distinguish between two kinds of simplicities. Something could be very simple for me, in my mind, and in my way of knowing mathematics, and yet be very difficult to articulate or write down in a mathematical paper. And conversely, something can be very easy to write down or say in just one sentence of English or French or whatever and nevertheless be all but completely inaccessible to my mind. This basic distinction is something that I believe to be classical, but, nevertheless, we mathematicians conflate the two.
>
> —Étienne Ghys

> The difficulty of determining something as simple or complex in an artwork, arises from the fact that any artistic image—painting, poem, a piece of music, or architectural space—exists simultaneously in two realms, firstly as a material phenomenon in the physical world, and secondly as a mental image in the unique individual experience.
>
> —Juhani Pallasmaa

> In much of modern topology, even though the main object of study is a plain vanilla space, one often adds extra structure to make the space more understandable—without that it can be featureless and enigmatic, simple in one way because it has no discernible features but potentially very complicated.
>
> —Dusa McDuff

> Sandback's idea of wholeness, and the idea, as he wrote, that "in my works the unity is given from the beginning" implies a temporality of immediacy... It is art-making in a single, simple act of synthesis.
>
> —Juliette Kennedy

> One reason for simplicity's connection with time is the development of technology, in all its forms. For instance, the simplest way for two people to contact each other changes

throughout history. The same is true in mathematics. After certain techniques or tools are introduced it's often no longer simpler to not use these tools, even for very basic calculations. They become tools of the trade and so lose some of their apparent complexity.

—Maryanthe Malliaris and Assaf Peretz

Because we don't usually think of mathematical experience in aesthetic terms and because we perpetuate the myth of ahistorical measures of complexity in mathematics, we think of simplicity in this arena as something given in advance of any of mathematics' details. I only wanted to explain that as artistic simplicity derives from art itself, so do our judgements of mathematical simplicity derive from our experience with mathematics. And further, that as mathematics evolves, so do our judgements of what counts as simple.

—Curtis Franks

The Simplicity Postulate is history, but it says something still. Not in the precise, quantitative way its formulators had hoped, but as a lasting insight. We often *do* equate simplicity with probable truth, instinctively.

—Marjorie Senechal

Many truths are complex, and they are simpli*fied* at the cost of distortion, at the cost of ceasing to be truths. Why then do we valorize quantitative simplicity? Because getting rid of clutter—an action that facilitates potency of meaning—can involve tossing items out. But getting rid of clutter can also involve re-arranging the items that one has without throwing any of them away. And it is crucial to notice that the clearest or most compelling arrangement is not always the one whose components have been most strictly reduced.

—Jan Zwicky

If you are a mathematician you ought to look at everything around, including mathematics itself, from a mathematical viewpoint. But to see something interesting, something new, something you had no preconception of, you have to distance yourself from what you try to discern.

—Misha Gromov

Practices of simplicity in the arts are discursive, and because they are discursive, they are part of a network of enunciations which can never be unidirectional or simple. Whether the Plotinian One haunts the unitary object of minimalist aesthetics is contestable, but it is almost certain that there are no primary structures: *Il n'y a pas de Structures Primaires*.

—Riikka Stewen

Albert Einstein, in a famous quote has said: *I have deep faith that the principle of the universe will be beautiful and simple*. One possible interpretation of that statement, though not the only one, is that the foundations of physics can be captured in simple laws. Mathematicians and philosophers have shown similar belief in the simplicity of the fundamentals of mathematics. By trying to reduce mathematics to logic, for example. Here simplicity should, I think, be read as self-evident.

—Rosalie Iemhoff

Simplicity conceived in this way takes *communicability* to be a central feature, so it has a pragmatic flavor. One might think of it as a mere fiction. Yet, in the end, being indispensable, simplicity is an ideal that remains robust, repeatedly embodied, even while remaining part of an ongoing process reflecting our needs, desires, and discussions.

—Juliet Floyd

The history of typography is marked by a persistent drive to rationalize.

—Dexter Sinister

In this paper I illustrate the contrasting view that *complexification* sometimes not only helps to achieve simplification but often even seems to be a *necessary* feature of it, how at some points apparent compromises of the simplifying process, apparent turns to complexity, may be needed in order to actually complete the move to simplicity.

—Andrés Villaveces

Roughly, a proof of a theorem, is “pure” if it draws *only* on what is “close” or “intrinsic” to that theorem. . . . [M]athematicians have paid considerable attention to whether. . . impurities are a good thing or to be avoided, and some have claimed that they are valuable because generally impure proofs are *simpler* than pure proofs. . . . After assembling evidence from proof theory that may be thought to support this claim, we will argue that on the contrary this evidence does not support the claim.

—Andrew Arana

Although not widely adopted, Brouwer’s reorientation of mathematics to include an idealized subject and his critique of formalism have intriguing, and in some cases explicit, connections to music and art of the 1960s and ’70s. In particular, the time and subject dependent form of Minimalist composition developed by the composer La Monte Young was later reinterpreted in light of such foundational concerns.

—Spencer Gerhardt

Restricting mathematics education to teaching “numeracy,” “practical mathematics,” “mathematics for life,” “functional mathematics,” and other *ersatz* products is a crime equivalent to feeding children with processed food made of mechanically reconstituted meat, starch, sugar, and salt. . . simplicity in mathematics education is not fish nuggets made from “seafood paste” of unknown provenance; it is sashimi of wild Alaskan salmon or Wagyu beef.

—Alexandre Borovik

Mathematicians often feel a mathematical story is not over until one sees the entire structure evolving painlessly from a quite small number of simple starting points.

—Dennis Sullivan

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