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Deriving Sense: Cognitive Aspects of Artefactual Creativity

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This paper explores the cognitive aspects of artefactual creativity in new media art. Starting with a concept of combinatorial inventiveness which is central to artefactual creativity, we outline its manifestations in the arts and culture, leading to contemporary applications of the emerging technologies for transforming the existing ideas, relations and data into new artworks. In view of the diverse art production in this domain, we focus on generative methodologies, and discuss the poetic features of the exemplar art projects created primarily by processing the material from cinema, television and the Internet. These artworks blend procedural thinking with bricolage, leverage complex technical infrastructures, foster curiosity and encourage vigilance in our critical appreciation of the arts, technology, culture, society, and human nature. In closing of each section, we outline the theoretical considerations that can be abstracted from the examples, and elaborate on them in the concluding section in which we examine the artists' motives and circumstances of analogizing, generating ideas and meaning making in relation with the cognitive implications of artefactual creativity.

1. Introduction

1.1. Combinatorial Inventiveness

Combinatorial inventiveness is essential in all manifestations of human creativity, from language, social and political relations, to the arts, science and technology (Boden 2004). In language and in the arts, it emerges from the cognitive processes for generating ideas, such as connecting the existing and the new, comparing the known and the unknown, and analogy-making (Hofstadter and Sander 2013). Combinatorial inventiveness in the arts and culture manifests in a range of creative procedures such as mashup, remix, pastiche, interpretation, free copy, allusion, citation, derivation, détournement, reprise, reference, reminiscence, homage, parody, imitation, forgery and plagiarism (Grba 2010, Boon 2013). With continuous recurrence of themes, motifs, forms and techniques, these procedures are among the key expressive and developmental factors in the arts throughout history. As an important part of art experience, combinatorial inventiveness induces pleasure through the recognition of source materials and models, and their interrelation with new poetic elements. It usually raises public attention in instances when a new artwork which references some copyrighted, commercially and/or otherwise prominent artefact becomes itself prominent, inciting the conflict over the 'creative interest' between two or more parties (Ferguson 2011). The obvious or implied creative use of cultural artefacts has been legitimized in different ways throughout the 20th century art—from Cubism and Dada, through Pop-Art, Fluxus and Conceptual Art, to Postmodernism in which it became a genre in itself—and today exists in many strategies and flavors. Within the context of contemporary culture, Lawrence Lessig extensively addressed various aspects of using digital technologies to transform the preexisting materials in creating the new artwork, and discussed the conceptual, legal, political, economic and social issues and consequences of combinatorial inventiveness, copyright and intellectual property (Lessig 2001, 2008).

1.2. Generative Art

In new media art, combinatorial inventiveness manifests through diverse applications of the emerging technologies for transforming the existing ideas, processes and data, and for exploring the expressive potentials of computational processing of all cultural phenomena that can be digitized. It is central in generative art, which we define as a heterogeneous realm of artistic practices based upon interfacing the predefined systems with different factors of unpredictability in conceptualizing, producing and/or presenting the artwork, thus underlining the uncontrollability of the creative process, and aestheticizing the contextual nature of art.[1] Like all other human endeavors, the arts take place in a probabilistic universe and always emerge from an interplay between control and accident, so in that

1. For other definitions of generative art in contemporary theoretical discourse, which vary by scope and/or inclusiveness, see Grba 2015: 201.

sense all the arts are generative. However, the awareness of the impossibility to absolutely control the creative process, its outcomes, perception, reception, interpretation and further use—which is often not the artists' principal motivation—becomes crucial in generative art (Dorin et al. 2012). Generative art appreciates the artwork as a dynamic catalyzing event or process, inspired by curiosity, susceptible to chance and open for change (Grba 2015). In its broad spectrum of creative endeavors, generative new media art frequently entails bricolage.

1.3. Bricolage

Bricolage is an analogizing approach that combines the affinity and the skills for working with tools, materials and artefacts available from the immediate surroundings. Reflecting the necessity-driven pragmatism of Italian neorealist filmmakers in the 1940's and 1950's (Giovacchini and Sklar 2013), bricolage became popular with arte povera movement during the 1960's as a critical reaction to the commodification of the arts. Since then, it has been adopted and explored in various disciplines including philosophy, anthropology, sociology, business, literature and architecture, and it has become almost transparent in a wide range of artistic disciplines. Discussing the concept of bricolage in *The Savage Mind* (1962), Claude Lévi Strauss noted that a bricoleur accumulates and modifies her handy means (operators) without subjecting them to a predefined objective, but the objective gets shaped by the interactions between operators (Mambrol 2016) in a dynamic process of analogy-making and discovery. Bricolage is therefore integral to new media art projects which constantly push the envelope of methodology, production and presentation through playful but not necessarily preordained experimentation with ideas, tools, and cultural resources.

2. Culture as Database

In our massive cultural production and consumption, various phenomenological aspects of everyday life can be quantized and approached as datasets. New media artists combine statistical tools with computation techniques to accumulate, categorize, process, transform and interact these datasets into new works that help us discover and compare the analogies, trends, regularities and trivialities in mass-produced culture. Adding an ironic twist to Jean-Luc Goddard's encyclopedic approach to cinema and modern culture epitomized in *Histoire(s) du cinema* (1989-1998), these artists turn the primary database operation of sorting into a conceptual device in order to explore supercut[2] as a generative mixer of cinematic and cultural tropes since the 1990's. By focusing on the specific elements (words, phrases, scene blockings, visual compositions, shot dynamics, etc.), supercuts accentuate the repetitiveness of narrative forms, routines and clichés in film, television and other media.

2. Supercut is an edited set of short video or film sequences selected and extracted from their sources by at least one recognizable criterion. It inherited the looped editing style from Structural film in the US during the 1960's and developed into the Structural/Materialist film in the UK in the 1970's (McCormack 2011).

For example, Matthias Müller's *Home Stories* (1990) is a collage of different scenes and protagonists from Hollywood melodramas of the 1950's and 1960's, edited into a series of recurring motifs of cinematic suspense such as uneasy sleep, getting up, listening at the door, turning on the lights, being startled, etc. In Jennifer and Kevin McCoy's installation *Every Shot, Every Episode* (2001) a strict application of sorting algorithm rearranges the complete television serial *Starsky and Hutch* into a collection of shots organized according to 278 formal and thematic criteria: every zoom in/out, every architecture, every disguise, every female police officer, etc. Shots in each category are sequentially arranged on DVDs that the visitors can play freely on several parallel displays (McCoy 2020).

Taking slightly broader selection criteria, supercut morphs into a condensed micro-narrative in the works such as Cristian Marclay's *Telephones* (1995) and *The Clock* (2010), Tracey Moffatt's *Lip* (1999), *Artist* (2000), *Love* (2003 with Gary Hillberg) and *Doomed* (2007 with Gary Hillberg), or Marco Brambilla's *Sync* (2005). These self-referential structures follow the thematic and formal logic, and accentuate the three essential components of screen culture: gaze, sex and violence. Exploring the possibilities for reproducing film imagery, Virgil Widrich elaborated the supercut micro-narrative in *Fast Film* (2003). It was assembled by making paper prints of the frames from selected movie sequences, which were then reshaped, warped and torn into new animated compositions. In 14 minutes, *Fast Film* provides an engaging critical condensation of the key cinematic tropes such as romance, abduction, chase, fight, escape, deliverance, etc. (Widrich 2003).

With the explosion of online video sharing since 2005, supercut became a popular Internet genre but has remained a strong artistic device. Kelly Mark's post-conceptual installations *REM* (2007) and *Horroridor* (2008) spiced it up with existential overtones through daily manual aggregation and filtering of television broadcasts (Mark 2020). In several manually aggregated projects such as *Timeline* (2010) and *Watching Night of the Living Dead* (2018), Dave Dyment expanded micro-narrative supercut into a full feature format which yields generative wonder out of the pop-cultural proliferation. To make *Watching...*, he collected the scenes from hundreds of movies and TV shows in which people are watching George Romero's film *Night of the Living Dead* (1968), curated and arranged them along the editing track of the original to reconstruct the complete zombie classic as the *mise-en-scène* of other films and TV programs (Hosein 2018).

Supercut became interactive and automatic in Julian Palacz's installations *Algorithmic Search for Love* (2010) and *Play it, Sam* (2012). Referring to McCoy's poetic of sorting, *Algorithmic Search for Love* invites the visitors for a playful discovery by entering a search phrase that generates a sequence of all video snippets with matching spoken phrases found in the project's library of films. In *Play it, Sam*, (Figure 1) the visitors can play a classical piano to trigger a projected sequence of snippets from feature films in which the corresponding piano keys were pressed (Palacz 2020).

Fig. 1. Julian Palacz, *Play it, Sam* (2012). Installation view.

With *Network Effect* (2015), Jonathan Harris and Greg Hochmuth routed the interactive supercut to the diversity and the anxiety of online cultures (Figure 2). They designed a web search interface in which the keyword selection returns a media stream from an online database of 10,000 video clips, 10,000 spoken sentences, news, tweets, charts, graphs, lists, and millions of data points. By limiting this overwhelming but addictive experience to between 6 and 10 minutes depending on the average life expectancy in the viewer's country, *Network Effect* confronts us with the reality of corporate online cultures that often frustrate any attempt at experiential completeness and induce the fear of missing out (Harris 2015).

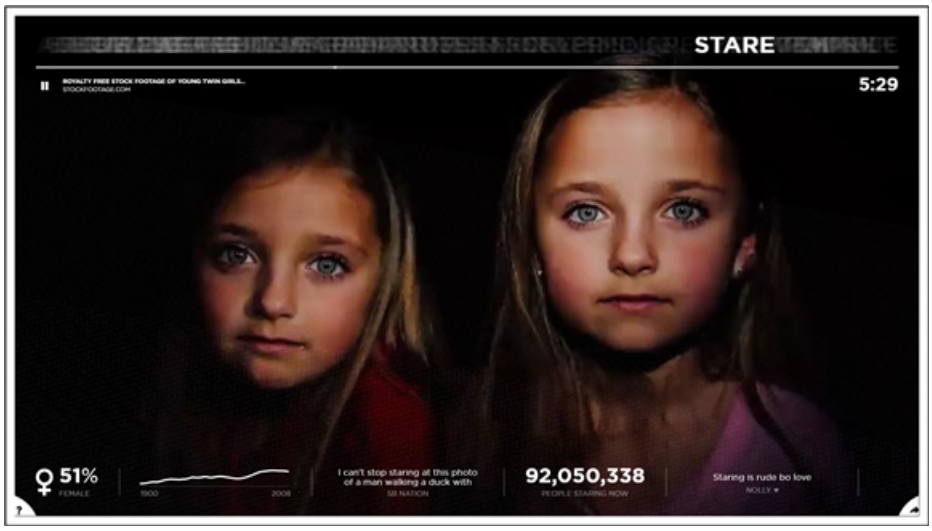

Fig. 2. Jonathan Harris and Greg Hochmuth, *Network Effect* (2015). Screenshot.

The poetics of automated supercut reached radical reduction and critical assessment with Sam Lavigne's open-source Python application *Videogrep* (2014) which generates video supercuts by searching the input query through subtitle files of an arbitrary collection of video files (Lavigne 2020).

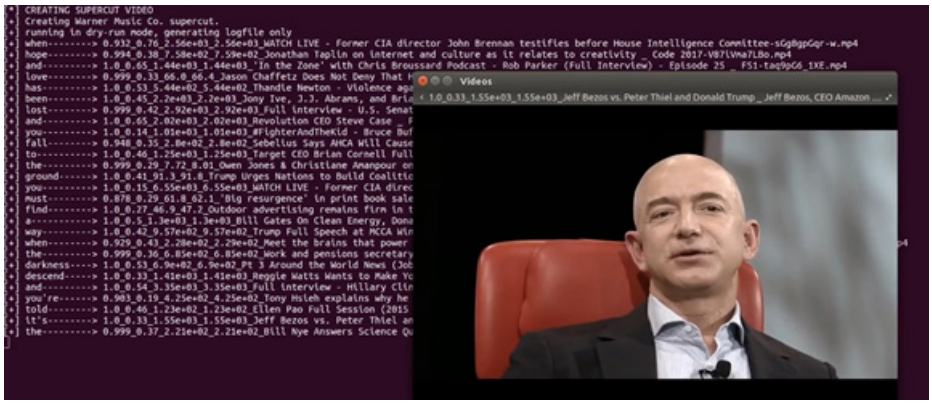

Fig. 3. Branger_Briz (Ramon Branger, Paul Briz, Nick Briz, Brannon Dorsey and Pedro Nel Ovalles), *Muse AI Supercut* (2017). Project case study screenshot.

Following this conceptual and technical logic leads to the machine learning (ML) systems that construct supercuts by searching the Internet (or large media datasets) for an arbitrarily selected artefact or a collection of artefacts. In *Muse AI Supercut* (2017) commission for the rock band Muse (Figure 3), digital agency Branger_Briz designed an ML system that generates daily supercut music videos in which every word of the Muse's song *Dig Down* (2017) is voiced by a different notable person from the videos found online (Branger_Briz 2017).

The innovative approaches to searching and editing the snippets of cultural production in these projects advance our understanding of animation, film, television, the Internet and other media, their experiential effects, social roles and consequences. They also demonstrate that there is no such thing as 'restricted creativity' but rather that creativity thrives on restrictions.

3. Sampling and Processing

Extending the logic of systematic selection, new media artists have been combining computational tools with statistical methods to explore the narrative and expressive potentials of automated accumulation, rearrangement and/or interpolation of cultural artefacts. Since the 1990's, Jason Salavon has been processing the various mass-media contents into refined visuals which define a peculiar aesthetic identity between infographics and abstract art. In *Every Playboy Centerfold 1988-1997* (1998), the artist merged all Playboy centerfolds from 1988 to 1997 into a single image using custom mean and median image averaging. In *100 Special Moments* (2004), he averaged the sets of one hundred conventionally themed stock photographs taken from the Internet: kids with Santa Claus, junior baseball league, the weddings and the graduations. In several video works such as *Everything, All at Once* (2001), *Everything, All at Once (Part II)* (2002) or *The Late-Night Triad* (2003), Salavon subjected the TV imagery to the radical abstraction through color averaging and slit-scanning (Salavon 2020).

Kurt Ralske elaborated the aesthetics of sequential frame sampling in a series of prints titled *Motion Extractions / Stasis Extractions* (2007-2009) in which he sequentially inter-dissolved the frames from various film classics[3] according to the degree of movement within each scene. *Stasis Extractions*

3. *Student of Prague* (1913), *Faust* (1927), *Citizen Kane* (1941), *The Seventh Seal* (1957), *Alphaville* (1965), *2001 Space Odyssey* (1968), etc.

comprises only the frames of static scenes, and *Motion Extractions* the frames with movement (Ralske 2007-2009). With *Cinemetrics* (2011), Frederic Brodbeck rounded up the infographic processing of the moving image into a Python application. It provides an interactive learning experience through the analysis of arbitrarily loaded films according to a number of criteria such as duration, average chromatic values, number of cuts, and sequence movement dynamics. It also allows comparison between the original version of a film vs. remakes, all films by the same director, films by different directors, by genre etc. (Brodbeck 2011). Multi-frame layering, averaging and/or collapsing in these works eliminate the details and reveal the formal and compositional trends in the source material, but also indicate some of the aesthetic preferences, as well as biases, in human visual perception.

However, perceptual biases such as apophenia and pareidolia[4] can be applied for analytical learning through extraction and rearrangement. For example, Benedikt Groß and Joey Lee's online project *Aerial Bold* (since 2016) utilizes the pareidolic effects to turn the alphabet shapes found in aerial imagery into a generative typeface (Figure 4). The project features a thorough documentation, a font catalog and an interactive word processor where the visitors can enter text and choose the font size, line spacing, different font classes, and locations (Groß, Lee et al. 2016). With cross-disciplinary development of crowdsourcing and machine learning techniques for deriving geodata from aerial imagery and enriching it semantically, this project also highlights the active role of artists and designers as data producers rather than passive data users.

4. Apophenia is a tendency to establish meaningful patterns within random data in general, while pareidolia is a tendency to recognize patterns within random visual data (nn 2014).

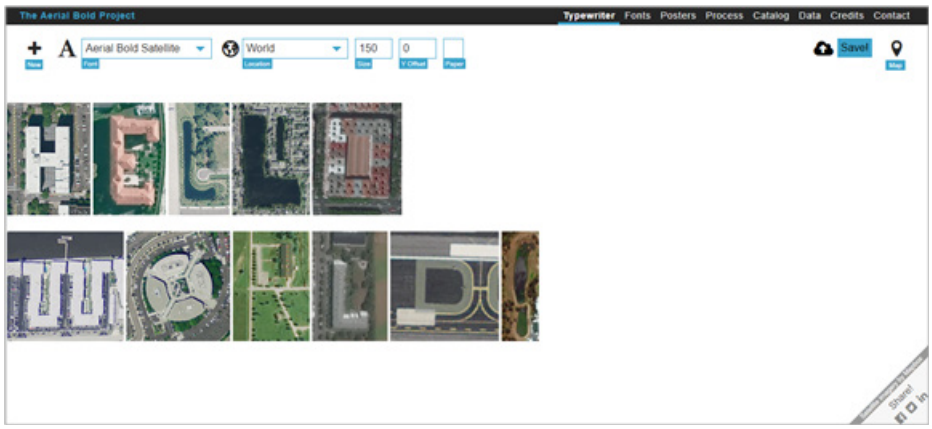

Fig. 4. Benedikt Groß and Joey Lee, *The Aerial Bold* (since 2016). Project website: typewriter.

The research in artificial intelligence (AI) has been providing various tools for the artists to interface and compare the human experiential learning with machine learning which relies on the large pools of accumulated samples. For example, Libby Heaney's *Euro(re)vision* (2019) is a moving image deep-fake in which two EU government leaders from 2019—Angela Merkel and Theresa May—sing absurd and nonsensical songs in a setting which mimics the Eurovision song contest (Figure 5) (Heaney 2019). Inspired by Dada and Cabaret Voltaire performances, this artwork uses two deep fake

models and three character-level recurrent neural network models to create new forms of algorithmic poetry which eerily encapsulates the nonsensicality of actual EU/Brexit discourse.

Fig. 5. Libby Heaney, *Euro(re)vision* (2019). Screenshot.

Ben Bogart's series *Watching and Dreaming* (since 2014) is an attempt in understanding the algorithmic depictions of popular cinema based on the visual and sonic percepts (Figure 6). In this series, various film classics are interpreted and represented through hundreds of thousands of percepts which consist of millions of image segments grouped by color and shape similarity, and serve as a visual vocabulary for the ML system to recognize, and eventually predict, the structure of the processed films (Bogart 2019).

Fig. 6. Ben Bogart, *Watching (2001: A Space Odyssey)*, 2019. Screenshot.

By abstracting or concretizing the spatial, temporal, visual and sonic qualities of their source materials, these statistically informed works open new perspectives for envisioning, assessing and appreciating cultural phenomena. By emulating the semantic, narrative and expressive capabilities of human-made cultural artefacts, these works also question the nature of creativity.

4. Society as Database

Not only cultural artefacts, but all social structures and relations relying on frequent exchange of information can be envisioned and treated as databases. Collection of the clients' personal data, behavioral tracking, prediction and manipulation of decision-making have long been the essential strategies of large-scale systems such as governments, industry, marketing, advertising, media, finance or insurance, which all rely on frequent

information exchange and processing. Computationally enhanced and virally exploiting the human need for socialization and communication, the new iterations of these old corporate strategies of quantization and statistical reductionism refresh our appreciation of privacy and our need for anonymity in a constant arms-race between the systems of control and the tools for individual advantage (Grba 2019). This is most evident in the interfaces of social media, whose design and functionality delineate their statistical logic, often by clumsily trying to hide it. Some new media artworks reveal this bizarre strategy in humorous and provocative ways. They emulate the models of corporate information services by virtually approaching the online participants as more or less complex datasets, but slightly repurpose their tools and objectives for the ironic revelatory effect.

Paolo Cirio and Alessandro Ludovico made several strong points in this context with their Hacking Monopolism Trilogy that began with *GWEI* and *Amazon Noir* (both 2006). For *Face to Facebook* (2010), the final project of the series, the artists created a bot which harvested one million Facebook profiles, filtered out 250,000 profile photos, tagged them by the facial expressions (relaxed, egocentric, smug, pleasant, etc.) and posted them as new profiles on a fictitious dating website called *Lovely Faces* (at http://www.lovely-faces.com) (Figure 7). *Lovely Faces* had been fully accessible and searchable for five days, during which the artists received several letters from Facebook's lawyers, eleven lawsuit warnings, and five death threats (Gleisner 2013).

Fig. 7. Paolo Cirio and Alessandro Ludovico, *Face to Facebook* (2010). Artists as Catalysts exhibition in Alhóndiga, Bilbao, Spain. Photo: Paolo Cirio.

For his project *A More Perfect Union* of the same year, Luke DuBois made a shrewd interpretation of the technical term 'relational database' to draw a socio-cultural outline of contemporary United States according to the preferred identities and intimate aspirations of its population. He designed a software which sampled 19 million user profiles posted on 21 US dating websites, and used the associated zip codes to geographically arrange the

most frequent keywords (blonde, cynical, funny, happy, open-minded, lonely, optimist, etc.) into 43 maps. In state and city maps, the artist replaced the names of cities, towns and streets with the most frequent keywords in dating profiles of local citizens. In federal maps, the brightness/saturation ratios of red and blue color show the relations between female and male preferences for the most frequent keywords in each state (DuBois 2011).

The uneasy positioning of the individual toward or within the online systems of control has been well analyzed by Alexander Galloway in his book *Protocol* (2004), and reverse engineered in a number of works by new media artists and activists such as Joana Moll (Moll 2017), Adam Harvey (Harvey 2017) and Vladan Joler. For example, Vladan Joler and SHARE Lab's project *Exploitation Forensics* (2017) (Figure 8) snapshots in a series of intricate diagrams the algorithmic logic and functionality of various layers in the Internet infrastructure: from the network topologies and the architecture of social media (Facebook) to the production, consumption and revenue generation complex on Amazon.com (nn 2017).

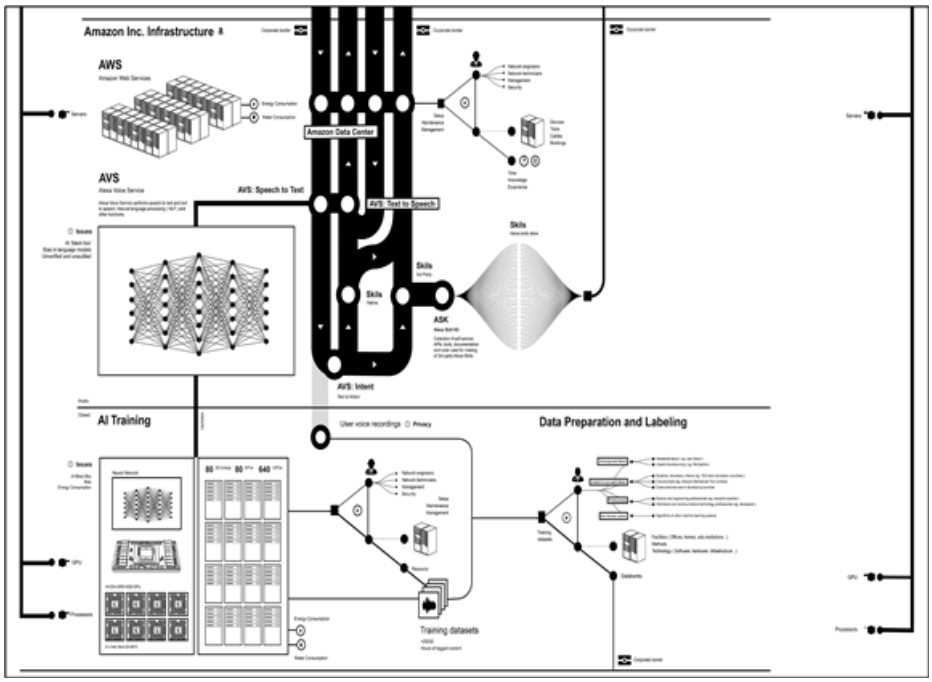

Fig. 8. Vladan Joler and Kate Crawford, *Exploitation Forensics: Anatomy of an AI System* (2017). Detail of the diagram.

These artworks skillfully criticize the digital implementations of governing mechanisms, point out their sophistication and pervasiveness, but also remind us that we are neither innocent nor completely sincere parties in this relationship. By adopting and using the profit-motivated digital platforms, our inertia, ignorance, selfishness and other fallacies (un)willingly support their functionality, build up their social authority and stir them to further exploit our participation explicitly (searches, clicks, selfies, stories, news), and implicitly (behavior patterns, intentions, desires, profiles). By extracting and representing the manifestations of our participatory-exploitative online strategies, these artworks also imply that only our fetishization of privacy

protects us from realizing that the stories *of* us (as told by the metadata and algorithmic systems logic) are often much more interesting and meaningful than the stories *we tell* about ourselves. As long as we avoid dealing with our narcissism and our delusions of self-importance, we will fall prey to the dishonest signaling, exploitative agendas, and socially constructed apparatuses with mundane interests (Todorović and Grba 2019).

5. Artefactual Creativity

The projects we discuss in this paper are a sample of the divergent artistic exploration which contributes to the recent expansion of the creative AI. Contemporary AI research centers around a biologically-inspired programming paradigm called 'neural network' which enables a computer system to refine and optimize the methods for solving a particular problem or set of problems by training on the observational data and by dynamically modifying its own code instead of being exclusively programmed (Nielsen 2019, Bishop 2017). Since 2011, the innovations in AI science, technology and art target the elusive high-level cognitive functionality (which often includes the manifestations of human intelligence in artistic creativity), and rely heavily on processing large training datasets of annotated texts, drawings, pictures, photographs, 3D models, sounds, music, videos, films, etc. (Mitchell 2019). Being designed on various models of brain functions, the artefactual basis of the creative AI reflects the fact that human learning and creativity also rely to a large degree on the existing models and examples. These technologies enhance the realm of *artefactual creativity* which we understand as the application of combinatorial inventiveness to the specific qualities, meanings, contexts and/or implications of existing artefacts in order to produce interesting new artefacts.

5.1. Cultural Convergence and Artists' Opportunism

Creative flows and trends in science, engineering and in the arts are shaped by cultural convergence – the perceived, unperceived and/or idiosyncratic mutual influences and crossbreeding between analogous modes of thinking that render similar ideas, sometimes in different domains. Although the discovery often rides on well-established conceptual models or recognizable narrative structures, this ride is nonlinear and frequently gets unpredictable directions with unexpected consequences. Bricolage is an epitome of this largely self-organizing and accidental 'social life' of creativity, pronounced by the practitioners' expressive and/or aesthetic unorthodoxies. It also illustrates the power of interaction between the cognitive evolution, the mature and the emerging technologies, which sets up the conditions for novel concepts. In that regard, the artworks we discuss in this paper discredit the myth that everything has already been thought of, invented or discovered. Similar to science and technology, they always start with(in) the

existing artefacts, but analogize, reconfigure, process and transform them with finesse and freshness which make us realize that they could only have emerged just now. They help us appreciate the difference between innovation (gradual) and invention (sudden change), showing that both have the potential to transform their contextual values and contribute to the enrichment of human experience, thinking, knowledge, and the world (Poole 2016).

The continuous zeitgeist-relative interferences in the arts, science and technology should be further addressed from the perspective of the unequal socio-political power and cultural hegemonies which keep some creative achievements unjustly overlooked, while disproportionately advertising others. This reflects in a tendency to praise certain creative models due to their luck of appearing within the right ideological authority, but without critically checking their originality or merit. On the other hand, in art and science only the 'fittest' survive by default, there is no copyright on ideas and one must fight their own place in the sun (Miller 2019). This is why feeling the zeitgeist, intuiting the paradigms and understanding the cultural convergence are strong motivational factors for the artists' appropriation of ideas, themes, techniques and technologies trending from other disciplines.

Within the context of code-based new media art, however, we also need to acknowledge the conceptual cogency, technical elegance, consequential power and aesthetic sophistication of the work in the related fields of computer science, engineering and robotics. In that respect, new media artists can be criticized for rarely going beyond smart or amusing spectacularization of the emerging techno-sciences and their cultural effects (Taylor 2014: 233). Although the artful spectacularization is necessary for making science and technology more accessible to the public and more open to critical insight (Taylor 2014: 113, 242, 243), the artists, the media and the cultural sector should outgrow the delusion (or cease promoting the illusion) that the arts can influence our world in the same way, to the same extent and with the same relevance as science and technology. Without the edge of critical self-consciousness, the artists' pragmatism easily slips into superficial, naive and/or exploitative strategies which support the hypothesis that the arts, among other components of human culture, have evolved as a suite of virtue signaling adaptations for sexual selection and social competition – one of the very views that the artists and art promoters oppose the most (Miller 2001). Respecting and exploring this edge, the artists can define new emancipatory horizons to help us question our ethical standards, assess our social norms, tackle our ever-changing present and anticipate the possible futures.

5.2. Above the Drive and Beyond the Procedure

Deeper understanding the cognitive aspects of artefactual creativity in new media art is instrumental for the artists' critical self-consciousness, and essential for our recognition of their achievements. At first sight, the

artworks in this paper may suggest that creativity is somehow degraded if its procedural elements can be presented as algorithms and converted into program code. But the executable procedure of any creative process—when clearly defined—can be algorithmized and coded. Plasticity and adaptability in mimicking natural processes are the defining factors of universal computing machine which lays the conceptual foundation for modern computer science (David and Martin 2000, Watson 2012). Achieving that plasticity and adaptability, however, is itself a creative enterprise which requires ingenuity, multidisciplinary research, critical understanding of accumulated knowledge, and learning.

The development of new media art projects involves two modes of thinking. One is matching the algorithmic and the unpredictable elements into a coherent system. It relies on the anticipation of the performative qualities of the system, based upon experience, knowledge and intuition. Another mode is the construction of algorithms as multi-purpose tools, which requires procedural literacy and programming skills. This "ability to read and write processes, to engage procedural representation and aesthetics", means that programming is not a mechanical task but an act of dynamic communication and symbolic representation of the world (Reas et al. 2010). It runs in three steps: dematerialization of certain phenomenon into a set of signs which describe it properly, resolving that sign-set into pure syntax (removing the semantic layer), and translation of the syntax into a series of operations (within the programming environment) (Nake and Grabowski 2011).[5] This 'trivialization' requires a spectrum of cognitive abilities and skills such as the sense for recognizing the phenomenon which can be algorithmized under given conditions, imagination and flexibility of reasoning, distinguishing between the rational and irrational aspects in our mental concepts of natural phenomena, and attention to the scope of the algorithmic system. Whenever a previously incomputable natural phenomenon or creative process gets algorithmized, it is human intelligence doing the complex job of scrutinizing, symbolically structuring and encoding it into a functional system. The relationship between human creativity and human-built emulation of creativity reveals the essential flexibility of human mind in allowing itself to be influenced by the technology, and simultaneously absorbing, repurposing, transforming and inventing it.

Procedural thinking faces some systemic challenges. The conceptual constraints of programming languages and hardware architectures can impose certain solutions and unwillingly spin the artistic process. The fixed performative capabilities of the hardware can reflect in roughness and lack of spontaneity (Watz 2010). Ultimately, there are the undecidable problems in computability theory, and the limits of mathematical formalization established in Gödel's incompleteness theorems (Penrose 1994). However, the material, formal and procedural boundaries are enforced by men or nature to all human activities, not just to procedural thinking. So, while the

5. This counterintuitive disassembly of the experience is clearly analogous to the core process of observation-based drawing, so it is probably just mental rigidity that makes many visual artists struggle to learn programming, and vice versa.

optimization of productivity and expressiveness within restrictive frameworks requires significant mental effort, the ability to break out of these frameworks is the essence of creativity (Kay 1997). In science, technology and in the arts, this ability often emerges through a combination of hard work and experimentation which can be pragmatic, playful or frivolous, but always implies the broader ethical aspects. The artists are motivated by the anticipation of poetic values and effects of their projects, but they also need to acknowledge the risks, to be open for the unwanted outcomes or failure, to evaluate and react by improving their methodology or by redefining their approach. Similarly, the agents of scientific, technological, economic or political experiments should be able to consider both their projected impact and the unpredictability of short- and long-term consequences, to be ready to question and improve their approach. Within such contexts of high stakes and high responsibility, artefactual creativity in new media art is instructive because it is defined by the artists' desire to overcome the fact that our experience is stronger than our imagination (Kay 2013), and that we predominantly understand new concepts through the existing (old) categories and models (McLuhan 1964).

The successful new media artworks which signify artefactual creativity are distinguished by the artists' abilities to transcend the conceptual, productive, aesthetic, and ethical constraints of algorithmic thinking and code-based expression. By leveraging the combinatorial inventiveness into the original structures, they offer inspiring, emotionally and intellectually rich experiences with unique aesthetic and ethical values. They are powerful cognitive tools for blending the elements of unrelated matrices of thought into the new entities of meaning through comparison, abstraction, categorization, analogies and metaphors. In a straightforward way, easy to understand and to empathize with, they affirm wit as one of the most attractive and valued human capacities. They tell us stories but, more importantly, they stir curiosity, stimulate imagination and further motivate creativity *through* experience, by revealing or suggesting their mental models which can be engaged implicitly or explicitly and incite new configurations and ideas.

References

Bishop, Chris.
2017. "Artificial Intelligence, the History and Future." The Royal Institution YouTube podcast. https://youtu.be/8FHBh_OmdsM.

Boden, Margaret A.
2004. *The Creative Mind, Myths and Mechanisms*, 40-53 and passim. 2nd edition. London/New York: Routledge.

Bogart, Ben.
2019. "Watching (2001: A Space Odyssey)." AI Art Gallery website. http://www.aiartonline.com/community-2019/ben-bogart/.

Boon, Marcus.
2013. *In Praise of Copying*. Cambridge: Harvard University Press.

Branger_Briz.
2017. "Muse AI Supercut." Branger_Briz website. https://www.brangerbriz.com/portfolio/muse-ai-supercut.

Brodbeck, Frederic.
2011. "Cinemetrics." Cinemetrics project website. http://cinemetrics.fredericbrodbeck.de/.

David, Martin, and Davis Martin.
2000. *The Universal Computer: The Road from Leibniz to Turing*. New York: W.W. Norton & Company.

Dorin, Alan, Jonathan McCabe, Jon McCormack, Gordon Monro, and Mitchell Whitelaw.
2012. "A Framework for Understanding Generative Art." *Digital Creativity* 23 (3-4): 239–259.

DuBois, Luke.
2011. "A More Perfect Union." A More Perfect Union project web page. http://sites.bxmc.poly.edu/~lukedubois/perfect/.

Ferguson, Kirby.
2011. "Everything is a Remix." Everything is a Remix website. http://www.everythingisaremix.info/.

Galloway, Alexander R.
2004. *Protocol: How Control Exists after Decentralization*. Cambridge: The MIT Press.

Giovacchini, Saverio, and Robert Sklar, eds.
2013. *Global Neorealism: The Transnational History of a Film Style*, 2. Jackson: University of Mississippi Press.

Gleisner, Jacquelyn.
2013. "Paolo Cirio's Lovely Faces." Art 21 magazine web page. http://magazine.art21.org/2013/08/12/new-kids-on-the-block-paolo-cirios-lovely-faces/#.XMLlPKQRVPY.

Grba, Dejan.
2010. "B.A.C.H. (References in Visual Arts)." Dejan Grba's website. http://dejangrba.org/lectures/en/2010-bach-references.php.

Grba, Dejan.
2015. "Get Lucky: Cognitive Aspects of Generative Art." *XIX Generative Art Conference Proceedings*: 200-213.

Grba, Dejan.
2019. "Forensics of a Molten Crystal: Challenges of Archiving and Representing Contemporary Generative Art." *ISSUE Annual Art Journal: Erase 08*: 4.

Groß, Benedikt, Joey Lee et al.
2016. "The Aerial Bold Project." The Aerial Bold Project website. http://type.aerial-bold.com/tw/.

Harris, Jonathan.
2015. "Network Effect." Jonathan Harris's website. http://number27.org/networkeffect.

Harvey, Adam.
2017. "MegaPixels." Adam Harvey's website. https://megapixels.cc/.

Heaney, Libby.
2019. "Euro(re)vision." AI Art Gallery website. http://www.aiartonline.com/highlights/libby-heaney-2/.

Hofstadter, Douglas, and Emmanuel Sander.
2013. *Surfaces and Essences: Analogy as the Fuel and Fire of Thinking*, 17. New York: Basic Books.

Hosein, Lise.
2018. "Night of the Living Dead Has a Scarier Story Than You Think...because Copyright is Terrifying." CBC website. https://www.cbc.ca/arts/night-of-the-living-dead-has-a-scarier-story-than-you-think-because-copyright-is-terrifying-1.4768307.

Kay, Alan.
1997. "The Computer Revolution Hasn't Happened Yet." YouTube website. https://www.youtube.com/watch?v=oKg1hTOQXoY.

Kay, Alan.
2013. "Keynote at the 6th Annual Fujitsu North America Technology Forum." Computer History Museum website. http://www.ustream.tv/recorded/29156602.

Lavigne, Sam.
2020. "Repositories." Sam Lavigne's GitHub repository. https://github.com/antiboredom?tab=repositories.

Lessig, Lawrence.
2001. *The Future of Ideas*. New York: Random House.

Lessig, Lawrence.
2008. *Remix: Making Art and Commerce Thrive in the Hybrid Economy*. London: Bloomsbury Academic.

Lévi Strauss, Claude.
1962. *The Savage Mind*. Chicago: University of Chicago Press.

Mambrol, Nasrullah.
2016. "Claude Levi Strauss' Concept of Bricolage." Literary Theory and Criticism website. https://literariness.org/2016/03/21/claude-levi-strauss-concept-of-bricolage/.

Mark, Kelly.
2020. "Video." Kelly Mark's website. http://kellymark.com/V.html.

McCoy, Jennifer, and Kevin McCoy.
2020. "Projects." Jennifer and Kevin McCoy's website. http://www.mccoyspace.com/projects/.

McLuhan, Marshall.
1964. *Understanding Media*, 4. London: Routledge & Kegan Paul.

Miller, Arthur I.
2019. *The Artist in the Machine: The World of AI-Powered Creativity*, 39. Kindle edition. Cambridge: The MIT Press.

Miller, Geoffrey.
2001. *The Mating Mind: How Sexual Choice Shaped the Evolution of Human Nature*, 258-291. New York: Anchor Books/Random House, Inc.

Mitchell, Melanie.
2019. *Artificial Intelligence: A Guide for Thinking Humans*, 52-107. Kindle edition. New York: Farrar, Straus and Giroux.

Moll, Joana.
2017. "The Dating Brokers." Joana Moll's website. https://datadating.tacticaltech.org/.

Nake, Frieder, and Susan Grabowski.
2011. "Computational in Art and Trivialization in Computing." HyperKult XX Lecture website. https://vimeo.com/27318263.

Nielsen, Michael.
2019. "Neural Networks and Deep Learning." Online book. http://neuralnetworksanddeeplearning.com/.

nn.
2014. "Apophenia." Skeptic's Dictionary website. http://skepdic.com/apophenia.html.

nn.
2017. "SHARE Lab: Exploitation Forensics Press Release." Aksioma – Institute for Contemporary Art website. http://www.aksioma.org/press/exploitation.forensics.zip.

Palacz, Julian.
2020. "Works." Julian Palacz's website. https://julian.palacz.at/en/works/.

Penrose, Roger.
1994. *Shadows of the Mind: A Search for the Missing Science of Consciousness*, 64-126 and passim. Oxford: Oxford University Press.

Poole, Steven.
2016. *Rethink: The Surprising History of New Ideas*, 81-99. Kindle edition. London: Random House.

Ralske, Kurt.
2007-2009. "Motion Extractions / Stasis Extractions." Kurt Ralske's website. http://retnull.com/index.php?/project/motion-extractions/.

Reas, Casey, Chandler McWilliams, and LUST.
2010. *Form+Code in Design, Art, and Architecture*, 17. New York: Princeton Architectural Press.

Salavon, Jason.
2020. "Works." Jason Salavon Studio website. http://www.salavon.com/.

Taylor, Grant D.
2014. *When the Machine Made Art: The Troubled History of Computer Art*. New York and London: Bloomsbury Press.

Todorović, Vladimir, and Dejan Grba.
2019. "Wandering Machines: Narrativity in Generative Art." *CITAR Journal of Science and Technology of the Arts, Special xCoAx Issue*: 55.

Watson, Ian.
2012. *The Universal Machine: From the Dawn of Computing to Digital Consciousness*. New York: Springer.

Watz, Marius.
2010. "Closed Systems: Generative Art and Software Abstraction." in *Eléonore de Lavandeyra Schöffer*, edited by Marius Watz and Annette Doms, 1-3. Dijon: Les presses du reel.

Widrich, Virgil.
2003. "Fast Film." Virgil Widrich's website. https://www.widrichfilm.com/en/projekte/fast_film.