

On the Origins of the Term “Computational Aesthetics”

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Abstract

To provide some background, as well as a historical context, for the Eurographics 2005 Workshop on Graphics, Visualization and Imaging we provide a chronology, complete with references, covering various research activities that invoke the term ‘aesthetics’ in a computational setting. Much of the research cited focuses on the problem of making numerical assessments of the aesthetic content of works of art.

Categories and Subject Descriptors (according to ACM CCS): K.2 [Computing Milieux]: History of Computing, J.5 [Computer Applications]: Arts and Humanities

1. Introduction

Our goal is to give a brief historical review of the origins of the term “computational aesthetics.” For reference, the time line we will survey is:

- Esthetic Measures — Birkhoff (1928)
- Information Aesthetics — Bense (1965)
- Generative Aesthetics — Bense (1965)
- Abstract Aesthetics — Bense (1969)
- Experimental Aesthetics — Berlyne (1974)
- Algorithmic Aesthetics — Stiny and Gips (1978)
- Computational Esthetics — Scha and Bod (1993)
- Computational Aesthetics — Leyton (1994?)
- Computing Aesthetics — Machado and Cardoso (1998)
- Emergent Aesthetics — Ramos (February 2002)
- Exact Aesthetics — Staudek (July 2002)
- Simulated Aesthetics — Greenfield (2002)
- Computational Aesthetics — Greenfield (July 2002)
- Computational Aesthetics — Sbert and Neumann (July 2002)

2. Chronology

Mathematician G.D. Birkhoff’s interest in aesthetics is well known [Bir33]. In retrospect, Birkhoff’s introduction of the aesthetic metric $M = O/C$, where O is order and C is complexity, and its subsequent application to evaluating pleasing polygons and elegant vases, seems to be more about measuring orderliness than about assigning any aesthetic measure to creative works that would be of artistic interest, but it does clearly mark the beginnings of computational aesthetics.

On April 14, 2005, during the oral presentation of his Creativity and Cognition Conference Proceedings paper [Nak05], Frieder Nake, a computer artist whose personal involvement spans the entire relevant time frame, in paraphrasing the words of Max Bense, reminded his audience that in order to trace the origins of computational aesthetics, we must agree that:

“The objective is to obtain a scalar or vector measurement of the aesthetics of a *work of art*.”

Max Bense was the focal point for a movement coupling Birkhoff’s original notion of aesthetic measure with the information theory of Claude Shannon to yield what Bense called *information aesthetics* [Ben65a]. Much of the groundwork for this movement was developed in the theses of Gunzenhäuser [Gun62] and Frank [Fra59], both of whom were supervised by Bense. In February, 1965, upon the occasion of the opening of the first exhibition of computer art in Stuttgart, when Bense was met by some hostile reaction from artists, he used language to help fend off his critics by reassuring them that computer generated art was just “artificial art,” thus associating it with the emerging discipline of “artificial intelligence.” He also argued in favor of using new means to assess generative art by appealing to *generative aesthetics* [Ben65b] (reminiscent of Chomky’s generative grammar) and *abstract aesthetics* [Ben69]. It is perhaps ironic that Alan Sutcliffe, one of the founders in 1969 of the Computer Arts Society (CAS) in the U.K., stated during the Creativity and Cognition 2005 panel session that CAS members were “anti-aesthetics” because they didn’t initially know what their computer programs would create, and when

they did know, they got bored with it, so they added some new wrinkle so the cycle could begin all over again. Space prohibits launching into a wide ranging discussion of the theories of Bense, of his contemporary Moles [Mol68] [Mol79], or of the impact of their theories; and even though Nike has mollified his position somewhat since he wrote [Nak98]:

“Although some exciting insight into the nature of aesthetic processes was gained this way, the attempt failed miserably. Nothing really remains today of their theory that would arouse any interest for other than historical reasons.”

we will conclude this portion of our review by quoting Claudia Giannetti [Gia05] who wrote:

“By introducing concepts such as micro- and macro-aesthetic, Bense made clear the gap between a subjective valuation of the art object and a new aesthetic based on objective information and sign systems.”

In the 1960's there was renewed interest on the part of psychologists in the evaluation of visual patterns by human subjects. In 1965, Daniel Berlyne founded the International Association of Empirical Aesthetics (IAEA). Berlyne's two books published in the early 1970's [Ber71] [Ber74] document the extraordinary variety of experiments his research group in Toronto performed in order to promote and publicize *experimental aesthetics*. Also in the 1970's, following their ground breaking work on shape grammars, Stiny and Gips adopted the term *algorithmic aesthetics* in their book renewing Birkhoff's quest to develop mathematical models of aesthetics [SG78].

In 1993, Scha and Bod published a paper with the Dutch title *Computationale Esthetica* that received the English translation *Computational Esthetics* [SB93]. The abstract in the English translation speaks of “‘computational esthetic’ models” and the section titled *Towards a process model begins*,

“Looking back at this short history of computational esthetics . . .”

Although the paper itself is primarily a review of the information theories of Birkhoff, Bense, and Leeuwenberg, it does contain the first three appearances in print of the term *computational aesthetics* that we are aware of.

Primarily “to bring strength to the discipline” of rigorously analyzing works of art, “in the early 1990's” Michael Leyton founded the International Society for Mathematical and Computational Aesthetics (IS-MCA) [Ley05]. On the IS-MCA web site [Ley94] the term *computational aesthetics* appears just twice, both times within the name IS-MCA itself. Be that as it may, by stating that the IS-MCA is concerned with “any design object” and with advancing research in “how aesthetic value is computed by the designer and

user,” it follows that the IS-MCA does embrace our understanding of the term computational aesthetics as formulated above by Nike.

In an effort to incorporate both biological and cultural issues into the formulation of metrics for aesthetics, in 1998 Machado and Cardoso [MC98] formulated computational complexity metrics that they tested against humans using a standardized drawing appreciation test. Their paper was titled *Computing Aesthetics*, and Machado together with several co-authors has continued to investigate computational metrics for various aesthetic classification and discrimination tests. As an aside, we should also point out that a manifesto for *aesthetic computing* [Dag03], defined as the “application of art practice and theory to computing” [FDPL05], emerged from an Aesthetics Computing Workshop organized by Paul Fishwick, Roger Malina, and Christa Sommerer that took place at Dagstuhl, July 15–19, 2002.

Prior to the completion of Tomáš Staudek's thesis titled *Exact Aesthetics* in 2002 [Sta02a], Staudek made available a preprint titled “How can exact aesthetics recognize good design,” and Staudek and Machala made available a preprint titled “Exact aesthetics of visual patterns.” Revised and re-titled, but still incorporating the term *exact aesthetics*, these later appeared as a conference proceedings publication [Sta03] and a SIGGRAPH sketch [Sta02b] respectively. The exact aesthetics method as formulated by Staudek uses a suite of statistical measurements to define vector valued aesthetic metrics. The exact aesthetics method has been applied to the problem of analyzing the aesthetics of simple arrays of colored squares [Sta03] and analyzing the aesthetics of chaotic curves [LS04]. There are three interesting historical footnotes. First, Nike has pointed out that starting in 1965, William Simmat began publishing a series of brochures with the German title “Exakte Aesthetik” that documented papers presented at symposia, exhibitions at Galerie d in Frankfurt, and were also dedicated to questions of aesthetic critique and measurement. Second, it has been brought to our attention that the term *exact aesthetics*, used in a way very similar to what is intended here, appeared in print in 1968 in an essay by Basicovic and Picelj [Bek68]. Third, Klinger and Salinger considered vector valued metrics for arrays of symbols prior to Staudek, albeit without introducing any new terminology [KS00].

Although its ties to computational aesthetics seem a bit more tenuous, following the explosive growth of research into autonomous agents in general, and ant colony optimization in particular, Vitorino Ramos incorporated the term *emergent aesthetics* into the title of his paper [Ram02] in order to describe the end-products of his “swarm paintings” produced by simulated colonies of ants. Since the rules his ants follow were not designed for aesthetic purposes, the aesthetic outcomes are a by-product of the visualization of the local interactions of the ants over time.

In 2002, a first re-emergence of the term *computational*

aesthetics arose as a consequence of my research interests in evolutionary computing. In evolutionary art and music, finished art works are culled from populations of digital images or musical scores using the simple genetic algorithm. For images, this method traces its origins to the seminal work of Dawkins, Sims, and Latham. In user-guided, or interactive, simulated evolution, aesthetic decisions are made by humans, while in non-interactive simulated evolution, algorithms must make such aesthetic decisions. The first non-interactive attempt to address this problem (making use of neural nets) is usually attributed to Baluja et al [BPJ94]. Having taken a co-evolutionary approach to this same problem, without knowing that the term had appeared previously, in my 2001 Alife VII paper [Gre00] I used the term *algorithmic aesthetics* in the abstract, and then proceeded to use the term *simulated aesthetics* in a subsequent section heading when I referred to the problem of implementing algorithms to rank the images belonging to an image population on the basis of their aesthetic merit. In 2002, I used *simulated aesthetics* in the title of a second paper covering additional aspects of this research [Gre02a]. By factoring in the lag time to publication, I know that at some point during 2001 a referee suggested to me that “simulated aesthetics” was a poor term to use because, in truth, aesthetics weren’t being simulated, rather they were taking place within a simulation. It was at that point, in order to emphasize the automated decision making that was taking place by having algorithms assign aesthetic values to images, that I decided to use the term *computational aesthetics*, and it has appeared in the titles of papers I published in 2002 [Gre02b], in 2003 [Gre03], and in 2005 [Gre05].

A second re-emergence of the term *computational aesthetics* arose in conjunction with a research proposal written by Mateu Sbert and Laszlo Neumann of the University of Girona in July, 2002, titled “Computational aesthetics for architectural applications” [SN02]. As a proposal to the Catalan and Quebec governments for a joint venture between the Universities of Girona, Spain and Montreal, Canada to be based on (the new discipline of) *computational aesthetics*, it is essentially a memorandum of understanding between the architectural design research group at Montreal and the computer graphics rendering research group at Girona to cover projects such as automating color harmony choices and interior lighting design choices.

3. Conclusion

We have documented a historical thread linking the term *computational aesthetics* with a seventy-five year effort to understand and develop numerical methods for assigning an aesthetic value to works of art.

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