XXVIII Generative Art Conference - GA2025

Material Matters

Peter Beyls
The School of Arts, University College Ghent, Belgium
www.kask.be, www.peterbeyls.net
peter.beyls@hogent.be, peter@peterbeyls.net,

Abstract

This paper reports on the Material Matters (MM) research project which aims to acquire both a model and a working strategy to integrate machine-originated action through a material and object-based studio practice in the general context of Generative Art. MM develops a framework based on notions of object-oriented ontology, embodied cognition, software as improvisation and explores the functionality of software in relation to material-based affordances. Preliminary implementations include large CNC machine drawings and robotic paintings. Interestingly, an aesthetic link is discovered between the intricacies of a drawing algorithm and the expressivity of its materialization in line segments of variable clarity. Still, crucial questions remain on the true nature of intelligence in the art studio.

Machines take me by surprise with great frequency.
Alan Turing

1. Introduction

The MM project explores the tight relationship between idea, concept, environment, object and material – all understood as a network affording creative action in a global framework of Generative Art. Since the introduction of transformer models in 2017 such as GPT (Generative Pre-Trained Transformer), generative art (GA) became synonymous with LLMs (Large Language Models), an AI-informed method to automate media creation by any individual through textual prompts. However, in 1999, generative symmetry-based tiling systems were discovered in both France and South Africa dating back to 70000 BCE. Since then, GA has flourished since the early days of computing [Galanter, 2003]. In art, generative or not, questions arise of how to externalize purely virtual artifacts making them available to grounded human experience.

Human culture exists by virtue of mysterious and enigmatic affinities expressed in the infinite network of invisible things - ideas, concepts and thoughts, as well as visible things: materials, objects and bodies. According to the notion of Object-Oriented Ontology (OOO) histories and social structures might be categorized as hyper-objects, “massively distributed in time and space relative to humans” [12, p. 1]. How can we identify and isolate systemic identity in natural and social arrangements – systems appreciated through the physical presence of a material universe? Human activity in the cultural workspace is informed by active awareness and observation of a very much concrete engagement with materials, objects or sounds. However, why does an infinite number of visible real-world interactions create an infinite number of invisible feelings, thoughts and impressions? Then, how does the depth of the aesthetic experience relate to the dynamics of this process?

The philosophy of mind concept “the inexplicable gap” implies that we do not have any clue about the relationship between cognitive processes – such as creative exploration and improvisation – and the grey matter of the human brain supposedly supporting these processes. So, we have no idea about the connection between the functionality of the brain and the physical stuff the brain is made of – when viewing a painting, do we have any knowledge of the correlation between the paint and the intensity of the aesthetic experience? So, can we say that art is like a brain, when we view it as a network of affinities of meaning in time and space...

Embodied cognition refers to human thought as fundamentally shaped by the body's sensory and motor experiences providing a holistic view of human experience and cognition [9]. Where does software fit in here? Well, according to OOO, objects include not only physical entities like pencil, paint and paper but also non-physical entities like concepts and events. In addition, no entity can be fully captured or exhaustively known by another, challenging the idea that objects are entirely transparent or reducible to their relations. OOO promotes a flat ontology; a non-hierarchical view that does not prioritize humans over the agency of objects such as computers. As Harold Cohen expressed his approach as an interest to see what a computer program could do, rather than what he could do with the program – speculative realism seeks to explore the reality of objects independently of human perception.

How could such an attitude be explored and mediated through the interaction of thoughts and objects, imagining behavior leading to the emergence of pictures, rather than thinking in terms of pictures themselves? OOO mingles well with software as speculative action, or as Nicholas Negroponte once aptly characterized speculative computing as “negotiation with nebulous ideas”. The beauty of software lies in its ability to handle uncertainty and ignorance in a tangible way; purely conceptual constructs are now explicitly accessible; one can actually play with one’s ideas. When implemented, the program talks back to the artist, therefore programming can be considered as aesthetic introspection [2], insight precedes *and* follows materialization, the process repeats and thus enters an endless loop. For that reason, more than anything else, generative art subsists in an infinite conceptual-materialist framework of time and space.

The Material Matters (MM) project suggests that art can be expressed as the creation of materials from other materials, including software. A fascination with autonomy (in contrast to automation) is further eminent in much generative art, not unlike self-creation known as autopoiesis [18]; the art becomes a living system embedded in a physical environment; the mind-body connection becomes the body-environment connection in shaping mind and consciousness. MM takes a holistic approach to the micro-universe of the artists' studio in the sense that human bodies, machine hardware, a widely diverse range of production tools, objects and materials all contribute to a materialist environment in continuous flux. All components contribute to the emergence of affordances allowing tangible creative exploration. Again, how does autonomy in software relate to this setting?

We know, most basically, people play piano and play with paint just for the thrill of it – they are intrinsically motivated by curiosity, experimentation with ideas and materials, by sharing a perspective and provoking thought in others, shaping and affirming cultural identity and by the sheer pleasure of making. In contrast, a machine has no desire since unconditioned by consciousness, embodiment or lived histories, a machine is not motivated; its action is not self-originated.

2. Intelligence in the art studio

MM aims to implement a creative strategy for human-machine co-creation where both partners co-exist in a shared physical environment, the principle of mind-body-environment unity emerges as a first principle [3]. Inspiration is found in the work of Kahneman [8] suggesting human cognition as a fusion of two interacting parts: a swift reflexive system handling information directly gleaned from the environment and a slower, deliberative system handling reasoning from first principles. Higher order regularities are extracted from the environment – meaningful patterns emerge simply from grounded awareness: this perfectly resonates with viewing the artist and the artist's studio as one integrated complex dynamical system. Impulsive reflexive action discloses behavioral patterns informative in the creation of a higher-level world model.

MM further suggests a speculative model for intelligence in the art studio from the interaction of human and machines agencies while maximizing the rejection of implicit virtual entities. We expect this model to encourage production of complex emergent behavior and morphology over time, as such, avoiding explicit design. Physically embodied agents exist as objects and materials in space and sense and affect their environment; object manipulation by human and machine result in a complex dynamical system merging influence and autonomy. Real environments are infinitely rich, noisy and unpredictable; the unknown is welcome. A fundamental question arises: can machines have goals? The goal of the human agent can be said to integrate human and machine intelligence to explore hybrid cognitive spaces potentially offering complex and compelling aesthetic experiences. One overall underpinning principle remains the *maximization of diversity* [2].

According to Nitsche [13, p. 128], "diversity is the range of different sensorial points of contact, and the richness of

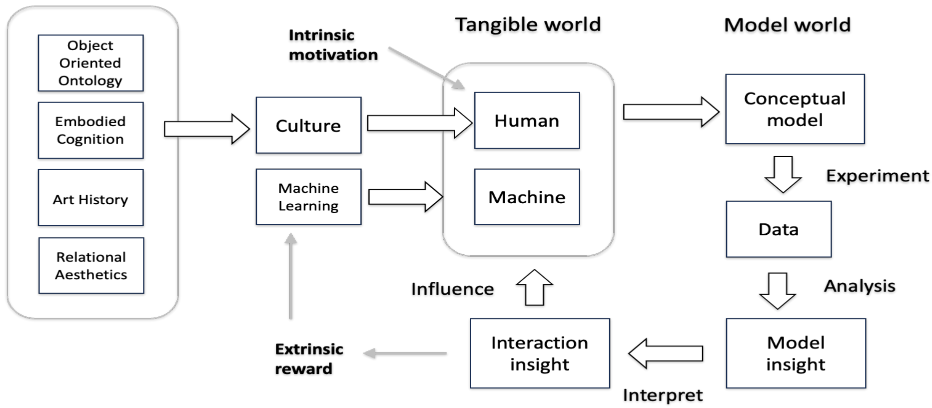

Figure1: Speculative model of human-machine co-creation

choices speak not only to the level of details in the nonhuman object but also to the senses of the human, which fosters the cognitive engagement with the object and the world" – diversity leads to specificity: the precision one can develop in one's relation to an object. Nevertheless, we also recognize the art studio to be an enigmatic place, according to Bruce Nauman: "It's always interested me how one does any work in the studio at all, what it's supposed to be about, how you get things started or make any sense out of the process. Even though the work is coming from somewhere inside, you can't put your finger on the source" [17, p. 22].

A basic speculative studio model is clarified in figure 1 above: human and machine entangle in a shared corporeal environment. A hybrid human-machine construct provides sensorial data informing a hypothetical (speculative) conceptual model generating some form of data updating the interaction loop. The infinite depth of human culture conditions their behavioral scope with obvious inexorable impact of art history. While humans are intrinsically motivated to play, experiment and explore, machines on the other hand, do not care about art history in any embodied sense, though machine behavior can be conditioned by external rewards, for example, issuing from a reinforcement machine learning algorithm.

3. Software as self-invention

Creative software development is understood as the gradual specification of objectives reflecting a particular cultural identity, a fluid medium affording the construction of a network of representations. Programs are particularly textual; they capture scripted procedures in a formal, by definition abstract language. Once the program actualizes itself, the implied representation emerges as sound, image or patterns of human-machine interaction. Then, cultural identity is disclosed from the evaluation of tangible media; and important: deep experiences result from a grounded experience – how the body-object relation entails resonant understanding. Software becomes a cyclic medium for self-construction, or more appropriately – the discovery of personal identity through improvisation with given computational paradigms.

In addition, creative software development is driven by a *continuous* wish to explore one's cognitive spaces, quite often, there is no specific target – therefore, improvisatory software development is not essentially about problem solving. Targets evolve according to the evaluation of intermediate results – focus is mobile.

Improvisation then raises consideration to the exploration vs. exploitation ratio; the artist balances between exploring unknown ideas vs. making good use of what happens to be at hand. Complex oscillations of this ratio are characteristic of creative action: fluctuations reflect levels of ambiguity in creative decision-making raising questions of intermediate evaluation – should one explore the quality of the moment or expand into the assessment of a quantity of prospective options? One improvises (1) by contemplating the meaning, value and aesthetic potential of current results and (2) by evaluating the complexity, significance and struggle of finalizing, extending or leaving the current playground.

Such experiential dynamic interrelating processes underpin self-invention. In a process of intimate human-machine interaction [1], the artist engages in an endless chain of dualistic decision-making in the typically confined conceptual space of a single computer program. In this multifaceted process, software actively affords the implementation of personal preferences, consequently pulling the artist into the confinement of a private aesthetic – conceivably, suggesting the illusion of power in the creative process.

Otherwise, since computer code often formalizes incomplete, ambiguous and speculative desires, unpredictable results frequently emerge. Then, self-invention may be understood as a process of creative human-machine interplay with multiple conflicting desires contributing to waves of peaking personal insight resulting in a particular style. According to Alva Noë "…style is the law to which I subjugate myself. Style expresses itself in the things that I do that are just below the threshold of my consciously doing them at all, in my posture, my gait, my look and smile, in my body… only a creature with a world can have a body… a world whose meanings are in turn opened by what we can bodily do and undertake" [14, p.159].

Any aesthetic experience relates to the synthesis of value from historical considerations, history informs and therefore conditions appreciation of the artwork.

4. Hardware as relational matter

More precisely, the art product (e.g. a painting) does not coincide with the work of art, i.e. the experience: "Art is a quality that permeates an experience, it is not the experience itself … the material of the experience is being human" [4, p. 399]. We learn that art is not a symbol system and conventional cognition cannot explain – enactive distributed cognition and cognitive unconscious (embodied cognition) are helpful resources to develop an aesthetics of behavior. Language belongs to the conscious, so we can't explain the essence of embodied knowledge in words. If so, how on earth could we ever write software that creates meaningful art?

For a moment, let's focus on experience – powerful products afford deep-grounded

Figure 2: robot watercolor (detail)

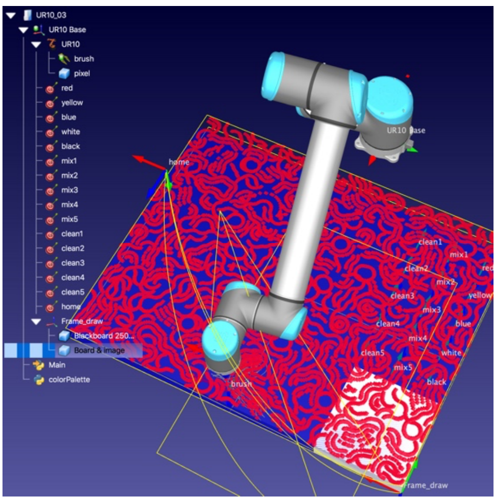

Figure 3: UR10 robot interface

involvement; the product performs as a catalyzer offering an authentic understanding. In other words, the identity of the artwork is revealed through active participation of the onlooker, the construction of meaning from a multitude of materialist considerations. How does this work with immaterial media?

Many of my audiovisual installations developed over the last two decades suggest a type of *relationship* between multiple distinct worlds, sometimes in a purely physical sense, sometimes in a virtual or computational sense, however, quite often equally in a metaphorical sense. Nonetheless, it would be misleading to merely categorize the nature of the experience; active engagement with any work of art implies a network of relationships, a vastly extended complex of affinities we all develop to consistently appreciate whatever hits our senses. Art might indeed be envisioned as a social construct thriving on the expression of continuous reciprocal tension, or in the words of Lawrence Weiner: “Art is and must be an empirical reality concerned with the relationships of human beings to objects and objects to objects in relation to human beings” [6, p. 10] or according to Marcel Duchamp 1957 statement: “art is a game between all people of all periods” [10].

Specifically, interactive art exists as experienced behavior; one assigns value to the relationship between effective features of the system and affective engagement of the viewer. Meaning is actively generated through engaged human/machine interfacing, it is conceivably feasible to describe perceived qualities but impossible to capture and communicate the individual experience. People assign value through grounded experience and typically care for the wider context in which a work is created and presented.

5. Process and materiality

Computational art confronts the challenge of devising powerful bodies reflecting abstract meanings. Uncertain relationships arise between implied system and its physical manifestation. Underlying algorithms made perceptible in

Figure 4: CNC drawing, "After Caravaggio", algorithm 1.

Figure 5: CNC drawing, "After Caravaggio", detail, algorithm 1.

shape or sound expose themselves by way of their materialist carriers. What is the behavioral scope of both components? How do functionalities merge to provoke a singular emergent experience? Does cognitive participation in art through physical engagement with the object require full understanding of any fundamental logic or systemic process?

Whatever, mapping meaning to matter is key to the art process.

Let's consider Matthew Barney's drawing restraint actions and view them in parallel to the notion of constraint satisfaction in software design. Barney mentions "three phases of a system: Situation, Condition and Production" for describing his creative trajectory as The Pad – "…the goal of The Pad was to abstract the form of Production, and to create a loop between Situation and Production" [15, p. 40]. Making an analogy with a sensor-activator system is straightforward; e.g. both the artist and a grounded robotic system interact through tangibility. However, this type of *'generative art beyond computing'* excels in psychological intensity typically unheard of in algorithmic art. Another fine example: Barney's sculpture "Secret Name" of 2011. It's made of lead, zinc, copper and thermal plastic, it actually functions as an electro-chemical system, a process of oxidization takes place since metals act as anode and cathode attracting molecules in a corrosive environment. Probably, both friction and harmony between narrative idea and its materialization contribute to full understanding and deep appreciation.

Subsequently, generative thinking unfolds in both structural and narrative complexity. We are particularly interested in the notion and meaning of 'complexity' in this hybrid context. Actually, an intricate relationship between the objective features of an artwork and the subjective properties of personal perception reflects the intricacies of viewing art as experience.

Over the years, I developed distinctive conceptions aiming to characterize

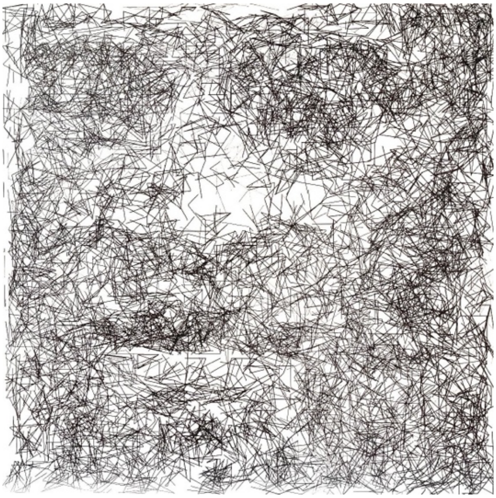

Figure 6: CNC drawing, "Portrait of George Floyd", algorithm 2.

Figure 7: CNC drawing, "Flora IV", (detail) algorithm 3.

writing software as artistic statement. For example, the notion of 'conceptual navigation' refers to an exploratory attitude in the creative process, a process of 'speculative computing' where human and machines engage in open-ended collaborative improvisation [2, p. 231]. My attitude shifted from merely procedural thinking to a more dynamic human-machine affiliation. According to Simon Penny's, post-cognitivist paradigm, such cognitive association involves "intelligences of structural coupling, sensorimotor feedback, loops, and engagement with materiality, artefacts, embodied procedures, and knowhow … which involve the construction of artefacts, organized spaces, and systems of gestures and movements as cognitive in a rich and sophisticated way" [16, p. 317].

So, if art is primarily a platform of grounded engagement and inter-human exchange, social commitment and communication, how can we talk about creativity and autonomous initiative in machines? Does creative computing allow for sharing responsibilities with a human artist? Then, the notion of complexity is understood to be informed by interpretation; complexity seen as judgment rather than observable fact. Post-cognitivist rationale expands to viewing all of the environment as an infinite network of interrelated generative systems; *found systems* emerge in natural, biological, social and cultural workspaces, patterns suggesting some form of systemic behavior. Incidentally, systems awareness and the concept-object interrogation were also key to the work of many conceptual artists of the 1960s [11].

6. Implementation

MM entails a large number of experiments exploring the intersection of materiality and software-initiated action involving large CNC drawing machines, a Nova5 co-bot and various home-made robotic structures. One project of human-machine co-creation suggests tracking the morphological similarity between human and machine-initiated drawing.

The machine bootstraps with random motivations instructing to follow human examples (integration) or pursue a private agenda (expression). Consecutive action by human and machine exposes a similarity profile: successive intervals in structural similarity; a spatiotemporal pattern emerges documenting human-machine (dis)agreement. Then, a significant peak signals a given temporal social human-machine bond, it informs a reinforcement algorithm which aims to maximize the tightness but also the fragility of the ongoing shared but materialist human-machine negotiation. Future papers will fully document this collaborative-mutual strategy.

Exploration of physical dimension as a core parameter plays a significant part in MM, we're using a large homemade (3m * 2m) CNC (numeric control) drawing machine outfitted with miscellaneous drawing tools: pencils, charcoal, pastels, brushes and ink pens. In CNC drawings, a strong impression of depth arises from ink pens wearing out, surprisingly, fading lines suggesting a third dimension. Watercolors painted by a robot arm apparently reveal freedom – seemingly unhindered by human cautiousness. In this process of handling surface, brush, water, paper and paint, character of some sort is revealed (figure 2). Personality of the machine emerges from the interaction of many known and even more unknown participating components, merging hardware and software, the number of dimensions is indeed infinite.

Drawings in figures 3 to 6 originate from digital photos, the bitmap is analyzed for contours using various algorithms, including Canny operator, isolated dots are connected with line segments according to a given set handcrafted constraints. Algorithm 1, as exposed in figures 2 and 3 effects expressive gestures although, initially it was considered buggy, a clean continuous line was expected (figures 4 and 5). Algorithms 2 followed producing clusters of straight lines as a function of brightness intervals in the source image (figure 6). Algorithm 3 attempts to reduce the complex density of algorithm 1 by filtering the image and connecting extracted dots by following strict rules (figure 7). At this point, it became clear that the true nature of algorithm 1 was not a bug but a feature.

7. Conclusion

This paper reflects on the relationship between materiality and software in the global context of generative art, considers ideas from object-oriented ontology and follows a methodology rooted in embodied cognition: viewing aesthetic processes as constituted and afforded through motivated bodily activity in a situated physical setting. MM specifically explores the choice of various drawing and painting materials in addition to the impact of physical dimension of large-scale machine drawings and small-scale robotic painting.

MM questions the role of AI in the art studio and emphasizes materiality as time-centered and situation-based action. A model of unified human-machine co-creation is proposed aiming to integrate both intrinsic human-motivated action and machine-motivated action. MM explores the role and behavioral scope of software in relation to the affordance scope of objects and materials. On the one hand, CNC machine drawings suggest a particular aesthetic end product through the interaction of their large physical size and the intricacy and unanticipated expressivity of clustered line segments.

On the other hand, initial attempts to incorporate human and robot gestures in a common painting playground look promising but need further research. However, fundamental issues remain. Afterall, humans create because they must: to express, to survive and to connect – art is considered a social phenomenon. Machines create because they can: because someone built a system that enables explicit action. Then, machine art serves the instrumental purpose of efficiency. On the other hand, meaning is generated by humans where art serves existential purposes such as identity, memory and resistance [5]. At one extreme, the machine doesn't care if the work exists or not, it has no choice. On the other hand, MM proves that tight human-machine negotiation in a blended exploratory format proves instructive, rewarding and affirmative for the human agent.

Acknowledgements

I am indebted to my former mentor Knut Wiggen for introducing me to the concept of resonance (section 3) as a measure of aesthetic appreciation. It refers to the capacity of an audio filter to resonate and become energetic, metaphorically suggesting an exceptional experience. I also express my gratitude to my colleagues Elias Heunink and Thomas Janssens for technical and logistic support.

The Material Matters project is financed by the Flemish Government of Belgium, its support is gratefully acknowledged.

References

[1] Beyls, P 1986 Intimate Machine Interaction, *The Visual Computer*, 2:152-158, Springer Verlag, Berlin, Germany

[2] Beyls, P (ed.) 2014 *Simple Thoughts*, MER Publishing, Belgium

[3] Beyls, P 2024 Embodied Interaction with Algorithms, *GA2024 Proceedings*, Domus Argenia Publishing, Rome, Italy

[4] Dewey, J 1934 *Art as Experience*, Minton, Balch, University of Michigan

[5] Dias Ramos, A and Snow, Tom (eds.) 2023 *Activism*, Documents of Contemporary Art, Whitechapel books, London, UK

[6] Furlong, William 2012 *Speaking of Art*, Phaidon Press Ltd, London, UK

[7] Galanter, P What is Generative Art? Complexity Theory as a Context for Art Theory, *GA2003 Proceedings*, Domus Argenia Publishing, Rome, Italy

[8] Kahneman, D 2011 *Thinking Fast and Slow*, Farrar, Straus and Giroux, NYC

[9] Lakoff, G and Johnson, M (1999) *Philosophy in the Flesh: The embodied Mind and its Challenge to Western Thought*, Basic Books

[10] Lebel, R 1967 *Marcel Duchamp*, Penguin Books, UK

[11] Lippard and Chandler, 1968 The Dematerialization of Art, *Art International*, Vol. XII, nr. 2

[12] Morton, T 2013 *Hyperobjects: Philosophy and Ecology after the End of the World*, University of Minnesota Press, Minneapolis, MN

[13] Nitsche, M 2022 *Vital Media*, MIT Press, Cambridge, MA

[14] Noë, Alva 2023 *The Entanglement.*

How art and philosophy make us what we are, Princeton University Press, NJ, 2023

[15] Obrist, HU, 2013 *Matthew Barney*, The Conversation Series 27, Verlag der Buchhandlung Walter Konig, Cologne, Germany

[16] Penny, S 2017 *Making Sense, Cognition, Computing, Art and Embodiment*, MIT Press, Cambridge, MA

[17] Richardson, B 1982 Bruce Nauman: Neons, exh. cat., The Baltimore Museum of Art, Baltimore, MD

[18] Varela, F and Thompson, E 2017 *The Embodied Mind, revised edition: Cognitive Science and Human Experience*, The MIT Press, Cambridge, MA