The Style Machine:
Digital Tactility Through Generative Collaboration

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Abstract

This project explores the creation and use of generative design software as an exercise in cross disciplinary collaboration. We propose a workflow that uses generative art and 3D printing as a means of communication of tacit knowledge between disciplines, in this case between a generative artist and an industrial designer. The relationship between generative artist, software, and artefacts is uprooted with the introduction of an industrial designer and 3D printer. The four nodes of this system, the designer, generative artist, software, and printer form a feed-back loop that constantly evolves a "sum greater than its parts". The produced artefacts in this case function as a means of feedback and communication between collaborators.

This workflow provides benefits for both (human) collaborators; For the industrial designer, the collaboration allows a creative paradigm shift from prescriptive pre-meditated creativity, to reflexive and explorative creativity that maintains the hallmarks of their own developed "style". For the generative artist, it provides a platform to explore how generative systems can be wielded in a collaborative context. The emphasis on collaboration shifts the focus from the process encoded by software onto the evolving multifaceted collaborative process.

A series of investigations, or "tactile conversations", were performed to assess the relationship and tensions between the generative spontaneity of the software and the intentions of the designer. Through this process, we develop the software to act as a creative prosthesis that assists the design process and functions as a collaborative mediator. The investigations involve different techniques to balance the system between all parties, we discuss the advantages and disadvantages of each approach. The techniques used to vary the parameters of the system are:

1)Using the human collaboration, and software with little generative randomness as a feedback loop to evolve the software and artefacts produced.

2)Introducing stochastic generative features (apparent in the form and surface of the objects).

3)Varying the surface qualities of the printed artefacts both with software, and the 3D printer.

The Style Machine

Collaboration is by nature a generative exercise where multiple independent parties are working together to evolve a result, a sum greater than its parts. If we refer to Galanter's often quoted definition of generative art that

> *"Generative art refers to any art practice where the artist uses a system, such as a set of natural language rules, a computer program, a machine, or other procedural invention, which is set into motion with some degree of autonomy contributing to or resulting in a completed work of art"* [1]

then we can see that by nature of engaging in a collaboration, the artist cedes some control to a system of negotiation with another creative entity (human, computer, or otherwise), and that this process must adhere to a certain set of communicative rules. This might seem too broad a categorisation, to say all art that has involved a collaboration is generative art tends to blur the identity of the work that is more appropriately considered generative.

So although it is true that in this interpretation any collaboration could be said to be generative, in most cases it isn't a particularly beneficial view; It doesn't offer a useful conceptual framework for those not interested in generative art and design. The benefit, however, of consciously taking the view of collaboration as a generative process from the perspective of a generative artist is that it offers a systematic way to think about how non-computational processes (whether human or otherwise) can be incorporated into a generative system.

The style machine uses this idea to develop a hybrid computational and human generative system with the purpose of communicating tacit knowledge between disciplines (in this case an industrial designer and generative artist). This sharing of knowledge facilitates the exploration, evolution, and production of artefacts based on a particular style.

The use of computation to create and execute generative systems has enabled a new way of thinking about design, a shift from labouring over a single form to thinking about designing automated systems from which designs can naturally arise. Although generative algorithms are frequently computational, generative rules need not necessarily be executed digitally, the work of Sol Lewitt [2], for example, relies heavily on the human execution of his instructions. Because a generative system need not be purely computational we explore in this project a collaborative approach to generative art and design that takes a broader view of designing a generative system than an artist and computer model.

Instead of focussing primarily on the computational aspect of the designed system, we instead view our generative system as a network of collaborators giving rise to an evolving series of forms. This view of generativity borrows from complexism [3] to describe a network whose resulting artefacts are an emergent property of the interactions between nodes. By taking this system wide view of generativity we enable a dynamic tactile conversation between two designers, a piece of software, and a 3D printer. This four node system is our generative process; the software is only one of four equally important steps in the evolving feedback loop that produces physical 3D printed objects. This system enriches the work of both [human] collaborators, enabling a freedom of creative exploration that would otherwise not be possible.

Process

The style machine is built on the principle of working with as little resistance as possible. From its outset as manually created CAD designs created by the industrial designer, the goal was to produce objects for an FDM 3D printer that would have it work with as little resistance and as much beauty as possible, ideally the printing head would never lift or stop printing and there would be no support material. This concept of least resistance is extended to every aspect of the system, decisions are based on their ability to make each collaborator work as easily and smoothly as possible while maintaining a high level of quality. The process is continually re-balanced in a series of tactile conversations; a feedback process where the system is attempting to optimize towards the ideal balance of ease, complexity, variation, and beauty.
Initially the project grew from an Industrial Designer creating a variety of 3 dimensional forms to coerce a 3D printer to work with as little resistance as possible.
The variety of abstract forms the industrial designer initially created were considered to be vehicles of translation between an aesthetic thought and the 3D printer. During the process of creating these objects, a set of rules was developed to generate objects especially conducive to FDM 3D printing. These objects, became after several prints, an evidence of style. The evident style that was initially developed by the industrial designer was expressed as a piece of interactive software by the generative artist. This software was developed with the purpose of making the exploration of the style significantly more efficient thus reducing the resistance of the industrial designer's creative process. The software functions as a creative prosthesis, allowing easy access to new creative territory that would otherwise be inaccessible.

figure 1. Industrial Designer's established form style

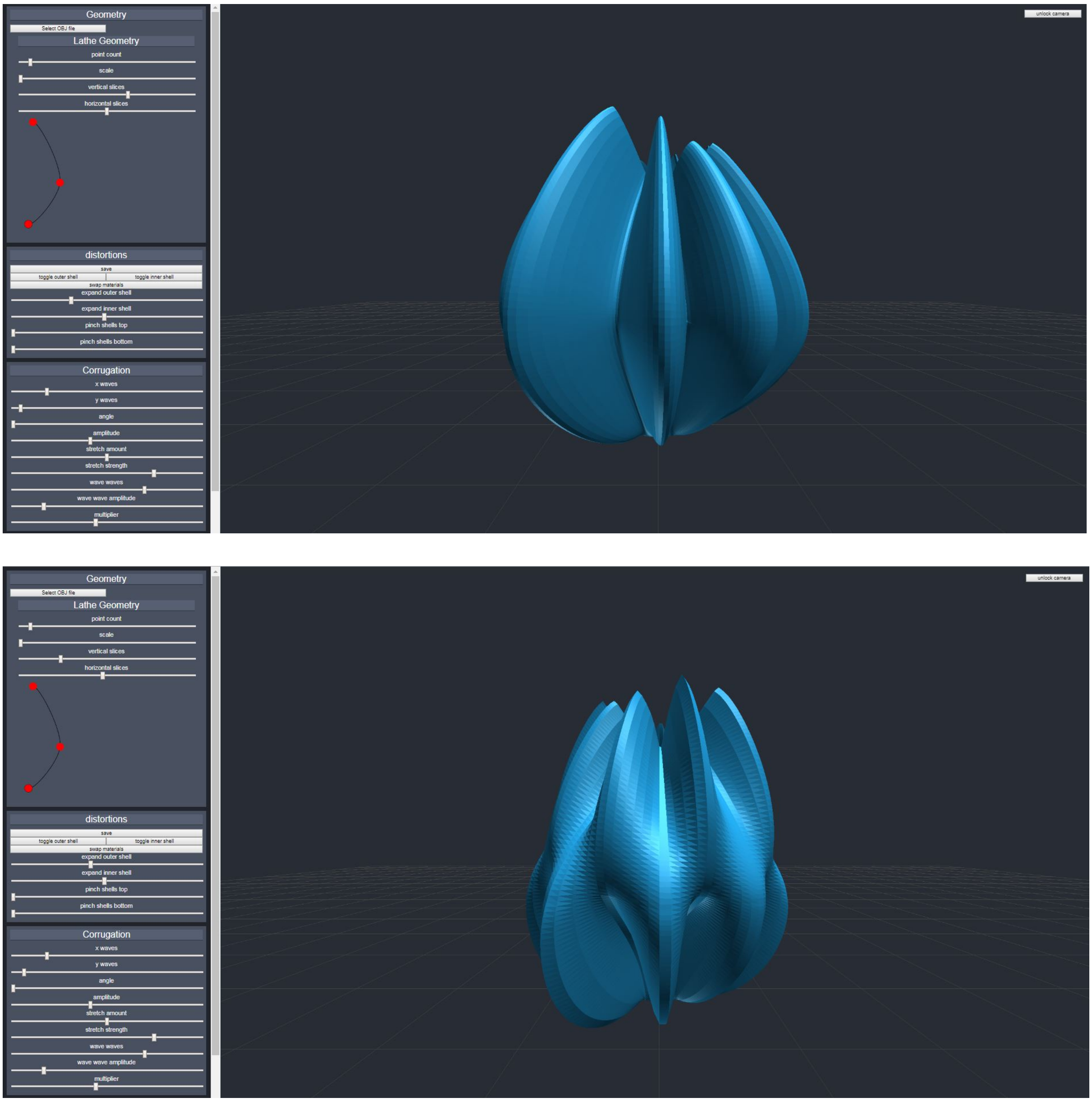

figure 2 & 3. The Style Machine software interface

This process of taking an established form style and building a parametric system around them "seeded" our four-node generative system of an industrial designer, a generative artist, Computer Software, and a 3D printer. This four node system comprises an evolving feedback loop. The artefacts created by the industrial designer using the software are fed back to the generative artist who makes observations and adjusts the system accordingly.

Generative collaboration

The style machine is a "collaborative-generative" system developed with the purpose of communicating tacit knowledge between disciplines of design. In the same way as all collaboration could be said to be generative, in some sense all generative systems are by nature collaborative. They are a collaboration between the system designer and the executor of the system, whether that be a computer, human, or other mechanism. When classifying the style machine quite specifically as a “collaborative-generative” system we are describing something more defined: a process of collaboration between multiple humans and software who function as nodes or pieces in a larger evolving feed-back loop. The generative system in this case is seen as the collection of collaborative nodes that give rise to emergent outcomes. This view is taken as opposed to viewing the software, or algorithm, as the generative system.

The distributed view of our generative system is as an expression or “application” in Galanter’s terms of complexism in design. The system is a feedback-network of nodes continually giving rise to new and unexpected artefacts. The artist and designer become parts of the system, stages in the process, rather than having a top-down influence on it. This network would not exist with the absence of any of the individual nodes, and its continued evolution and feedback supports the title of a distributed generative system.

The introduction of multiple collaborators necessitates an agreed upon form of communication. In a more traditional computational system of artist and computer, the artist communicates with the computer via written software and the computer responds with artefacts. In the case of the style machine the 3D printed artefacts become the primary form of communication, a grammar that describes physical properties desired by the designer or artist. These artefacts form the vehicle of communication not only within the system (between designer and artist), but are also the externally visible products for outside observers.

The collaborative-generative system of the style machine looks like the following:

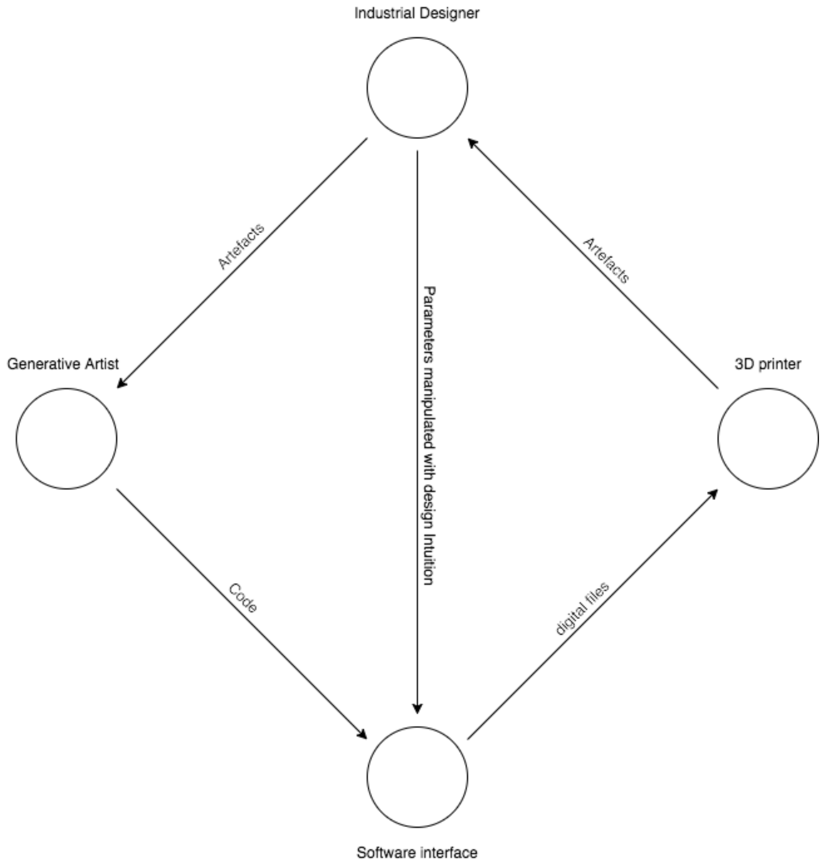

figure 4. diagram of the style machine’s generative feedback loop

Each node performs a specific function:

The industrial designer both seeds the process with their previously developed style and uses their trained understanding of form to draw out the very best and most beautiful objects from the software. The industrial designer offers insight into how the system can be further evolved to a state of maximum ease and quality.

The 3D printer imbues the digital 3D models with tactility and surface qualities. The artefacts it produces are significantly richer in expression than the digital files they are printed from. The artefacts it produces communicate visceral and tactile information between the designer and artist.

The generative artist interprets the artefacts and develops and refines the software to provide a streamlined expressive tool for the industrial designer to wield. The generative artist's contribution is to understand the parametric landscape that the objects of the industrial designer sit within and to provide tools for the efficient exploration of that landscape. It is also the job of the generative artist to provide occasional mutations to the system to offer the opportunity of unexpected evolutionary progress of the initial style.

The software functions as streamlining tool allowing the industrial designer rapidly iterate and explore their style. This allows much greater depth and breadth of exploration of the initial style. The other function of the software is to change the mode of creativity of the industrial designer from prescriptive creativity - premeditated ideas meticulously executed in CAD software - to explorative, or reflexive, creativity. The reflexive creativity of exploring the parametric landscape encoded by the software opens up ideas previously un-imagined and offers new opportunities and trajectories whilst still maintaining the hallmarks of the initial style.

Tactile Conversations

With the structure of our collaborative-generative system set up, we undertook a series of continuing investigations, or tactile conversations. A tactile conversation can be seen as an evolutionary generation, a series of artefacts produced by a single iteration of the software. Each time a series of artefacts are produced, they are shared between the designers who observe and discuss the physical and aesthetic properties. This sharing of understanding then informs the next evolution of the software and the process repeats. These conversations also function as a method of communication of tacit knowledge between designers. The forms become vehicles of knowledge, expressing tactile and physical information that couldn't otherwise be communicated with words. The goal of each iteration is to balance the system between the needs of each collaborator, seeking the path of least resistance for all.
We have tried three methods of varying the properties of the system to try to enable each node to work with as little resistance as possible while still providing space for natural discovery and evolution. These are:

1) Parametric determinism
2) Stochastic generativity
3) 3D printed form studies

Parametric determinism:

The first iteration of the software was purely parametric, meaning there is no randomness involved in the software itself. Each variable of the system is exposed to the direct control of the industrial designer. Although this seems against the spirit of generativity, it is not the software we consider the generative element of the style machine, rather it is the evolving collaborative-generative system that includes both the human collaborators and the machines. By shifting the focus off of the software and computer and onto the system as a whole we allow a greater breadth of exploration of generativity. In this iteration we aren't encumbered by the need to find an algorithmic fitness function, or seek techniques to cleverly adjust each variable and hope the computer happens upon a combination that is beautiful, refined, and unique. In this way using the industrial designers refined intuition regarding form helps the generative artist find his path of least resistance (in the lack of having to solve the previously mentioned problems). The downside of this technique is less systemic spontaneity.

figure 5. Early forms created with the style machine working as a procedural process

figure 6. Dynamic physical properties

Stochastic generativity:

This tactile conversation included the use of stochastic generative mutations to the original style. In this case the generative artist introduced some chaos, attempting to take the highly ordered parametric system and bring it closer to the fine balancing point of complexity by introducing some structural noise. In this case the industrial designer had little control over the mutations, which would theoretically allow for spontaneity and evolution. In practise it simply added unnecessary resistance to the industrial designer's process, making him less able to find beautiful forms due to the unpredictability of the mutations. Although It's possible that other more beneficial and beautiful "mutations" could be developed, the idea of artificially introduced spontaneity seems to be an unnecessary burden. The spontaneity of this particular generative system arises through the interactions between collaborators, the software, and the printer (as described below). However through various smaller conversations and mutation tweaks, the industrial designer found unknown subtleties in the style machine that were intriguing and of value.

figure 7. Aesthetic anomalies from the introduction of noise into the style machine

figure 8. later forms using both generative and parametric processes together

3D printed form studies:

The final node of the conversation is the manifestation of physical 3d prints, here the artefact performs as a witness to the collaboration, acting as a measure of 'style' and the ease to which it is attained. This may seem un-research like, where the outcomes are evaluated by the researchers, however each new iteration offered new ideas that could be digested at an achievable pace by the designer and artist and acted upon. 3D form studies provided tactile objects, these in turn offered new dynamic and printed qualities, and larger artefacts presented previously unseen spatial qualities.

Much of the work was printed in a wood flour (PLA) material which is particularly sympathetic to visual and tactile interaction [4]. This material and printing method provided surface qualities dependant on 3D form and angle to axis. While an intuition is held by the Industrial Designer of the possible 3D printed outcome, the feedback between the nodes provides a rich source of complexity in this system, evidenced in the prints.

By leveraging these physical qualities, we don't have to rely so heavily on computational stochastic randomness to create subtle complexity and variation. This reduces resistance in the industrial designer's process and also for the generative artist who is left to add more precise and easily wielded aesthetic features to the software. This is a much more natural expression of spontaneous complexity than artificially injecting stochastic mutations into the form itself.

figure 9. Internal spatial qualities

figure 10. External qualities

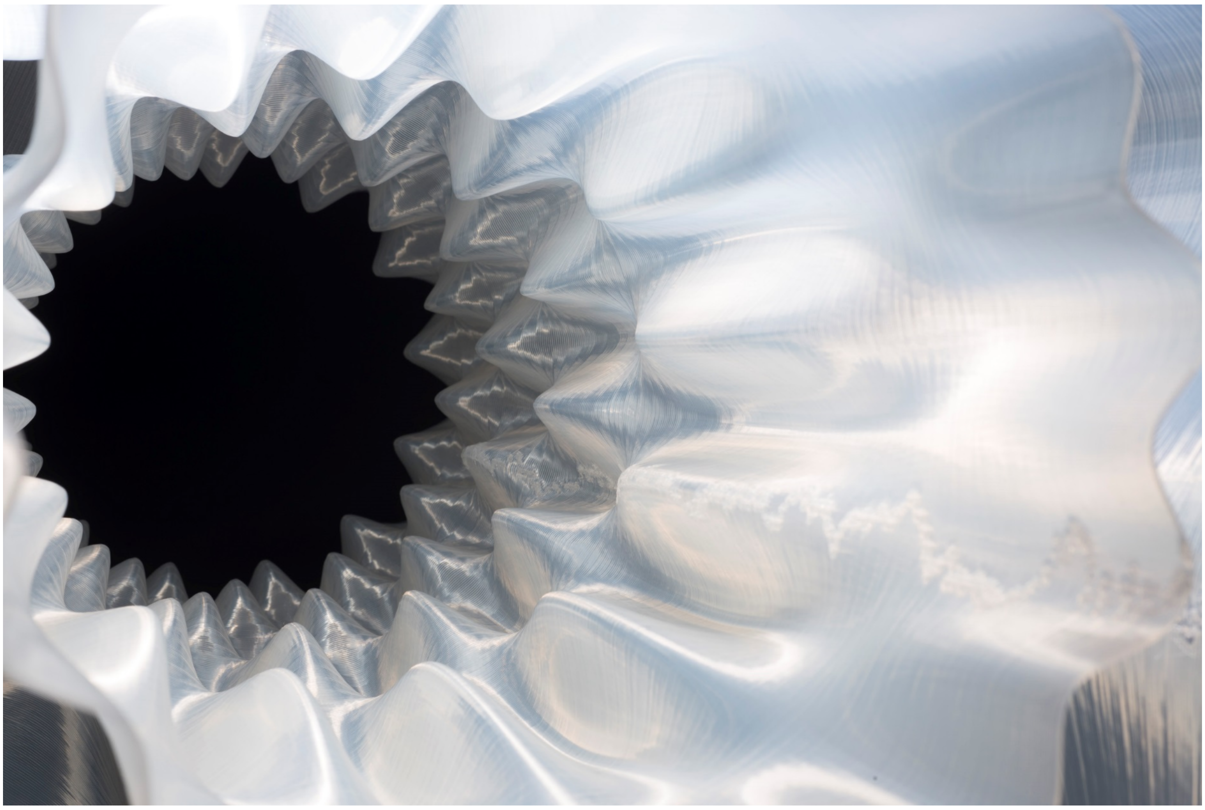

Figure 11. spatial qualities at a large scale and towards product

Figures 12 & 13. Post printing treatment of the artefacts by staining and surfacing.

Conclusion

The style machine presents an example of a “collaborative-generative” system. By taking a wider view of generative systems than the artist - computer paradigm we can begin to build a complex feedback network of software, hardware, and human collaborators. With the right conditions this system can not only generate and evolve complex and attractive objects, but also function as a means of communication of experiential knowledge between artists and designers with different views and experience. Further experiments in generative collaboration are warranted, it would be interesting to see what emergent properties come of a system with other diverse collaborators (in the form of humans, software, and hardware).

References

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