Ethics and the Auto-Generative Design Process: Evaluating Digital Architecture.

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Abstract

In the last decade the rise of sophisticated software tools has enabled a growing number of designers to experiment with new processes for the creation of architectural form. Several of these processes, which are loosely grouped under the rubric “auto-generative”, rely on the computer to evolve evocative biomorphic or topographic forms. In the years since the rise of this approach, prominent members of the architectural community have embraced the computer-generated buildings produced in this way and praised them as being the products of an innately *ethical* or *moral* design process. This paper seeks to test this supposition through a focussed critique of several high profile architects’ works. The critique, which is qualitative in nature and reliant on critical textual analysis, is focussed exclusively on accounts of the design process and not on the buildings that are produced in this way. To support this critique, the paper develops a three part conceptual framework for the ethical analysis of a creative or constructive process. The purpose of this paper is not to holistically condemn auto-generative design, but rather to use examples of the work to selectively question the claims made about this movement from a moral or ethical standpoint.

Preface

The site was modelled using forces that simulate the movement and flow of pedestrians, cars, and buses [...] each with differing speeds and intensities [...]. The forces of movement established a gradient field of attraction across the site. To discover the shape of this invisible field of attraction, we introduced geometric particles that change their position and shape according to the influence of these forces. From the particle studies, we captured a series of phase portraits of the cycles of movement over a period of time. These phase portraits are swept with a secondary structure of tubular frames linking the ramps, existing buildings and the Port Authority Bus Terminal. (Lynn, 1999: 103)

According to its author, the process outlined in this description uses “advanced physics” to model the “speed, decay and trajectory of particles” in a complex dynamical system (Lynn, 2006: 95). The paths traced by these particles define a surface structure; a canopy over a transport interchange. The resultant form – a complex folded skeletal structure – is, if the description is to be believed, a scientific solution to the problems of shelter on this specific site. If it wasn’t for some minor clues it might be assumed that the process was completely automated. However, the presence of the pronoun “we” suggests that someone has initiated the operations in this system and then captured the resultant data. But who is this laboratory technician, apparently extrapolating the computer’s modelling of a physics problem into an environmental solution? It certainly isn’t a scientist.

Physicists understand that quantum mechanics only operates at a sub-atomic level and complexity theorists know that the desire to predict a static solution to any problem in the natural world is inherently futile (Hameka, 2004; Mandelbrot, 1983; Bogg and Geyer, 2007). This suggests that, despite outward appearances, the operation proposed in the description is not scientific. Perhaps then, if the veil of science is removed from the description, the authorship and intent may be more apparent. From the words that remain – “we introduced [a] structure of tubular frames linking the ramps, existing buildings and the Port Authority Bus Terminal” – it is clear that the text is by an architect and its intent is to describe the design process for a covered space.

Architect Greg Lynn’s 1995 proposal for a canopy for the New York Port Authority transport interchange is one of a set of works that heralded the arrival of a particular computational design process that raises critical questions about authorship, responsibility and authority. While Lynn’s project was instrumental in the rise of the “blobitecture” (Waters, 2003) movement, the biomorphic or biomimetic aesthetic of the work is not the primary concern of the paper. Instead, the design process itself – which has since been repeated by multiple, high profile architects – is the focus of the present work. This is a process that was celebrated by Fuksas (2000a) at the Venice Biennale as shifting the focus of architecture away from facile debates about meaning and symbolism and towards a more accountable, rigorous and data-driven model of design. Such was the fervour with which this design process was greeted, that its allegedly righteous qualities were encapsulated in the title of that event; “less aesthetics more ethics” (Mandrelli, 2000: np.). While the accuracy of this dictum, which Leach describes as “somewhat ambiguous” (2005: 135), is not directly questioned in this paper, the clear implication that the computational design process is somehow exceptionally ethical is a catalyst for the present work.

Introduction

When applied to architecture, the words “iterative” (Sharples *et. al.*, 2002), “algorithmic” (Terzidis, 2006), “evolutionary” (Watanabe, 2002), “morpho-ecological” (Hensel and Menges, 2008) and “emergent” (Hensel *et. al.*, 2004) have all, in recent years, been used to describe a shift towards auto-generative design processes. Regardless of whether such processes are openly computational, as Kolarevic (2005) describes them, or are metaphorically presented as biological, as Novak (2002) does, all of these design tropes share a common set of three features. First and foremost they celebrate a system’s innate capacity for autonomous development. Each of the strategies describes a set of conditions wherein a design is able to grow or change without overt human influence. Lynn’s description of the “advanced physics” system responsible for the evolution of the design of the Port Authority canopy is typical in this regard. Moreover, this process is never random, it occurs within certain preordained limits; often called “reflexive” parameters

(Castle, 2002). This is the second feature of auto-generative design strategies; their capacity for evolution is constrained by rules or boundaries. Such rules could be derived from spatial limits, social patterns, functional requirements or material properties. For example, in the case of the Port Authority design there are both physical limits (adjacent buildings) and rules generated from the movement of people and traffic.

The third and final feature of the auto-generative design approach is that it does not produce a singular design solution. Instead, it operates by defining a set of conceivable solutions to a design problem. Thus, the system produces a constrained continuum of possibilities, typically as an animated sequence recording the evolution of a series of forms, all of which are shaped by different combinations of rules (Fear, 2001).ⁱ The forms produced in this way tend to be overtly organic or topological. This explains part of the appeal of the process and the reason it is so often metaphorically linked to natural systems. This also means that in the auto-generative approach the architect is frequently invisible until the moment when the evolutionary process is stopped or certain frames in the animated sequence are retained as a final design. The Port Authority example is typical in this regard. The architect only becomes visible (as “we”) at the moment when a particular sequence (“phase portraits of the cycles of movement”) is selected for modelling as a canopy. Although this tripartite definition of auto-generative design is relatively neutral in its framing various architects and scholars have offered alternative descriptions of the same characteristics that imply the approach has an innate moral or ethical quality.

First, according to Waters, “an important shift in the relationship between designer and computer” took place in the 1990s and now, in the auto-generative design process, the computer, unlike any previous architectural support tool, is an equal “collaborator” (2003: 10). Because the computer plays such a major role in the process, the resultant design is considered to be free of the cultural, social, aesthetic and symbolic prejudices that have encumbered previous architectural movements. Next, because the design process is now governed by data, science and mathematics it is typically presented as both egalitarian and universal (Fuksas, 2000b). Or alternatively, because the process is organic and evolutionary (within certain natural limits) its outcomes are timeless and appropriate (Watanabe, 2002; Novak, 2002).ⁱⁱ For example, Lynn (1999) argues that the process is about “the evolution of a form” (9); a process which “suggests animalism, animism, growth, actuation, vitality and virtuality”(9). Regardless of which of these interpretations are placed on the process, the third and final characteristic is that it avoids simplistic solutions to design problems by embracing multiple, simultaneous possibilities. Massimiliano Fuksas (2000b) celebrates these qualities as responding to the widespread “crisis in style” that dominated architecture in the last decade of the 20th century. He proposes that the auto-generative design process draws on the “complexity” of “actual conditions” as a means of supporting “the elimination of social and cultural barriers” (np.). Therefore, auto-generative design signals a shift in architecture away from a

fixation on the aesthetics of the finished object and towards a more ethical design process and practice. Ethics in Fuksas's (2000a) thesis is not about the business practises of a design firm, the conventional domain of moral philosophy in architecture, but rather of an ethical design process or method. In each of these examples, the components of the auto-generative design process are presented as being "ethical", "good" or "right"; all words with moral intonations.

The present research investigates the ethical implications of the auto-generative design process. This paper is not explicitly concerned with the outcomes of this process – the resultant buildings or unbuilt designs. Past research (Ostwald, 2004; Ostwald, 2006) has demonstrated that some of the architecture that has been produced using such computational approaches is ethically problematic when viewed from an inclusive philosophical perspective that accommodates the synthetic world in moral systems (Fox, 2007). For example, many computer-generated buildings lack human-scale, social responsiveness or contextual consideration; all features which are conventionally regarded as being central to a "right" or "good" building (Levine *et. al.*, 2004). Some of these problems may be a result of the design process while others are simply a reflection of the values and concerns of the designer.ⁱⁱⁱ Thus, one of the problems with criticising the resultant building is that multiple models of ethical thinking are necessarily engaged in this process. In contrast, the design process itself is neatly compartmentalised from an ethical viewpoint; it is a system of actions, reactions, revisions and propositions. This is why the present research is focussed on accounts of the design process and not the design outcome.^{iv}

In order to address the question of ethics and the design process, the paper examines four theories that propose it is possible to criticise a creative process (design) rather than the work which arises from this process (a building). From these examples, a conceptual framework is proposed which involves three interconnected themes; authorship, motivation and comportment. In the following parts of the paper examples of auto-generative design are tested against the conceptual framework. This testing process is not empirical or quantitative; the purpose of the paper is not to determine the percentage of auto-generative designs which contain certain characteristics, properties or flaws. Instead, the goal of the research is to test the limits of the proposition, described previously, that the auto-generative design process is necessarily more ethical or moral than other design processes. Thus, the research method is framed around the demonstration of the presence of ethical flaws in selected, high profile, auto-generative designs rather than an attempt to provide a more inclusive analysis of several hundred possible examples. The designs selected to support his augment include works by architects Greg Lynn, Ali Rahim, Solan Kolatin, William Macdonald, Hernan Diaz Alonso, Michael Hensel and Achim Menges. These architects are amongst the highest profile advocates of the auto-generative design process and their works span between the inception of the movement, in the mid nineteen-nineties, and the present day. Finally the paper offers a series of observations

about the ethical problems uncovered in these selected exemplars of the auto-generative design process.

Before progressing, several components of the work require clarification or explanation. The first of these is that it must be acknowledged that a few of the architects working within this particular design trope are aware that there are moral implications to their work. Lynn in particular has shown a level of understanding of the potential problems with the method he has become famous for (Lynn and Speaks, 2003). Oosterhuis (2001), an architect who has produced multiple completed buildings using this method, is also sceptical about several aspects of it.^v Thus, it must be stressed that the criticisms contained in this paper are directed at propositions regarding the ethical nature of auto-generative design, and not necessarily at all of the designers who are referred to in the paper or who are using this method.

The next issue for clarification concerns the difference between auto-generative design and Computer Aided Design (CAD), Building Information Modelling (BIM), Code Checking and Parametric modelling. The middle three of these are software programs that can automate a small number of operations as part of the design process, but which do not fulfil the definition of auto-generative design. For example, CAD software can be set to automatically fillet right-angled connections and spline complex curves (Szalabaj, 2000). BIM software can be used to correct inefficient lighting grids and optimise sunshade orientation (Szalabaj, 2006). Code Checking software can be deployed to determine whether a design complies with, for example, disabled access provisions and can then suggest how the design of ramps and safety railings may be corrected. All of these processes may be automated to refine low level or repetitive components of a design but they do not otherwise conform to the definition of an auto-generative design process and are therefore outside the scope of the present work.^{vi}

The final type of computational design, Parametric modelling, has much more in common with auto-generative design and, at the Venice Biennale, Schumacher (2008) anointed Parametricism the natural successor to auto-generative design. A Parametric model is a computer-based object that has been augmented with additional characteristics or qualities that restrict the degree to which it can be altered (Meredith, 2008). Thus, a CAD image of a column can be designated “reinforced concrete” and the model will not allow itself to be deformed in ways which would undermine the structural stability of that material. Much like auto-generative design, this seemingly pragmatic tool has become venerated for its capacity to evolve organic or biomorphic forms (Schumacher, 2008). However, whereas Parametricism is essentially about innate qualities (the materiality or function of a form), auto-generation is typically focussed on extrinsic properties (external or non-building related forces).

The Ethics of the Architectural Design Process

Until relatively recently, the Western philosophical tradition has taken an anthropocentric stance on ethical issues. In this tradition, non-human subjects, whether synthetic, natural, or sentient, are generally excluded from ethical consideration (Fox, 2006). While there is a long history of architects using moral or ethical arguments to support their design theory (Forty, 2000; Markus, 2002; Benton, 2009) and a similar history of ethical discourse about architectural practice (Wasserman *et. al.*, 2000; Spector, 2001) criticisms of buildings from moral perspectives have tended to be controversial (Kruft, 1994; Harries, 1997; Watkin, 1997). Moreover, almost all of the ethical criticisms of buildings that have been published have focussed on the completed object, not the process used to produce it. Indeed, few ethical criticisms of objects explicitly acknowledge that a process has been undertaken at all to produce them. The following four ethical theories are rare in this regard. They each implicitly acknowledge that qualities or characteristics of the creative process can be ethically criticised and that signs of the moral flaws in the method may be evident in the resultant work.

In 1849 John Ruskin famously suggested that some geometric forms found in gothic architecture are morally right while others are ignoble and base. While Ruskin is perhaps best known in architecture for his arguments about truth and honesty in aesthetics, it is one of his secondary theories, known as Daedalic Right line, which is of present interest (Moore and Ostwald, 1997a). In *The Stones of Venice* Ruskin suggests that two, ostensibly identical ornamental fretwork carvings may be morally distinguishable on the grounds of their construction process. Construction, in this context, does not refer to issues of fabrication or tectonics but rather to the process by which a mason designs the ornament. Depending on the process, one ornament could be “right” while another is “vulgar”. Ruskin maintains that a subtle trace of the process of designing the ornament remains visible in the finished work. Thus, while two fretworks could have the same shape, size and dimensionality, one might have different tool marks or the faint outline of a mason’s cutting guide and thus it is possible to discern the process from the object. In 1872 Ruskin argued that while the design of ornamentation requires that a person be “sensitive to symmetry, and precise in mathematical measurement” it was more important to be “sensitive to the change and grace by which Nature makes all beauty immeasurable.” (Ruskin, 1903: 237). Here Ruskin argues that an ethical process of design is informed by mathematics, science and rational thought, but is physically shaped by a sensitive hand, controlled by an expert eye and lead by the pure heart (Moore and Ostwald, 1997b).

In his 1989 book, *The Ethics of Geometry*, David Lachterman offers a moral theory about the construction of geometry. Like Ruskin, Lachterman uses the word construction to refer to a design process and he similarly proposes that two, seemingly identical geometric forms can be ethically compared through a review of the method by which each has been created. In this work, Lachterman (1989) shows how different design

processes can be used to produce the same result or form. For example, there are multiple ways of constructing a hexagon. Some of these processes are elegant and descriptive – generally those involving bisecting sequences of arcs drawn with a pair of compasses – and are able to be understood and repeated by both novices and experts. Such processes impart a true sense of the geometric properties of the shape. These are, for Lachterman, ethical processes; they are open to scrutiny and testing, they are pedagogical rather than hermetic and they take responsibility for their outcome. Alternatively, the same hexagon can be constructed using parallel lines, set squares and a protractor. The result may, superficially, be the same, but the second process hides the true qualities of the object behind multiple unnecessary processes and complex tools. For Lachterman, such a process displays a disdain for the audience or worse, a desire to obfuscate and glorify an otherwise simple process. Ultimately, Lachterman, like Ruskin, argues that forms retain an ethical trace of the process that lead to their creation. This trace is a reflection of the person's "motivation" for producing an object and their "comportment" during this construction or design process.

Two further theories are relevant in the present context; each maintaining that certain qualities of the creative process are discernable in the finished work. While both of the theories are focussed on readings of the resultant object, each explicitly acknowledge that the ethical value is a result of the creative process that preceded it. The first of these theories, "ethicism", was developed by Gaut (2001) and it is concerned with "a work's manifestation of certain attitudes"(192) held by its creator and which are intrinsic to its process of production and to its representational content. A similar balance between the capacity to criticise a completed work and an acknowledgement that its ethical qualities are a result of a process is found in Taylor's "ethics of care". Taylor (2000) suggests, "any lack of care given to the design of a building is also, in effect, a lack of care shown to the public who have to live with it" (202). While Taylor's theory is framed around the capacity to interpret a completed work, its ethical virtue, "care", is an attitude that is part of the design process. This attitude may be read, like the innate nobility of Ruskin's "Right line", or Lachterman's transparent construction, in the completed work but it is intrinsic to the design process.

From these four examples, three overlapping themes can be distilled.

- The first theme, *authorship*, refers to the extent to which an architect takes active and visible responsibility for the design process.
- The second theme, *comportment*, refers to the levels of "care" and "clarity" present in the design process. Taylor's concept of care relies on an architect giving due attention to the building "as a whole" and "in relation to its context" (2000: 203). Lachterman (1989) identifies clarity as a virtue because every process is a potential learning experience through which new knowledge might be gained and humanity advanced.

- The final theme, *motivation*, refers to the impetus for an architect's design process. This theme shares common concerns with the first two themes, *authorship* and *comportment*, but whereas they are focussed largely on finite aspects of the design process, this third looks at the overarching rationale for the architect's actions. For the purposes of the present paper, the architects' motivation is assumed to be reflected in their espoused theory.

The purpose of identifying these themes is not to provide a detailed defence of their logic from the point of view of classical ethical theory. All three themes rely on a combination of what might be called professional virtues and learnt duties. Instead, these themes provide a structural framework for the remainder of the paper and the review of selected examples of auto-generative design.

Issues of *authorship*

The theme of authorship is closely affiliated with issues of responsibility. The inference is that an ethical design process is one wherein an architect's role in shaping a design is visible and thereby accountable. Conversely, an unethical design process might be one wherein authorship is uncertain and the architect abrogates responsibility. Given this premise, consider a typical example of auto-generative design; Ali Rahim's description of the "emergent" process for a residence in Islamabad.

Rahim (2002) prefaces his description with the observation that the design process is "endogenic, machinic and has the potential to spontaneously self-assemble" (57); this is a process where the computer is the self-organising, autonomous mechanism of design and only "[o]ne possibility out of many [design solutions] is actualised" (59). These are the standard characteristics of the auto-generative design process previously identified. Rahim then describes the design process as follows.

We used animation techniques that evolved through time to study the relationship of the scale and intensity of events and their correspondences with the temporal cycles of the site. Specifically, we used inverse kinematics, which coded events as a field condition, and which had an equal capacity to react to particular site cycles measured by their intensity, duration and frequency. These relationships were deterritorialised through the use of vectorial and gradient force fields that responded to different degrees of environmental specificity. For example an existing well on the site was coded with a continuous pointal force which acted on the field condition, and subsequently reacted to the continuous vector of force exerted on it. This provided unlimited potential in the system which grew in complexity, evolved and formed mutual associations between site stimuli and event. These pointed towards future possibilities, and were guided and shaped to form tendencies through an iterative process. The actualisation process involved applying these tendencies to multiplicities in event intensity and duration, producing a variety of performative effects. (2000: 61)

In this description, the architect (“we”) explicitly appears twice in a passive role, and there are two further occasions where the active presence of the architect is inferred but not stated. The first two of these appearances are for the purpose of explaining the auto-generative system (a combination of “animation” and “inverse kinematics”). This is, in essence, the only time in the process that the architect takes a visible role and that role is arguing for the authority of the computational model. The architect only becomes an active participant, albeit without personal pronoun, in this process at the end of the quote when the process of “actualisation” occurs.^{vii}

This example is typical of the genre and, while written seven years later, has strong similarities to Lynn’s process for the Port Authority canopy. Each of these outlines is carefully worded to imply that the computer is the primary device shaping the finished design. The architect appears at the outset to explain that the system that will be undertaking the design is rigorous and complex. This is, in effect, the first negation of responsibility. Thereafter, it is inferred that the architect has some role in selecting the parameters that will shape the design, although the criteria for this selection remains abstruse. Finally, when the process is almost complete, the architect must be involved once more. This is because it is a straightforward process to direct any advanced modelling system to evolve an organic form from a set of conditions. It is more difficult to program the software to stop this process when optimal conditions are reached. Thus, the architect typically has to appear to halt the evolutionary design process in some arbitrary way.

Kipnis (qtd. in Davidson, 1996) calls this instant, when the architect re-engages with the auto-generative process, “the freezing point” (107). Asada (2006) similarly describes the same moment as the “stopping point”, the instant when the designer’s hand becomes visible in the process. Eisenman (qtd. in Davidson, 1997) calls this impulse to stop a dynamic, seemingly autonomous process the production of “architecture as frozen movement” (262). At this moment, Eisenman argues, the architect effectively concedes that the process is not independent and that there is a human author concealed, like a ghost, within the machine. Each of these scholars identifies that the moment is paradoxical because it is typically the first evidence that the architect is finally taking some role in the process but it is also a somewhat belated gesture suggesting that a convenient or opportunistic decision has transpired.

In this example of the auto-generative process, the architect’s role is limited to proselytising the virtues of the computer and later shutting it down at some arbitrary point. In between these moments, if the description is to be believed, the computer is responsible for all of the other decisions. In combination these characteristics suggest an ethical failure in the auto-generative process from the perspective of authorship. Alternatively, if the reader is suspicious that the architect is actually more heavily involved in the process than their account suggests, the result is equally of concern

because an attempt is being made to obscure authorship or avoid responsibility. In either case, from the point of view of clarity and accountability, the process has ethical problems.

Issues of *comportment*

The ethics of *comportment* combines a number of considerations associated with due care and attention as well as methodological transparency (Lachterman 1989; Taylor 2000). Using this criterion, an ethical design process would be one that displays an appropriate investment in time and energy across all scales of the work as well as one wherein the process is transparent. Conversely, an ethically flawed design process is one that is rushed, does not take into account the complete range of issues or hides the true nature of the process. Two typical auto-generative projects are described and tested in this section from the point of view of the ethics of *comportment*.

Solan Kolatin's and Bill Macdonald's "chimerical houses for customisation" is a rare design project of this genre which makes a virtue out of the auto-generative processes' predilection for producing multiple solutions to a single problem. Rather than using the process for a single building, they propose its application for "mass-customised, prefabricated housing" (Waters 2003: 89) to suit different sites and client needs; thereby making the selection of multiple "freezing points" a viable possibility. Kolatin and Macdonald (2000) are also unusually clear in how their design process actually works.

Kolatin and Macdonald commence each design process with a "found object" or indexical work; what they call a "'base' identity" (2000: 73). For their chimerical houses project the base, which was chosen from the set of library-parts that came with the standard "architectural drawing programme", is a "normative three-bedroom, 2½ bathroom colonial house" (2000: 71). They candidly admit that any house or object "including modernist ones" could have been chosen instead. The base object is then selected in the computer and a transformation is applied from a menu in the software. This transformation automatically converts the base object into a series of possible target objects; those moments in the animation when the process is halted. In the particular case of the chimerical houses project, Kolatin and Macdonald selected the base colonial house and applied a melting transformation to it to gradually liquefy the form until finally the house was converted into a puddle.

While the full description of the design process provided by Kolatin and Macdonald contains all of the typical devices found in an auto-generative design process, it is one of very few to openly acknowledge that its starting point is largely subjective. The majority of similar designs simply deploy Phileban solids within the initial stage, or "drop" sets of objects, generally balls, into the system observing their reactions and tracing their paths as a design. These are all, in effect, found objects and while Kolatin and Macdonald are at least clear in the origins of their design process, the arbitrary nature of the base, and the somewhat facile transformation process suggest a low degree of care and a minimal

investment in time. However, there is an additional dimension to Kolatin and Macdonald's design process which might undermine this argument. It is possible that the process of selecting appropriate frames from the animated liquefaction sequence might constitute a degree of care.

Hersey and Freedman (1992) note that the "computer contributes [to the design process] the ability to calculate a huge number of permutations and combinations" (10) which can be assessed for their potential merit. In their computational analysis of Palladio's villas they use the computer to produce hundreds of potential variations of designs but select very few to consider in detail. This suggests that, in the design process, the methodical and systematic evaluation of alternatives to seek optimal outcomes may constitute a high level of care. This is certainly true in general, but what about the case of Kolatin's and Macdonald's "chimerical houses?"

Kolatin and Macdonald chose twelve intermediate stages in the liquefaction sequence to "freeze" or "target" specific forms. They describe their selection process as involving classifying the forms into three, visually determined, categories; "monsters", "noise" and "supremes". The latter category, "supremes" is the one the architects are seeking because it has some capacity for "houseness" (2000: 77). There is a further suggestion in their text that the "noise" category lacks the formal qualities to accommodate functional spaces and that is why it is rejected. Paradoxically, they go on to define a sense of "houseness" as being not so much a structural a functional quality, but rather one based on novel or original spatial relations between the interior and exterior. In this example, Kolatin and Macdonald have clearly invested more care in the assessment and selection process of design options than they have in the starting point of that process, the found object. However, if the key to making a determination of care resides in the presence or absence of a rigorous process of assessment and rejection then the ethical flaws of the starting point are not redeemed by the strengths of the assessment process in this particular case.

The work of Hernan Diaz Alonso and his firm Xefirontarch, is described by Neil Spiller (2008) as one of the more "wayward practices" in architecture; it uses computers to develop a "highly wrought, alien-seeming aesthetic inspired by biological mutation" (70). Diaz Alonso's 2007 project for a canopy and circulation structure for Boston describes a self-evolving system which "is framed by multiple determining contexts [...] that productively contaminate the moment of reception" producing a "critical insight" into the design for a habitable zone in "the city and its flows" (Diaz Alonso, 2008: 72). The form of the design "is conjoined with the city and its site but is self sustaining in its capacity to focus public flows and creative intensities." The entire work being described as a synthetic epiphyte; "a plant [...] that grows on another plant upon which it depends for mechanical support but not for nutrients" (72). When the entire description is reviewed in detail, Diaz Alonso's circulation design is revealed as having several similarities to Lynn's Port Authority canopy although in Lynn's case it is possible to unravel what is

happening in both the resultant design and its process. In contrast, in Diaz Alonso' design the computer and the architect are concealed within an evocative, metaphorical description of an architectural design which appears to have grown parasitically onto an existing building. While, in a poetic sense this may describe the architect's intent, in reality it obscures both what is really happening in the process and what has actually shaped the design.

If these works, by Diaz Alonso, Kolatin and Macdonald, are assessed against the ethical criterion of comportment, the chimerical houses project fails as a result of a lack of appropriate care and the Boston covered space design is undermined by its absence of transparency; a quality which negates, amongst other things, the pedagogical potential of a work.

Issues of *motivation*

Motivation, the final category for investigating the ethics of the design process, is closely related to issues of both transparency and authorship. While, a lack of transparency may be an ethical flaw because it undermines the educative potential of a work (Orr, 1999); more commonly it is problematic because it is a result of a designer's attempt to seek authority through analogy or by association (Ostwald, 1999). Similarly, while the tactic of hiding the role of the architect in the auto-generative process is possibly an ethical deficiency because it suggests a desire to avoid responsibly, it may equally relate to the attempt to unduly enhance the designer's reputation. In both instances, the ethical flaw can be traced to the motivation of the architect. In this section two examples are used to explore this idea.

In 2006, architects Achim Menges and Michael Hensel offered a description of a design exercise wherein

[e]volutionary computation is used to initiate a process that coevolves different generations of two interlocking surfaces through perpendicular or tangential sections. The morphogenetic process yields an ever-increasingly complexity of the two coevolved surfaces that nevertheless remains coherent through the logics of the material system and the manufacturing [process]. (Hensel and Menges, 2006: 38)

This description, itself a microcosm of the definition of the auto-generative process^{viii}, could equally have been reframed as follows.

We used computer-modelling software to experiment with two overlapping organic shapes until we were happy with the result. We then used a different piece of software to select the optimal cutting schedule for the material thickness required by the manufacturing process.

Both of these accounts are essentially the same. Admittedly, for a reader who is well versed in morphogenetic processes and the realities of computer aided manufacturing, the first description contains marginally more information, but it is also heavily coded. The

second description is only slightly less informative at a technical level, but it is more transparent in terms of both the actual process and its authorship. Significantly, the first description appears to not only emphasise the complexity of the process, it seems to exaggerate this complexity at every turn.

Terzidis (2006) is highly critical of the auto-generative design process for its propensity for falsely emphasising complexity and thereby suggesting a high level of design sophistication. Terzidis observes that while the

objective or result of an [algorithmic design process] may be complex, the strategy itself does not necessarily follow that complexity. In mathematics, it is common practice that a simple formula generates extremely complex outputs. For instance chaos [theory] itself is a study of how simple systems can generate complicated behaviour. (2006: 119)

The problem with many descriptions of auto-generative design is precisely that they dwell on how supposedly complex the process is, while, in reality, all of the hard work has been done by the computer software and the remainder is not complex at all.

Terzidis (2006) argues that most recursive, stochastic, emergent and evolutionary design strategies rely on “simple means” (118) to produce intricate forms. The real complexity in the auto-generative design process has been resolved by the software engineers who are responsible for authoring the programme (Ostwald 2006). This implied criticism is also apparent in Mark Burry’s thoughts on the true position of creativity in auto-generative design. For Burry the question is, should such

designers produce their own algorithmic self-learning tools, [...] or is it a perfectly reasonable proposition for the designer to rely on the algorithms that come with the various software packages? John Ruskin's view of artists needing to grind their own colors in the preparation of paint has some contemporary relevance here. (2001: 9)

In the final example in this section, Greg Lynn’s portrayal of the design process for the House in Long Island provides an example of seeking authority through analogy.

Lynn’s design is initially presented as facilitating the “ethic of motion” (1996: 92) and thereby creating architecture that is appropriate for its era.^{ix} He goes on to describe the “dynamics system analysis” and “gradient fields of forces” that he plans to use to create the design. From that point, the design process follows the traditional auto-generative line wherein the architect locates a series of “gradient fields” and “points of intensity”, defines the “field of Newtonian gravity”, the “radial field” and the “graduated field” all of which generate an organic form (1996: 97). The design is produced through the process of tracing “free particles set in [a] three-dimensional space” that is focussed on

a vortex field [...] that would collect forces in a spiral pattern. The particles moved within these fields until they behaved periodically and fell into recursive patterns. At this point I [Greg Lynn] stopped the animation and converted the particles to linear splines. (Lynn, 1996: 97)

The design process Lynn outlines is replete with mathematical and pseudo-scientific language. However, despite the implications of the terminology, the entire process is controlled by Lynn's hand, from the moment he sets the system in motion to the instant when he "stopped the animation." This property is immediately apparent to the perceptive reader who is left with an uneasy sense that the whole process is simply a way of authorising the production of novel forms. This situation arises in architecture because language which obviates universal meaning often provides the user with a semblance of power and this is especially so if that language has been appropriated from seemingly irrefutable sources (like science or mathematics) (Sokal and Bricmont, 1998; Ostwald, 1999). If the language is used to divert attention, to artlessly conceal or legitimise, then it operates against social and individual expectations and is potentially ethically flawed.

When Lynn's design for the *House in Long island* was first presented, both Jeffrey Kipnis and Saskia Sassen were strongly critical of it, in part because it seemed to be seeking authority from mathematics for a process that was largely aesthetic. Lynn was eventually forced to admit that what he is proposing should not be mistaken "as a way of validating [...] a completely unscientific approach." (1996: 110). This is a rare admission in digital architecture; despite the majority of auto-generative design processes adopting some form of scientific and mathematical language, the reality is that few, if any, of the hundreds of examples of this genre, can justify this connection at anything other than a superficial level. Such architectural works, which are motivated by seeking authority through analogy or by obscuring the true nature of the design process, are unethical from the point of view of the third and final theme; motivation.

Conclusion

In this research three interlocking theories about the ethical characteristics of the design process are used to test claims about the moral value of the auto-generative trope. Issues of clarity of authorship (and responsibility), appropriate comportment (care and attention) and motivation, are all useful for divining the moral or ethical merit of a process and its resultant design. Final evidence for the veracity of these three themes can be found in the concerns raised by one of the key proponents of this approach.

At the start of this paper, Lynn's design for the Port Authority canopy in New York was used as an example to explain the auto-generative process. Almost a decade after documenting this process, Lynn was asked to reflect on his work and he offered a surprisingly candid, self-critical response. For the Port Authority Building he states,

I made a design by [...] dropping sonic bouncing balls, which drew, trajectories. I surfaced those, came up with the design and rendered it. It was a three-day exercise to learn the software. I learned something very valuable: when you don't know how to use a tool, you give the authorship over to the tool. Essentially, I decided to become a statistician. I calculated traffic on 7th Ave. vs. traffic on 3801 Street: mapped pedestrian movement vs. cars; and then I visualized a pattern from it by

dropping balls and letting those draw the forms for me. I would not call it an experiment: I would call it a learning exercise. My ineptitude in the use of the tool resulted in several intractable problems that are intrinsic to that project. Though I did not have the perspicacity to know it at the time, almost every design dilemma that emerged over that weekend has since returned in other projects. (Lynn and Speaks 2003: 124)

In this short, reflective passage, Lynn intuitively identifies that the auto-generative design process is problematic from the point of view of authorship (and the problem of giving control to the computer), comportment (and associated lack of time invested in the project) and motivation (admitting that it was a learning exercise and not a scientific process). With this understanding, it should be possible to produce an ethically meritorious design using similar methods. However, without a similar degree of self-awareness and self-reflection, the problems inherent in the process will continue to be repeated.

Ultimately, if auto-generative design is to find a legitimate place in an architect's creative vocabulary then it must avoid overtly privileging the computer; it must not hide behind the "black-box" of the software or develop an equally concealing mask of bio-metaphorical cant. Most of all, it must apply due care not only in setting up the auto-generative system, but in proposing, explaining and demonstrating that an appropriate and rigorous assessment protocol exists to help the designer choose the optimal result from the myriad generated by the computer.

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End Notes

ⁱ Architects sometimes describe this as a “non-linear” (Lynn, 1999: 23) approach to design although, in a strict mathematical sense, the continuum of possibilities produced in this way is almost always linear. While multiple reflexive parameters may be combined together in the computer in a non-linear or complex system to produce a design, the output that is visible to the architect’s eye, typically as an animation, is almost always linear insofar as it has a clear starting and end point. Thus, by the time the “sequential transformations” (Lynn, 1999: 23) are visible to the architect, they are no longer part of the complex system that produced them.

ⁱⁱ Not, as Steadman (2008) observes, that there is anything organic about the process other than an unconvincing metaphorical connection.

ⁱⁱⁱ These flaws could be considered to reflect ethical criticism of a building from the point of view of the normative values of *virtue* theory or *deontological* theory (LaFollette, 2000); respectively that the design fails to respond to the reasonable human needs or expected architectural standards. However, interpretation from the point of view of the third major school of ethical thinking, *teleology*, is much more complex. Teleological theorists ask that the ramifications of a decision be considered as the primary determinant of moral value. Teleological ethics is thus a *consequentialist* form of reasoning because it is focussed on the benefit of the outcome not the act (Beauchamp, 2001). It is difficult to offer authoritative teleological readings of buildings because they change with shifting circumstances. For example, a building that is wasteful of energy, relies on non-renewable materials for its construction and houses activities which a majority of the community would regard as morally repugnant, would typically be condemned by ethical theorists. However, a teleological thinker might argue that such a building is a perfect example for architects of “what not to do” and thus its localized failure has a more widespread positive moral influence because it is a notorious exemplar of poor design. This is why ethical arguments about architecture from a teleological perspective are problematic. It is also why an isolated focus on design process, rather than design outcomes, is an effective way of limiting the ambiguity.

^{iv} Johnson (1994) observes that the writings or explanations of the architect are not necessarily reflected in the deeds of the architect. Johnson describes the former as “espoused theory” and the latter as “expressed theory”. The problem for the scholar is that they cannot assume that espoused theory and expressed theory are perfectly consistent. The present research is primarily concerned with espoused theory, and while acknowledging that this is not necessarily a true indication of an architect’s actions during the design process, it remains widely accepted as a reasonable facsimile thereof. Thus, and unless otherwise indicated, the paper assumes that a designer’s words accurately reflect their actions. If they do not, then there is further reason to be critical of the ethical stance they have taken.

^v Oosterhuis (2001) has argued that designers “need a well trained intuitive insight” into the strengths and weaknesses of the computer if they are to produce great architecture. For Oosterhuis, the computer is “like a pet that must be tamed and bred” (37).

^{vi} It is also important to differentiate high level CAD modelling software, as it is used in auto-generative design, from any and all other tools which conventionally support the architect’s design process. While it is possible to argue that architect’s tools (including the T-Square, the parallel drafting machine and the pair of compasses) have always shaped their designs, such an influence is relatively subtle and such tools are never venerated as the author of a design. While certain tools, say a set-square and T-square, may encourage, through their proximal relationship, architects to work with orthogonal forms, this is not the same as a tool being left to produce the ideal form of a building of its own accord. The ethical implications of the design process begin to become apparent at the moment the tool subverts, obscures or overwrites the architect’s hand. To date, only auto-generative and parametric design come close to achieving this situation.

^{vii} It might be possible to argue that Rahim’s description of a design process is not dissimilar to other architect’s descriptions for different movements and that, therefore, many architects are guilty of ethical failures using this reasoning. However, the issue with Rahim’s design process is not that he avoids the use of personal pronouns, but rather that his presence in the text is only for the purpose of reinforcing the power and authority of the computer. It is the combination of the framing and content that differentiates the ethics of authorship in this example (and the case of Lynn in the preface to this paper) from other cases.

^{viii} The description (1) relies on an underlying system, evolutionary computing, and the hand of the designer is largely invisible, (2) it has both material and abstract limits, the surfaces of the two sections, and (3) it has had certain frames chosen as the resultant design (for manufacturing).

^{ix} Here it is apparent that Lynn is adopting a “spirit of the age” ethical position: see Harries (1997).