Kinetic Architectural Skins and the Computational Sublime

Jules Moloney

The term “sublime” has become ubiquitous within the technological arts and has been widely appropriated within the humanities. Since Edmund Burke’s formulation of the sublime as a distinct category [1] and the systematic development by Immanuel Kant of the mathematical and dynamic sublime [2], variants now include the religious, American, feminine, ecological, biological, nuclear, racial, erotic, textual, postmodern and technological. More recently, the sublime has been introduced into discourse on data art by Lev Manovich [3], while the idea of the “computational sublime” has been introduced by McCormack and Dorin in relation to the generative electronic arts [4]. Given this ubiquitous use, what is to be gained by extending the sublime as a theoretical model to the generative electronic arts? The contingent position I adopt here is that this rich vein of critique can enable a contribution to theoretical discourse. In particular, a discussion of the sublime may address a recent call by McCormack for theories of art particular to the genre and for works that make an “artistic contribution (as opposed to any purely technical fetish or fascination)” [5]. In the first section of this paper the two threads referenced above are summarized: McCormack and Dorin’s 2001 paper, which introduced the “computational sublime” in the context of a conference on generative art; followed by Manovich’s “anti-sublime” and the counter-argument by artist Lisa Jevbratt [6]. From these sources I develop the position that, for an artwork to exploit the computational sublime, the mapping of code to output is crucial. I suggest that digital-analogue hybrids within an urban context allow engagement with a wider audience and the capacity for the work to be surveyed over multiple timescales. To this end, a framework for the design of kinetic architectural skins is presented for artists to consider as a potential resource for collaboration.

In recent times, the postmodern sublime has contrasted beauty, as a form that can be apprehended, against the sublime, as that which is unrepresentable in sensation. As discussed, emergence of artificial life and the generative processes of nature in machines seek to give experience to that which cannot be experienced in totality but only suggested through a dynamic interaction. Therefore the concept of the computational sublime is introduced—the instilling of simultaneous feelings of pleasure and fear in the viewer of a process realized in a computing machine. A duality exists in that even though we cannot comprehend the process directly, we can experience it through the machine—hence we are forced to relinquish control [7].

The proposition that generative digital art can be discussed in terms of the sublime would seem to be made in two ways:

**Fig. 1.** P. Janssen and J. Kramer, visual programming interface controlling simulated architectural surface, 2007. (© Patrick Janssen) This image is based on screen shots of research currently being undertaken within the author’s research group, Critical Research in Digital Architecture (CRIDA). More information can be found at <www.crida.net>.
first, by invoking the legacy of Kant's mathematical sublime; and secondly, through the authors' citation of Lyotard's postmodern version. I shall briefly discuss the relevance of the postmodern before concentrating on Kant, a legacy I consider potentially more relevant to the challenges of current practice. In relation to Lyotard there seems to be an inferential logic at play: The postmodern sublime focuses on art that is un-representable to the senses; emergence, the central concept of much generative digital art, is un-representable; "therefore the concept of the computational sublime is introduced." What is perhaps overlooked in this alignment with Lyotard is that the postmodern sublime was predominantly a stance on the ontology of art. New media theorist D.N. Rodowick provides an insight into the political motivation behind the postmodern sublime [8]. According to Rodowick the essence of the postmodern sublime is indeterminacy and a corresponding resistance to Western cultural norms of beauty. Hence Lyotard's interest in painters such as Paul Klee and Barnett Newman is for their resistance to artistic consumption (at the time of their making). If we follow the political agenda of Lyotard, it would seem that there is potential for the computational sublime to pose the question "What is art?" in the context of generative computing. This is an issue beyond the scope of this short essay, but is a line of inquiry that might be productive for others to pursue.

The concentration of this paper is on the relevance of Kant's mathematical sublime, with a discussion of some implications for practice—in particular the surveyor's engagement with exhibited artworks. The quote below from Kant's *Critique of Judgment*, in a section titled "The estimation of the magnitude of natural things requisite for the idea of the sublime," identifies the capacity for comparative measure as being central:

> We get examples of the mathematical sublime of nature in mere intuition in all those instances where our imagination is afforded, not so much a greater numerical concept as a large unit as measure (for shortening the numerical series). A tree judged by the height of man gives, at all events, a standard for a mountain [9].

If the key factor is comparative scale, how might the computational sublime be considered an extension of Kant's mathematical version? For an experienced programmer, there is the possibility that contemplation of lines of code may introduce a variant of Kant's mathematical sublime, but most surveyors would require engaging "output" in order to imagine the scale of algorithmic process. With a base measure of process over time—the temporal version of Kant's tree—the relative scale of evolving generative art could be imagined, thus perhaps effecting a sublime moment. If we accept Kant's requirement for measure, we can tentatively propose that the computational sublime cannot reside solely in contemplation of code—we would require some output to provide a measure by which we can extrapolate variation and unexpected outcomes possible with emergence in computation. The description of an encounter with such a work could be along these lines: The surveyor is confronted and intrigued by a process manifest as evolving output; there is then a realization that neither the beginning nor the end state is tangible, as the artwork momentarily condenses, then reforms or dissolves in endless permutations, each subtly different and continually drawing the attention of the surveyor. In such an encounter the artwork is experienced as multiple moments of becoming; a beginning or an end is incomprehensible (cue sublime encounter). Whether the artwork produces such an effect on all surveyors is an open question, but I would suggest two key issues that determine engagement are the form of the output and the temporal scale over which the work is surveyed.

**The Anti-Sublime**

Data visualisation art is concerned with the anti-sublime. If Romantic artists thought of certain phenomena and effects as un-representable, as something which goes beyond the limits of human senses and reason, data visualisation artists target the exact opposite: to map such phenomena into a representation whose scale is comparable to the scales of human perception and cognition [10].

"The Anti-Sublime Ideal in New Media Art" by Lev Manovich was published online after McCormack and Dorin's paper and has produced discourse in an aligned field, that of data art. Starting with a description of the various ways in which information or processes, for example weather or economic data, are visualized with 2D or 3D graphics, Manovich examines examples of data art. Relevant to this discussion, he uses among others the example of John Simon, whose works "used real-time computation to create artworks that have a starting point in time..."
but no end point; as time progresses, they constantly change” [11]. The paper goes on to describe Simon’s artworks in a vein similar to the discussion here in relation to the computational sublime. Manovich contends the use of techniques such as cellular automata allow the works to suspend data in a state of timeless “coming into being.” However, in this case, this is interpreted as the anti-sublime compression of what was incomprehensible data. The position that data art is inherently anti-sublime has not gone unchallenged, not least by Lisa Jevbratt, also cited by Manovich as an example in his text.

Jevbratt proposes an alternate view of the sublime in relation to her data artworks. As opposed to the 18th-century romantic sublime, in which the incomprehensible was “out there”—an anthropomorphic perspective on the vastness of nature—for Jevbratt the condition of the 21st century requires an introspective and “methodological distancing” from computer-enabled visualization of complex nature. Rather than information being beyond human sense—either glimpsed “out there” in the cosmos or in the “in there” of the microscopic—her proposition of contemporary experience is one of “(hypothetical) familiarity.” For Jevbratt the sublime is now dependent on suspending this familiarity, and she references the mystic tradition of Via Negativa, “a method of distancing, of negation, in which we claim or pretend to not have any preconceived notions” as a means to create a necessary detachment [12]. As proposed by Jevbratt, the incomprehensible is visualized but is rendered meaningless by removal of the significance of the data mapping, typically through conversion to an abstract graphic representation. In a mode of indifference, the surveyor locates significance in a small part, which then engenders a sublime effect when the newly significant detail is expanded in relation to the larger data set. Figures 2 and 3 are images of Jevbratt’s Migration project that illustrate the relationship between the part and the larger data set.

Jevbratt’s counter-argument would seem to be a logical extension of the mathematical sublime: Significance is attached to a part, which enables a scale reference; the scale of the whole then becomes incomprehensibly large; the “wow” effect occurs. The vivacity of this approach would seem to rely on the artwork fostering intuitive engagement with the surveyor, a factor that may also be instructive for an understanding of the computational sublime. The general distinction between data art and generative electronic art is inherent in the nomenclature. The data in data art “exists,” and the artwork maps this source to an output, while for generative artists who use emergence as a central concept, the output is constantly evolving novel outcomes. Given this indeterminacy, can generative electronic art elicit the sort of response described by Jevbratt? The artwork is definitely “Via Negativa” in that code has no significance in hexadecimal form (except to those literate in the programming language and computational techniques). However, the artist typically chooses to map the code to something more engaging, and at that point the form and context in which the mapping is presented to the surveyor is crucial. The legacy of artificial life is, in this respect, perhaps an unfortunate hangover for the generative arts. The output is often described as a “life form” and the surveyor is invited to share in the wonder of its synthetic evolution. Arguably, overt contextualizing within familiar natural frameworks could restrict potential for the sublime as outlined by Jevbratt. For today’s audience, mutating life forms are more Monsters, Inc. than sublime manifestations of a temporal process.

**Output Matters**

The caveat at the start of this paper proposed that regardless of the problematic overuse of the sublime, discussion starts to address an acknowledged gap in theory for this specialized form of arts practice. From Rodowick we gained some insight into the political aspect of Lyotard’s postmodern sublime—the confrontation of fixed views on what constitutes art. From this position the key attribute of the sublime is indeterminacy—for Lyotard this would require the work to pose the questions “What is (generative) art?” and “Has it happened yet?” We then returned to the mathematical sublime, where the importance of scale was established—imagining the un-representable paradoxically requires a scale measure to be established. The strategy of Kant, to relate a local object to the scale of a distant object (man, tree, mountain), can potentially be a model for temporal scale—hence the importance of the output in establishing measure. In the second section, Jevbratt’s tactic of Via Negativa was examined. Within her version of the sublime, the work of art encourages the surveyor to find personal significance at a detail level, which would then facilitate a (sublime) encounter with the incomprehensible scale of the system. According to Jevbratt, the interplay between the extremes of the personalized reading of the detail and the incomprehensible whole triggers a state of suspension, a flickering between sensorial engagement with the part and mental transposition to the larger system, a state that accords with the sublime.

Recurrent in these two sources is the importance of the output—the manner, form and context in which the mapping of computational process occurs. This is perhaps a timely reminder in an era when the digital, in all its multiple forms, has become ubiquitous and to an extent domesticated. It has been posited that the point of difference between genera-

![Image](https://example.com/image.png)

**Fig. 3.** Lisa Jevbratt, **1:1** (2) Interface Migration, detail view. (© Lisa Jevbratt)
Kinetic Architectural Skins

I suggest that there is much to be gained by linking output from the generative and data arts to more tactile/tectonic form. Tectonics is a term often heard in the architectural design studio, where it refers to an aspiration to a visual quality inherent in constructional logic and detail and is particularly relevant to industrial machine-like architecture [14]. Of all human-made artifacts, machines—from the industrial to the miniature—seem most able to compete with the complexity of natural processes. The legacy of physical automata translated to the wide range of technology available now suggests one possible thread for the generative arts within the architecture of the city. Technology has advanced to the point that the interactive architectural surface is a constructed reality, as evidenced by an expanding range of experiments. Activity is currently split between so-called intelligent façades that manipulate screens or material properties to meet an environmental performance agenda and media façades that map image or data to large-scale urban screens. As both approaches are reliant on control systems, there is a capacity to utilize the technology as large-scale artworks. This potentially opens generative arts practice up to a wider audience and allows engagement with a broader slice of contemporary arts theory and criticism.

Elsewhere I have explored a framework for designing kinetic façades or “skins” [15]. I propose that the novel challenge of kinetic skins is a shift in design objectives toward the production of a system rather than a singular design. There is a growing precedent in architecture for a systems approach in design method, with some contemporary architects using parametric or emergence systems as an aid to generating possibilities at the early stages. For both these architects and the developing practice of kinetic skins, the objective of design changes, from the invention and refinement of components to the specification of systems. However, with kinetic skins the process does not end, for the motivation is to allow performance over multiple time scales. Rather than a singular design, the outcome is the kinetic system from which multiple permutations will be realized over time. This changes the design objective from the refining of one solution to the specification of the system parameters that determine the limits of the kinetic permutations. These sets of parameters can be conceived as three interrelated decision planes, as indicated in Fig. 4.

Conceptualizing kinetic skins in terms of these sets of parameters may also be useful for artists to consider in terms of collaboration. The “decision planes” are an adaptation of the input-control-output model developed in cybernetics. Rather than input, the term sampling is used to make explicit that input specification is a design parameter, that specification determines what information is to be sampled and as such excludes or includes opportunities. Sampling is a term borrowed from electronic music. The association in usage of the term here derives from the multiple inputs that can be used as a source to generate performance over time. The first sampling axis, as illustrated in Fig. 4, is the range of potential samples, from the environmental to the sociocultural (including direct interaction by occupants and surveying pedestrians). The sampling cross axis indicates data that can be sampled locally or via remote sources, accessing for example historic weather data or long-range sociocultural statistics.

The second decision plane is that of control, with one axis indicating the degree of top-down versus bottom-up approaches. As usefully summarized by
Katherine Hayles in a discussion of cybernetics and emergence, there are a range of approaches that can be adapted for the control of kinetic skins: homeostasis—simple feedback systems designed to maintain a steady state; reflexivity—feedback conditioned by multiple variables to produce more complex outcomes; emergence—interaction between variables set in motion without preconception of a steady state, producing novel outcomes [16]. The cross axis raises the issue of distributed versus centralized nodes of control, a pertinent issue given the scale and multiple orientations of architectural skins.

The final decision plane determines the output; in this case, the term tectonics is used. In architecture this refers to an aesthetic that results from the expression of construction technique. As indicated in Fig. 4, the primary tectonic axis represents the range between mechanical and material approaches. At one end of this spectrum are systems wherein metal screens and the like are connected to rods and cables that physically move, either in translation or rotation. Toward the middle ground are pneumatic skins and new materials such as shape-memory alloys, where kinetics is based on expansion and contraction. At the other end of this axis are technologies that perform through controllable transformation of material properties, for example changes in the opacity of glass. The cross axis here draws the distinction between passive energy systems such as the wind walls of artist Ned Kahn [17] and energy-intensive “active” tectonics such as the Aegis Hyposurface [18].

THE ADDED VALUE OF ARTISTS IN CONTROL

Architecture typically accommodates artworks as appendages to the main act, the building at best providing a sympathetic backdrop to the work. The developing field of kinetic skins suggests opportunities for the generative arts to collaborate on architecture, which goes beyond the prosaic agenda of most environmental control systems or media façades. In general, architects engage only with the final stage of the kinetic system—the design of the building component and specification of materials. The sampling and control stages are left to other consultants, who, in the case of environmental control systems, optimize performance in relation to a scientific agenda. Most available control systems, however, operate at the level of first-order cybernetics, using simple feedback systems that operate components such as sunscreens to maintain a steady state, in this case an optimum internal temperature range. There are some examples that break the closed system of sensor/controller/output to include the user directly as an input “device.” For example, the control system of the Gemeinnützige Siedlungs- und Wohnungsbaugesellschaft (GSW) headquarters building in Berlin makes recommendations to occupants about the selection of natural or mechanical ventilation by means of green or red lights on the window transoms [19]. The user can decide to accept or override the recommendation from the control system, thus enabling a level of direct interaction.

There are obviously opportunities for artists with programming skills to act as consultants, using their skills to optimize environmental performance with more sophisticated control logic, but the more interesting engagement would be to promote an artistic agenda to sit alongside functional criteria. The conception here is of environmental screens that have added value—screens that are functionally effective and perform as large-scale artworks. This may be as subtle as the kinetic design of transitions from one state to another, where control systems generate permutations based on the specifics of local input; or, alternatively, individual components may be allowed to deviate when a relatively steady state is reached, producing, for example, the twitchy behavior of a Pol Burry kinetic artwork. When the environmental system is not needed, such as during an overcast day or at night, the whole skin could revert to arts-driven kinetics. Artists could conceive works that engage with pedestrians in real time, such as Rafael Lozano-Hemmer’s Relational Architectural Series [20], or operate at a longer timescale, such as McCormack’s Eden project.

As indicated in the above framework, collaboration can occur in all three stages: widening the agenda in terms of what and how data can be sampled; embedding control systems with aesthetic as well as functional goals; and design of the tectonics. Nor would collaboration necessarily be dependent on expensive mechanical systems. Take for example the work of Ned Kahn, in particular his wind-driven screens, adapted to provide kinetic systems at an urban scale. His Wind Veil (Fig. 5), commissioned for a non-descript parking building in the

city of Charlotte, North Carolina, comprises 75 mm² reflective aluminum discs hinged on a tensioned wire net. The 80-x-15-m façade allows wind eddies across the stretched skin to produce undulating patterns of movement, which seemingly transform a concrete monolith into a fine-grained metallic liquid. At a pragmatic level the wind veil also reflects light and radiant heat, while allowing air movement. Kahn’s innovative walls suggest collaboration may not be a one-way street—this arts precedent could potentially be developed to provide a low-energy environmental system.

**Sublime?**

Where does the idea of the computational sublime fit in the context of kinetic skins? No easy answer here, unfortunately. The usefulness of the term, as stated in the introduction, is that it brings to the foreground the need for theoretical points of reference and provokes critique in terms of artistic contribution rather than technological novelty. The references opened up by McCormack and Dorin—Kant’s mathematical sublime and Lyotard’s postmodern version—are useful enough starting points and ideally will stimulate further dialogue and practice. In a subsequent essay, Dorin discusses three-dimensional visualization in terms of evoking in the surveyor the sublime encounter with algorithmic process he experiences regularly as an artist programmer [21]. It is hoped that this essay contributes to the debate by highlighting the importance of the chosen output, with the argument that linking the code to tangible form may foster more engagement by the surveying public, and that the context of architecture may address the need for some works to be surveyed beyond the timescale of typical gallery exhibitions. To this end, the potential of kinetic skins may provide the framework for works of a sublime scale, in terms of both space and time. The architectural theorist Dali-bor Veselý has noted the origins of the sublime have their roots in architecture, in the works of the Italian Baroque [22]. Churches such as San Lorenzo in Turin by Guarino Guarini captured through sinuous surface and optical effect the infinity of nature in human-made form. Kinetic skins developed in collaboration with artists offer the opportunity to extend this agenda, to enable the realization of engaging artworks embedded in an accessible and enduring context.

**References and Notes**

Undated references as provided by author.


19. The GSW headquarters building in Berlin was extended and renovated by architects Sauerbruch Hutton in 1999 and has become an emblem of sustainable design. A review of the extension can be found online at <www.architweek.com/2003/0813/environment_1-1.html>

20. The Relational Architecture Series by Rafael Lozano-Hemmer is cited here as precedent for engaging interfaces for architectural skins. The importance is not so much in relation to the technology used, but the idea of pedestrians interacting directly with an architectural skin. The works are documented at <www.lozano-hemmer.com/proyecto.html>


Manuscript received 30 July 2007.

Jules Moloney moved from architectural practice to academia in 1996. He is a co-founder of the group Critical Research in Digital Architecture (CRIDA) at the University of Melbourne, which engages in research and teaching projects as vehicles for critical inquiry and innovative design practice.