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Programming the beautiful

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ABSTRACT

The term *generative art* is mostly reserved for practices in which artists construct systems containing various degrees of autonomy. This is designed to generate results that would otherwise be unlikely. In contrast, photography is understood as a situation wherein an agent, the photographer, uses a pre-existing system constructed by other agents with the sole purpose of yielding results that must always be predictable.

One strand of photography wherein such conceptions of the medium prove inadequate is generative photography. This unique exploration is characterized by three qualities: (1) Extensive use of self-constructed apparatuses for harnessing technologies explicitly dedicated to the creation of photographs; (2) Uncompromising insistence the seriality principle in producing photographs; and (3) The integration of chance or randomicity as an important creative factor.

This paper traces the history of generative photography from its origins in the near-forgotten philosophical movement of information aesthetics. It argues that generative photographs elucidate a concept of artistic constructivism onto which may be grafted the numerical programming of apparative art systems. Thus, generative photography, with its precision of production and concise visual expression, can be understood as the final phase of photography, or, through Max Bense's concept of 'programming the beautiful', as a precursor of generative computer art.

KEYWORDS

Algorithmic art; generative art; information aesthetics; generative photography; Gottfried Jäger

Algorithms and photography

Contemporary image-makers, like scientists, investigate the world using complex algorithms, routinely integrating advanced computer programmes into their creations. However, the more image-making processes become steeped in algorithms and programmes, the more it becomes clear that a theory capable of comprehending these processes is unavailable. Because of their ostensible arbitrariness, iterative character and high complexity, the platforms, environments and technologies used by artists become increasingly unintelligible from the point of view of art history. This unfavourable situation is exacerbated by the fact that many imaging processes nowadays do not yield artworks in any traditional sense, and rarely leave behind any material artefact. Consequently, such artistic endeavours tend to become resistant to visual analysis, as it reveals nothing about the instruments, tools and activities on which they are founded. Thus, the claim that will be made in this article is that an algorithmic-inspired philosophy of photography is sufficiently dynamic to support a speculative theory applicable not only to these works but to all art in the information age.

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Before getting into the core of the argument, however, we need to gaze directly at the emperor's proverbial new clothes and dare ask, *what is an algorithm*? Importantly, the term is phonetically derived from the name of ninth-century Persian mathematician Muhammad ibn Musa al-Khwarizmi. In other words, algorithms *predate* computers by over a millennium. An algorithm is a calculative solution to a problem. Further, it is a concise description of a finite set of actions leading to the solution to a problem, which itself need not be mathematical. It does not contain any information, language or signs, other than those necessary for that solution. Nowadays, algorithms are frequently discussed in contexts of computer science and artificial intelligence; however, algorithms do not require computers any more than geometry does.

Algorithms, we might say, are means of making a situation explicit, of making it utterly clear and unambiguous. Nevertheless, this is something we have a hard time accepting, or even grasping in the context of art. The theory of photography testifies to this. However, are not *all* mathematical models for making and evaluating works of art precisely about reduction to an absolute form of determination? Is this not the case with our unified conceptions of space as measurable and calculable, wherein every point is identical to every other? Why is it that the logically ordered picture of the world called linear perspective, perpetuated since the Italian Renaissance, does not usurp the open interpretation that art theory traditionally consecrates?[1] This, I argue, is because total determination and absolute unambiguity *do not* amount to restriction or limitation, just as interpretation does not always allow contradiction or debate. A philosophy of photography as *algorithmic* and *programmatic* reveals the exact opposite. There is great virtue in strict forms of instruction: they provide the ability to know less in order to do more, and reliably at that. This, argues philosopher Patrick Maynard, is *the* purpose for which photography has been invented (Maynard 1997, 127).

To this end, the following theory stems from the conviction that the greatest contribution of photography to art had little to do with depiction, representation, or even with imagery.[2] [3] Rather, it will be postulated, it had everything to do with *how* those goals and others were achieved. Quite simply, 'the nature of photography', the subject of much controversy and debate in the nineteenth and twentieth centuries, is decisively algorithmic. Three observations may be adduced in support of this construal. First, strict conceptual, procedural and technical circumstances needed to emerge in order to yield the expertise required to 'discover' photography (Snyder 1982, 111–112). This, arguably, is *the* most interesting story in the history of photography.

Think for example about the intricate stepwise experiments conducted for devising the best course of action in concocting photochemical solutions (Schaaf 1992). These were hesitant yet trailblazing attempts to determine optimal operativity by way of algorithmic measures. Of course, they remained attempts so long as they depended on unstable chemistry and so, for the most part, were algorithmic only in potential. However, consider Eadweard Muybridge's motion studies or those of Étienne-Jules Marey. The structures of movement they revealed were enabled exclusively by instating clear, unambiguous and *finite* protocols of action, which by that time had become possible. The same may be said of Peter Henry Emerson's detailed sets of instructions outlined in his naturalistic photography publications (such as his insistence on differential focusing) (Emerson 1973; Fuldner 2017). These were sets of instructions for a sequence of procedures designed to achieve a specified *desired* result.

Second, the history of photography is one of learning how to methodically apply this expertise and subsequently develop it. Gustave Le Grey, for example, is well known for having trained several other French artists-turned-photographers, some of whom have famously participated in the Mission Héliographique.[4] It

is less known that the distinctive ephemeral quality of many photographs from the mission is due to Le Grey's improvements in the paper negative process. Le Grey has also developed a less-than-fully functional collodion process in addition to inventing combination printing: the technique of using several standard but differing exposures to depict a scene comprised of too wide a luminance range (for example, a seascape). This technique is nowadays called high-dynamic-range photography and is embedded in most high-end mobile phone cameras.

A pinnacle within this trajectory towards algorithmic thinking is undoubtedly Ansel Adams and his Zone System. This course of action, today mostly ghettoized, underappreciated and well nigh forgotten, requires that at the film exposure stage, accurate measurements and calculations be made to anticipate what future discrete actions would be required in the darkroom (Adams and Baker 1983a, 1983b, 1983c). This brings us to another crucial point. Algorithms, argues mathematician and computer art pioneer Frieder Nake, are 'finite descriptions of *infinite* steps' (Nake 2010, 57, emphasis mine). Adams' process required a sequence of precise stages and in return, guaranteed that the particularities of a pre-visualized photographic image could thereby be realized. In other words, by instantiating or allowing for only finite descriptions, all dynamic processes can become operational. When this happens to processes, they also become reiterable and hypothetically infinite.

Third and perhaps most importantly, the intricacies of this technological expertise are embedded in every aspect of the photographic apparatus—in its mode of production and distribution, and in every amateur or professional manifestation thereof. Few other media have demonstrated such continued voluntary self-structuring through technical and technological tropes. Take for example the strict regulation called an 18% grey card, which corresponds to an agreeably pleasant tone of grey, or the Kodak colour data guides and the sensitometric equations that determine how certain types of human skin tones should appear on certain types of film. The fact that there is always but one proportion per photographic apparatus is in itself a radical form of algorithmic image disciplining. In photography, I assert, there can never be a non-algorithmic form of image synthesis.

Information and aesthetics

Formerly, tones, colours and composition were regarded as the raw materials of the artefact; today, they are more often considered information carriers. This transition from previously irreducible aesthetic qualities to quantifiable and thus computable components was enabled by Claude Shannon's mathematical theory of communication (Shannon 1948). Significantly, this theory analyses just about any instance of information exchange in quantitative terms, wherein the more unexpected the contents of a message are, the more informative it becomes and vice versa. Importantly, the theory ignores all unquantifiable aspects involved in communication. It thus cannot but disregard the semantic value of messages, therefore treating information as a raw, dimensionless quantity; or, to put it differently, as a mere placeholder. In other words, for Shannon's theory it matters not if a photograph features a mailman or a penguin walking down a suburban street; all that matters is the likelihood that it would feature this or that creature (Flusser 1986, 330). The theory thus fundamentally delimits communication at the syntactic level alone, where it is concerned exclusively with the transmission of information and not with information *itself*. Accordingly, it is highly effective in contexts where semantic value is not a priority—for example, in electronic communications or computations—but its applicability diminishes greatly under most circumstances where meaning is central to the analysis, such as in aesthetic practices.

One of the most courageous attempts to apply Shannon's quantitative definition of information to the analysis of aesthetic artefacts is the short-lived theory of information aesthetics (Bense 1965; Moles 1966). Intended to apply to all aesthetic objects, it has never specifically mentioned photography, nor has any attempt, academic or other, ever been made to link it explicitly to photography—as attempted below. The narrative that will unfold in the following pages is that one unlikely strand of photography called concrete or generative photography provides proof that art forms can transform, and indeed that many *have* been transformed into information aesthetic logical modes of operation previously thought impossible within the context of aesthetic production. Put differently, the claim is that much like photography, other arts have the potential of becoming information-technical in one form or another.

The movement of information aesthetics, or rather the sentiments from which it emerged, existed in two centres, both in Europe. To date, it remains mostly unknown outside continental Europe. One centre was at the University of Strasbourg, whose leading figure was Abraham A. Moles. The second and more influential centre was at the University of Stuttgart, whose well-known head was Max Bense. Moles was more interested in sequences in time as exemplified in music and language, and Bense in arrangements of signs in space, as exemplified in images and text. Common to both was the expectation that measures of *aesthetic information* could be found, which would allow a rational and objective theory of aesthetics to emerge. To do so, the daring idea was to use the Shannon's concept of statistical information as the mathematical basis of an objective measure of aesthetics. Information aesthetics could thus become a system to allow one to measure the amount as well as the quality of information in aesthetic objects, thus enabling a wider evaluation thereof.

Bense's early aesthetic thinking started with a Hegelian view, wherein art was a teleological epistemic process. Subsequently, his interests shifted to Charles Sanders Peirce's pragmatic semiotics, which viewed logic as a function of signs and symbols (Pierce 1931–1936, 1958). By understanding aesthetic objects as signs, Bense linked semiotics to Shannon's purely technical information theory, where he adapted the concepts of linguistic signs to the problem of signal loss in technological communication. As a link between the technical and the human notions of communication, Bense built on Norbert Wiener's cybernetics (Wiener 1948). Following Wiener's theory of feedback, whereby some proportion of the output signal of a system was fed back into the input, Bense devised a model for theorizing how the processes of artistic production, consumption and criticism could be procedurally related in terms that suggest computation. In this theoretical frame, the aim was to create a rational aesthetics free of subjective speculation and grounded in a purely mind-independent base.[5]

In locating the aesthetic value of objects within a framework of semiotics, Bense could also argue that on the whole, art demonstrated an 'inversion' of the second law of thermodynamics—the physical process of entropy, or the universe's unremitting tendency towards disorder. Art, contrarily, seeks order, not chaos, and the relationship between chaos (or complexity) and order is what defines the aesthetic value of artefacts. Order is a state of circumstances; it is a property that is both definable and identifiable in relations between entities. Artificial objects can thus be said to have properties that correspond to a privileged state of 'co-reality'. In the case of aesthetic objects, co-reality is determined by macro-aesthetic rules that can be interpreted as *executed algorithms*, whose 'result' can be seen to represent a condition of or at least a process towards negative entropy or negentropy.

Information aesthetics relies on three fundamental assumptions. First, that there are general

and objective features that characterize an object as *aesthetic*. A feature is *general* if it can be detected in all objects irrespective of their particularities. A feature is *objective* if it does not change when another observer judges it. Information aesthetics regards objects as material carriers of aesthetic states, and such states as independent of subjective observations. Second, it assumes that a particular kind of information is conveyed by the aesthetic state of the object or process: this information is called 'aesthetic information' insofar as it is contingent with the physical reality of the object, which it transcends.

The third and final assumption is borrowed from mathematician George David Birkhoff. In the 1930s, Birkhoff studied artefacts such as planar polygons or rotationally symmetric vases for their aesthetic merits (Birkhoff 1932). His general approach to defining an objective aesthetic measure was to take the degree of order relative to the degree of complexity in an object. If a class of objects was given, the task therefore consisted of defining order (O) and complexity (C) as numeric quantities. The aesthetic measure (M), according to Birkhoff, was then given by the formula $M = O/C$. Importantly, this formal definition does not preclude that such mind-independent negentropic or aesthetic clusters be generated *intentionally* from a host of pre-programmed possibilities.[6] All that is necessary is that two conditions be met: specific desire and sufficient speed. First, one must know which available combination of information one wants to produce, because even if all combinations are foreseeable in principle, only some are desired. The more probable ones are most often the less desired. It is the improbable combinations, the informative ones, that are usually desired, but these usually occur by blind chance and only after a lengthy run of the machine or the programme—involving numerous iterations. Second, the calculation, if this is how we now define image-making, should be artificially accelerated to ensure that desired combinations are achievable within a finite time span. This, then, we could say, is intentionality in art according to information aesthetics: to build an artistic apparatus that speeds up chance events and programme it to stop when a desirable aesthetic coincidence has occurred.

In this context, the treatment of artistic intuition becomes highly complicated. The creative aspect is reduced to a creative selection process; and the process of aesthetic consumption is reduced to the critical selection of values. Both selection processes are part of the model of the aesthetic process itself. The creative selection offers an object based on judgment, while the critical selection offers a judgment based on an object. What this can be taken to mean is that 'art-making' no longer needs to adhere to a traditional dictum of trial and error. Instead, information aesthetics proposes that art-making be understood as an experimental *scientific* situation that is not only verbally describable but also notatable, and hence always repeatable, at least potentially if not in practice.

Arguably, such a conception could henceforth imply that it is possible to find the most efficient 'imaging algorithms', which could then be used as 'universal picture generators'. All that such a generative form of aesthetics would need to become 'universal' and fully functional is a well-defined set of at least one of the following elements: (1) a repertoire; (2) a procedure for selecting elements of the repertoire; (3) a procedure for distributing the elements in aesthetic space; and (4) a procedure to fix the results in a medium comprehensible by human minds. Does photography meet these criteria? If it does, can we then revise Patrick Maynard's definition of photography? Instead of 'the engine of visualization', ought we not say 'the program of visualization'?[7]

Generative photography

The term generative art is usually reserved for practices wherein an artist constructs a system that when set in motion, contains some degree

of artist autonomy or independence. This contributes and is in fact designed to generate results that would otherwise be unlikely (Boden and Edmonds 2009; McCormack et al. 2014). Photography, contrary to this definition, is usually understood as a situation wherein a human agent, the photographer, uses a pre-existing system constructed by another agent with the main, and sometime exclusive, purpose of yielding results that would always be predictable, given no external interference.

Running directly counter to mainstream conceptions of the medium is the current called concrete or *generative photography*. These terms do not refer to an easily recognizable artistic movement or artistic group. Rather, they refer to what may best be described as a shared sentiment, identifiable in several scattered, isolated and largely unconnected artistic experiments. Most of them took place in post-war Germany. For lack of a better definition, they may be taken to refer to photographic explorations characterized by three qualities. The first is the extensive use of apparatuses and technologies explicitly dedicated to the creation of photographs, often involving hand-crafted devices with a specific aesthetic orientation. The second is an uncompromising insistence on a principle of seriality in making photographs. And the third is the utilization of chance as an important creative factor.

Gottfried Jäger, probably the most salient voice of this strand of photography, states that 'Concrete photographs exclusively use the most elementary, innate means of the discipline … Its works are self-reflexive, self-referential, auto-dynamic and universal' (Jäger, Krauss, and Reese 2005, 15). A fine example of this insight is undoubtedly his own artistic trajectory and particularly his 1967 series *Lochblendenstrukturen* (*Pinhole Structures*). These works are performed with a multi-pinhole camera obscura that he describes as an 'apparative system to design geometric patterns', after a programmed and traceable generative image-grammar has become available (Jäger 1989). Importantly, these works are also subtitled programmes. It is not only that this proclaims the works' aesthetic specificity, since they are endowed with properties of seriality and genesis from chance procedures. It also, I cannot help thinking, eventually tethers specificity, seriality and chance to the pictorial surface of the works in a prophetic way, anticipating that their sub-titles, and with them these qualities, will one day become part of what we call meta-data and, in that sense, part of the image (Figures 1 and 2).[8]

Jäger further describes works performed within these parameters as 'pure photography: not abstractions of the real world, but rather concretions of the pictorial *possibilities* contained within photography' (Jäger, Krauss, and Reese 2005, 15). Lest we forget that pictorial possibilities in photography are traditionally thought to exist 'out there in the world' and rarely anywhere 'within' it.[9] Therefore, this statement strongly resonates with Vilém Flusser's programmatic philosophy and the latter's insistence that photographic 'envisioners' only 'visualize' (Flusser 2000, 2011b). Envisioners do not, perhaps need not, depict. By expressing itself through a self-proclaimed pure, photo-immanent, photographically conceived structure and syntax, concrete photography suggests itself as a project of formal aesthetics performed with and through photography. It is, put differently, not a style of photographs but rather a *method* for creating them. By extension, we could also say that generative photography is a rhetorical experiment demonstrating that photography, taken in the main, is not only a style of image, but rather a method for creating images. Further, while the style may be visual, the method is not.

Importantly, this autonomous, auto-dynamic, self-referential and self-reflexive expression of photography is implemented by incorporating rigid rules into the photographic system, which in itself is designed to generate not singular but rather chains of images. Once conceived, or 'programmed', such a system

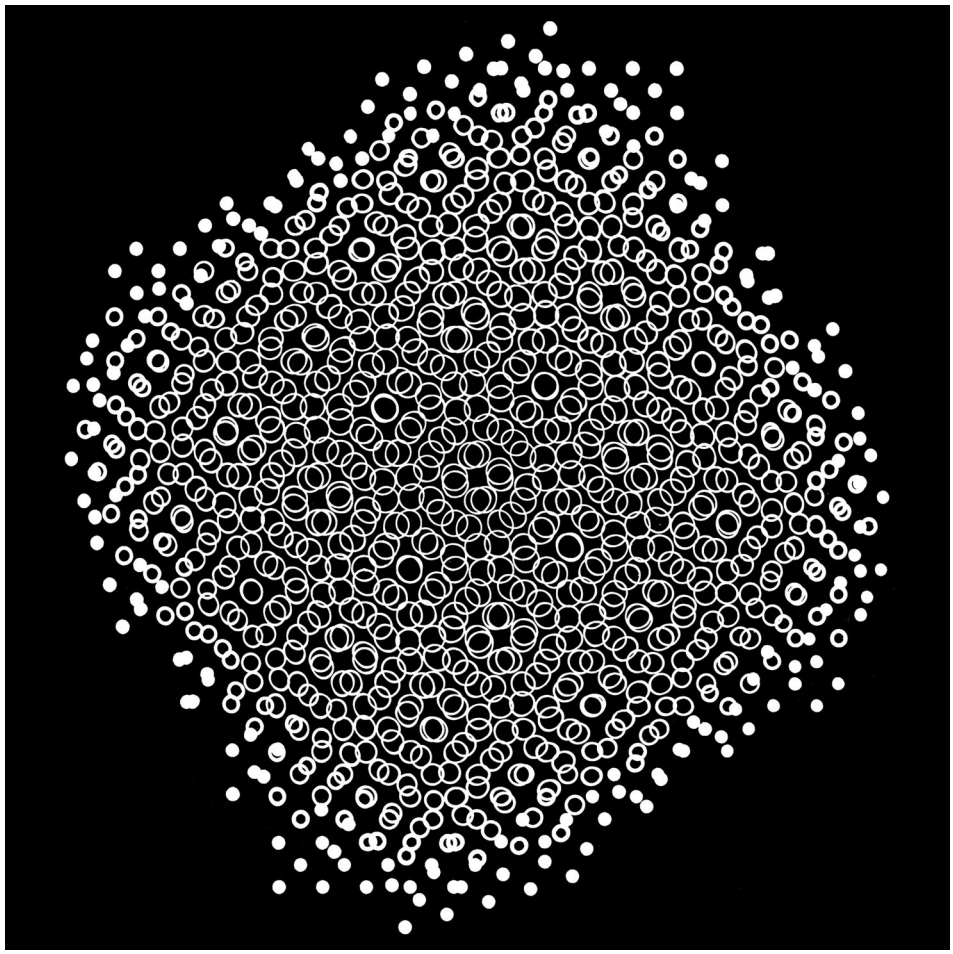

Figure 1. Gottfried Jäger, *Lochblendenstruktur 3.8.14 D 3.5*, 1967.

executes what has been 'entered into it' and delivers a theoretically infinite number of results. Generative photography therefore seems to suggest that we ought to distinguish between aesthetic conception and technical realization in photography. This raises the possibility that artists, to the extent that photography is taken as art, need not always be obliged to choose from a series of single 'shots' the one that best captures their original aesthetic concept. Rather, in the spirit of scientific exploration, they could ultimately choose to pronounce the entire series as the aesthetic product of the experimentation.

As noted above, the theoretical basis for understanding photography as a rudimentary, generative aesthetic programme is information aesthetics. In contrast, most of photography's historians and theoreticians have tended to tone down and mitigate the often-intimidating idea that the discipline's most important property is enduring engagement with technology. Because of this self-deceit, it has too often been deemed necessary to express the expectation that photography's locus of artistic intent should reside in a motivation to declare technology as conceptual, as if this is not anyway so, or to designate the partnership with technology as provisional, as if this is ever possible. This is why photography theory has always tended to favour fixed results rather than potentialities,

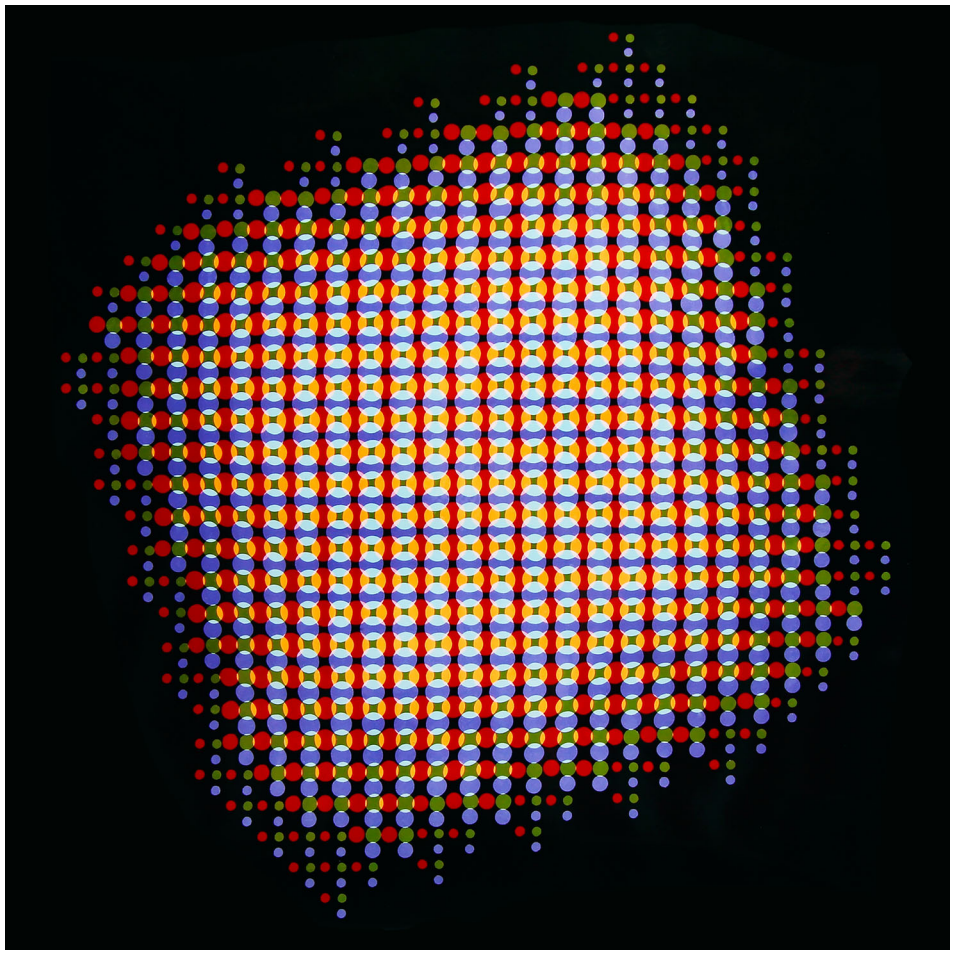

Figure 2. Gottfried Jäger, *Lochblendenstruktur 3.8.14 C 2.5*, 1967.

because they are easier to measure against the benchmarks of traditional art history. Visual representation, it seems, is simply easier for our minds to comprehend than the abstract idea of representation in concept or in potential, which the idea of technology as designated art seems to suggest.

By way of contrast, what generative and concrete photography make clear with their almost spiteful insistence on rigid technical and technological processes as vessels of creative expression is that it is simply futile to ever separate the terms 'generative' and 'photography'. Photography, we should say, should always be generative if it is to avoid complete redundancy. This is what an undistorted history-of-photography-as-artistic-technology should be about. In fact, Flusser's programmatic philosophy (Flusser 2011a)—coupled with Bense's concept of 'programming the beautiful' (Bense 1960), nowadays enabled by previously unavailable technologies—suggests that generative photography, with its concise visual language, be seen as the final phase of photography as it enters the digital age. Seen this way, generative photographs elucidate a concept of artistic constructivism onto which can be grafted the numerical programming of apparative art systems (Franke and Jäger 1973).

Conclusion

Writing a theory of art is always risky business. With regard to photography as to algorithmic art, there is simply too much going on for only one narrative. Moreover, a theory of photography *as algorithmic art* also becomes a meta-question of how to present overwhelming conceptual complexity when evidence cannot be displayed on the page. How can one textualize technologies that abstract the very idea of text and arguably make it redundant? Accordingly, instead of hoping for an overarching narrative of algorithmic abstraction it is perhaps more fruitful to think in terms of multiple narratives of pioneering endeavours, experiments, practices and hybridizations. As I hope to have shown, one of them, the narrative of generative photography, can serve us well as a blueprint for today's media art ecology.

Generative photography underscores a problem that has thus far remained latent and now requires acknowledgement, if only as a precursor of future theories. The problem is this: given that every aesthetic message is generated with, in or through apparatuses, and that not only aesthetics can be prescribed in algorithms but also creativity relegated to computer programmes, it seems that there is no more place for human intention. When new information is in a certain sense epistemologically obsolete there is no longer a pressing need to generate new information: 'Not only are authors no longer necessary' declared Flusser, 'they are not even possible' (Flusser 2011b, 99). Is this true?

Conversely, for photography to be 'creative', in order for its algorithmic activity to be considered 'art', it must be something else entirely. What could that be? Nake seems to suggest that it would have to be the programmatic *invention* of a new apparatus:

> No computer operates without software. The artist may use software in her creative process. Either she has acquired it from somewhere or she has developed it herself. If she hasn't and is only using packaged software, her work may still please people. It may be sold by a gallery. Critics may react enthusiastically. But the state of such work is that of the digital Sunday painter's work. It will not attain the realm of acknowledged art. (Nake 2014, 108)

Must every photographer therefore be an Étienne-Jules Marey, a Harold 'Doc' Edgerton or an Erol Morris (credited with having invented chronophotography, the rapatronic camera and the Interrotron, respectively)? Probably not. Most camera operators will undoubtedly settle for the term 'photographer', which, to reiterate, is not all that different from 'computer'.[10] However, the select creative endeavourers which have been able to shift and expand the theoretical boundaries of photography have always been photo-programmers, photographic-makers or, as Flusser calls them, 'envisioners': algorist image-makers seeking to reinvent the parameters, the programme and the prospects of their apparatus.

Notes

1. Traditional histories of photography usually open with a long chapter on perspective. But perspective is also a principal form of algorithmic structuring. An argument in this vein has been made by Lev Manovich. Following this line of thinking, I would argue that photography is a more extreme (and efficient) algorithm than perspective because it does much more than reduce a 3d space to a 2d surface (Manovich 1994).
2. While the theory of photography played a central role in defining various phases of modernity, and has been pivotal in transitioning between them (from classical to late to postmodernity). its salient feature is an never diminishing belief in representation by way of image depiction (Barthes 1977; Bazin 1960; Talbot 1839).
3. I have elsewhere referred to this as the Turin Shroud model of photography (Toister 2020).
4. In 1851, the Commission des Monuments Historiques, an agency of the French government, selected five photographers to make photographic surveys of the nation's architectural patrimony. These 'Missions Héliographiques',

as they were called, were intended to help the commission determine the nature and urgency of the preservation and restoration of work required at historic sites throughout France.

5. Arguably, Bense's desire to create a mind-independent aesthetic was underpinned by the catastrophic outcomes of nazism. Information aesthetics, Bense hoped, would never render themselves useful or even relevant to political sentiment in the same way that 'emotion-based' aesthetics always could (Nake 2015–2019).
6. Sean Cubitt makes the point that 'the negentropic instinct for order' is, in fact, an instinct for life (Cubitt 2014, 3).
7. I am intentionally paraphrasing Pierce's famous statement: 'All my notions are too narrow. Instead of sign ought I not to say medium?' (Pierce 1906).
8. In a later publication Jäger in fact declared that 'their' (concrete photographs) 'self-reference is their own programme' (Holsing and Jäger 2015, 15).
9. This is how Victor Burgin phrased it:

> It seems to be extensively believed by photographers that meanings are to be found in the world much in the same way that rabbits are found on downs, and that all that is required is the talent to spot them and the skill to shoot them. (Burgin 1982, 40)

10. In this original article in which the 'machine' is 'invented', Alan Turing in fact imagines a living person (whom he calls 'the computer') who executes these deterministic mechanical rules slavishly (Turing 1936).

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