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by Martina Pace

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Feedback Loops
Sougwen Chung
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The Algorithmic Age: On Dynamic Interactions Shaping Creative Practices

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Abstract

Generative Adversarial Networks (GANs) and a panel of selected artworks by the artist Sougwen Chung are analyzed hereafter as paradigmatic and innovative case studies able to express a conception of interactivity intrinsic to the human-mediated relationship with our interconnected world. This paper investigates the manifestation of this feature as constitutive of an artistic practice based on collaboration. By integrating the latest artificial intelligence technologies into their methodologies, these practices become conceptually richer than in the past. The gradations that inform human-system interactions express an interactivity that enhances the creative process not only on a compositional level but also in terms of reworking content that, in their final form, exceed preordained operational mechanisms. I aim to discuss how these two case studies exhibit these traits within a theoretical framework where Visual Arts, mixed with philosophical questioning, are proposed as a preferred point of view to lead reflections and examine the new inquiries arising from the evolution of a technology deeply rooted in the environment we inhabit.

Keywords GAN Interactivity Feedback Loops Sougwen Chung Algorithm

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Introduction

While traditionally focused on the appearance of things and their representation, art is now concerned with processes of interaction, transformation, and emergence.[1]

As noted by Fausto Tomei, who echoes a reflection by Piero Biannucci, "elements of interactivity have always existed in every form of art."[2] This article starts from this assumption in order to examine the different levels through which this interactivity is expressed within contemporary artistic practices, hybridized with the latest technologies. By integrating the generative mechanisms into their own methodologies, these practices are not only expanding our expressive potential,[3] but have also become an exemplary case to analyze how increasingly profound entanglements between individuals and technologies contribute to their mutual constitution. This framework is consistent with a "more general approach to art as residing in a cultural communications system rather than in the art object as a fixed semantic configuration."[4] Elemental aspects of such a perspective were already detectable in Roy Ascott's artworks, the media art pioneer who actively contributed to the notion of a computer-based art able to reflect the transformations of its own time. Ascott's theoretical framework owes much to the discourse on Cybernetics: this inherently interdisciplinary field of research focuses on behavior, communication, and the control of information

1 R. Ascott, *Telematic Embrace: Visionary Theories of Art, Technology, and Consciousness* (Berkeley: University of California Press, 2003): 375.
2 F. Tomei, *Arte interattiva. Teoria e artisti* (Bologna: Pendragon, 2006): 22.
3 E. Cetinic, J. She, "Understanding and Creating Art with AI: Review and Outlook," *ACM Transactions on Multimedia Computing, Communications, and Applications* (*TOMM*) 18, no. 66 (2022): 1-22, https://doi.org/10.1145/3475799.
4 R. Ascott, *Telematic Embrace*: 233.

flows, interconnected by the concept of feedback,[5] which is ultimately central for the notion of interactivity itself.

Several artistic experiments, Ascott's efforts included, have embraced this theoretical foundation, which was in addiction closely intertwined with the emergence of studies in Artificial Intelligence and Computer Vision, also flourishing during the same years. Ascott decided to employ cybernetic concepts of feedback, process, and system in order to introduce them into the contemporary art establishment through his proposal of interactive art. In particular, Ascott believes that it is possible to see works of art essentially as "creative systems, the behavior of which could be altered and regulated by the interactive exchange of information via feedback loops."[6] More broadly, this exchange serves as the explanatory basis for all phenomena occurring within an organism, as well as those between the organism and its environment. Ascott's aesthetic-cybernetic proposal assimilates all these aspect and introduces a *cybernetic vision* that allows us to consider art, culture, and society as interconnected systems within an uninterrupted communication that balances the dynamism between ordered and unpredictable elements within the experience of the creative process.[7] To this end, the cybernetic framework provided Ascott with the occasion to experiment with an artwork that emerges from a context of interactions between the spectator and the piece beyond the artist's control.

All these elements contribute to a concept of interaction more complex and stratified than expected, especially now that this very aspect of uncertainty, as part of the outlined communicative stream, is enhanced

5 N. Wiener, *The Human Use of Human Beings. Cybernetics and Society* (Boston MA: Houghton Mifflin, 1950).
6 R. Ascott, *Telematic Embrace*: 4.
7 For further readings, see R. Ascott, "The Cybernetic Stance: my process and purpose," *Leonardo* 40, no. 2 (2007): 189-197, https://doi.org/10.1162/leon.2007.40.2.189.

by algorithmic systems deeply involved in the artistic endeavors. This primarily means focusing attention on the part of the process that precedes the moment of reception, beyond a form of "real-time control over the computing process (that) is placed in the hands of the user."[8] In this direction, the leading purpose is to focus the current analysis on what this frame of interactivity fails to fully account for, providing conceptual tools that are better aligned with the richness of an up-to-date artistic-creative experience, as it involves complex dynamics of reciprocity and, more broadly, mutual shaping between a human being and a technological apparatus able to "determine our situation."[9] Going beyond the simple fact that each action performed by the user triggers an immediate reaction from the machine means, first and foremost, reflecting on dynamics that escape interactions with pre-determined outcomes. Furthermore, it integrates a primary definition of interaction as action between into a more extensive concept of interactivity as action *between and through*[10] elements that mutually constitute one another without being fully resolved in linear immediacy or complete control. To summarize, it calls for a notion of interactivity capable of translating the conceptual framework of the *cybernetic vision*, as reinterpreted by Ascott, into the more strictly productive phase of the artistic process, while simultaneously underscoring the idea that "numerical operations are always entangled with human operations."[11] All these elements converge in the theoretical proposal of a more extensive concept of meta-interactivity, the essential feature of a co-creative process shaped by the dynamic relationship between the

8 L.A. Suchman, *Human-Machine Reconfigurations. Plans and Situated Actions* (Cambridge: Cambridge University Press, 2nd edition, 2007).
9 F. Kittler, *Gramophone, Film, Typewriter* (Redwood City: Stanford University Press, 1999).
10 For a further reading and a complete analysis on the ontological relevance of the category of relation, see R. Diodato, *Immagine, arte, virtualità. Per un'estetica della relazione* (Brescia: Morcelliana, 2020).
11 S. Fizek, *Playing at a Distance: Borderlands of Video Game Aesthetic* (Cambridge, MA: MIT Press, 2022): 104, https://doi.org/10.7551/mitpress/13605.001.0001.

artist and the machine. The emergency of this quality will be therefore analyzed primarily by revisiting the 'preceding phases' of the creative process through the introduction of the operating mechanisms of Generative Adversarial Networks (GANs), an intrinsically interactive technology capable not only of transforming pre-existing images but also of generating entirely new ones, thus marking a significant turning point in the contemporary artistic and visual landscape. The highlight will finally shift to Sougwen Chung's artworks as a paradigmatic example of a human-machine open dialogue, gestural and opaque, that finds in its renewed unpredictability the key to deeply understand hybrid art as an ongoing, meta-interactive collaborative process.

Exploring Meta-Interactivity: From Cybernetic to Generative Adversarial Networks

Given these conceptual premises, the following sections will be dedicated to the investigation of interactivity as a result of a gradual and increasingly complex stratification within the broader process of artistic creation and reception. The first case under analysis does not refer to a specific artwork, but rather to an *architectural system*, widely used for artistic purposes. A Generative Adversarial Network (GAN) is an example of neural structure that falls under the broader systematic economy of Creative Deep Learning, wherein we see "the application of (unsupervised) DL to the production of artistic works and creative media."[12]

12 M. Akten, *Deep Visual Instruments: Realtime Continuous, Meaningful Human Control over Deep Neural Networks for Creative Expression* , PhD diss. (London: University of London, 2021): 11, https://doi.org/10.25602/GOLD.00030191.

Deep Learning (DL) is a field of research within Machine Learning that investigates how algorithms can learn from vast amounts of high-dimensional, highly complex "raw" data.[13]

When it comes to visual information – specifically to images – DL has proven to be a valuable resource not only for classification and analysis of digitized images, but also for their manipulation and generation processes, entailing algorithmic systems able to classify the existing world through a continuous learning process based on data feeding. For this to be possible, the system must implement a conversion process that translates images into a language it can understand, enabling it to "see" them, along with a categorization of the translated image based on indexing.[14] The *a priori* adherence to these two procedural conditions allows the system to implement the training operation, which consists of a feeding flux of a vast number of images "previously described by humans."[15] Consequently, the algorithms learn to identify recurrent configurations, patterns, and regularities that are mostly invisible to human sensitivity.

2014, Montréal. Ian Goodfellow, researcher and computer scientist, had an exceptional intuition: a Canadian pub was the improbable setting where Generative Adversarial Networks first took shape.[16]

GANs, inspired by game theory, therefore consist of exchanges regulating the interaction between two neural networks, the generator and the discriminator. The latter is trained on a quite extensive dataset, entirely composed of real-world images. This dataset is precluded to the generator, which therefore starts producing a series of

13 Ibid.: 3
14 A. Somaini, "Algorithmic Images: Artificial Intelligence and Visual Culture," *Grey Room*, no. 93 (2023): 74-115, 80-81, https://doi.org/10.1162/grey_a_00383.
15 S. Arcagni, *L'occhio della macchina* (Turin: Einaudi, 2018): 96.
16 I. Goodfellow *et al*., "Generative Adversarial Nets," *Neural Information Processing Systems* (2014): 1-9, https://doi.org/10.48550/arXiv.1406.266.

abstract images, initially "pure noise,"[17] strange intertwining shapes originating from its latent space, a technical setting that "contains infinite possibilities, like our imagination"[18] and where "digital objects"[19] are transformed "into latent representations so they can be processed and used to generate new digital objects."[20] At this point, the discriminator's task is to determine whether the images it receives are real or not. The level of abstraction of the initial images is so high that they are immediately sent back to the generator, which then uses its resources to make subsequent and more challenging interactions for its adversarial network, making it harder to evaluate the quality of the produced images. This unsupervised process highlights the "social"[21]nature of these networks and the level of independence they can achieve from human intervention, perceptible in all the attempts the generator must take to convince the antagonist network that it is learning to intuit the shapes of reality, while simultaneously transcending them, in that "the data it eventually produces are not mere copies, but (...) new images that imitate and transform the initial images."[22] The datasets that inform the training process are the epistemological tool that allows the machine to "experience"; however, they are also the result of both a situated process of categorizing classes of images[23] and the network of previous interactions between humans and media apparatuses. That is to say, the two adversarial networks interact based on past interactions that inform their training, and consequently also their outputs. As Somaini rightly points out:

17 A. I. Miller, *The artist in the machine: the world of AI-powered creativit*y (Cambridge MA: MIT Press, 2019): 89.
18 Ibid.
19 A. Somaini, "Algorithmic Images:" 74-115, 77.
20 Ibid.
21 A. Barale, ed., *Arte e Intelligenza Artificiale. Be my GAN* (Milano: Jaca Book, 2020): 28.
22 Ibid.: 10.
23 Algorithms are trained using a wide variety of data. I will narrow the discussion to classes of images because they are the specific kind of data used to train the systems I'm going to analyze.

The images generated by various kinds of GANs are not the output of completely autonomous algorithmic processes. On the contrary, they are always the result of a complex series of interactions between the artists, the programmers that in some cases collaborate with them, the algorithms (with their different versions, possibilities, and limitations), the images that are part of the training set, and the images that were generated out of the latent space.[24]

Artificial intelligence systems express the potential to recombine the pre-existing as a continuous becoming, however starting from a pre-understanding originated from how we humans index or label the things we interact with – it is no coincidence that datasets are often biased. Once these systems are employed in the creative progression, it is possible to be about an "implicate process"[25] that highlights the "artist's enfolding of ideas and images in a density of Web connections,"[26] which is in turn "accompanied by the unfolding of links and trajectories created by the user's interactions."[27] Therefore, a first level of interactivity emerges as an intrinsic characteristic not only of our relationship with computer media – to the point of making the concept of interactivity itself tautological[28], and therefore vague and redundant – but also of the learning process itself, and consequently the functioning of the technological apparatus.

This advanced learning model is fascinating to examine also because its governing framework conceptually relates to the cybernetic emphasis on process and system, on the network of feedback loops and on the relevance of the information. These elements, in turn, allow us to focus on the procedural dimension of the hybrid

24 A. Somaini, "Algorithmic Images:" 74-115, 98.
25 R. Ascott, *Telematic Embrace*: 378.
26 Ibid.
27 Ibid.
28 L. Manovich, *The Language of New Media* (Cambridge MA: MIT Press, 2001): 55.

artistic activity, while simultaneously moving beyond some of the limitations of the *cybernetic vision*, which failed to emphasize the essential fact that "for information to exist, it must always be instantiated in a medium."[29] On the other hand, an analysis mainly focused on closed and controlled systems fails to fully align with contemporary complex and open systems, which elude complete control and cannot be reduced to purely mathematical processes. This, in addition, risks promoting the idea of a technical neutrality that does not reflect the reality of algorithms; contrary to the perception of a "view from nowhere,"[30] generative networks are, in fact, capable of conveying a partial conception of the world – an archival logic that tends to exclude the unconventional and the rare in its search for regularities.[31] GANs can also suffer from a similar flaw: if training is conducted using overly generic datasets, there is a concrete risk of extending this logic to the artworks, perpetuating stereotypes and assumptions rooted in the Western cultural framework and thereby producing a more standardized aesthetic. As a result, for these practices to be capable of generating value, human intervention is necessary to guide the collaborative dynamic through a clear and purposeful design, one that can consciously support the process, as "a neural network does not understand what it generates."[32] Nonetheless, it retains the capacity to generate an unpredictability that makes the exchanges between the artist and generative networks even more compelling if we consider the fact that the result isn't something that the human artist could achieve alone and fully control, but it is always crafted by

29 K.N. Hayles, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics* (Chicago: University of Chicago Press, 1999): 13.
30 M.F. Hakopian, "Art histories from nowhere: on the coloniality of experiments in art and artificial intelligence," *AI & Society* 39 (2024): 29-41, https://doi.org/10.1007/s00146-023-01768-0.
31 For further readings, see S. U. Noble, *Algorithms of Oppression. How Search Engines Reinforce Racism* (New York: New York University Press, 2018).
32 L. Manovich, "Towards 'General Artistic Intelligence'?," *Art Basel*, (June 1, 2023), https://www.artbasel.com/news/lev-manovich, accessed December 20, 2024.

a collective effort. The artwork is tied to "an interaction between human and non-human actors"[33] and therefore can only be analyzed "within a network (...) that includes human subjects, devices, and other images."[34] This is why we can speak of a first level of systemic interactivity. Creative human-machine interaction produces a dynamic meaning that goes beyond a deterministic structure ruled by predetermined conditions and is oriented towards finding a balance between the necessary and constitutive adherence to rules, which allows the system to exist and function correctly, and interactivity itself. I believe that what Garroni argues regarding the relationship between rules and creativity is particularly relevant in this context:

> Both language and games must obey certain rules; without these rules, they would not exist. Nevertheless, they are fundamentally manifested as typical creative activities (...) A game without rules, like language, would not merely be a strange game; it would not be a game at all. It would not be possible as such.[35]

In these works, adherence to rules and cycles of interaction go hand-in-hand: it is the synergy between these elements that makes this type of art possible. The rules do not limit the artist's creativity; rather, they expand it in unconventional ways through alternating processes of creation and reworking. Sougwen Chung's Drawing Operations will demonstrate how.

33 R. Eugeni, R. Diodato, "L'immagine algoritmica: abbozzo di un lessico," in *La Valle dell'Eden. Semestrale di Cinema e Audiovisivi*, no. 41-42 (2023): 5-21, 9, https://doi.org/10.13135/1970-6391/10819.
34 Ibid.: 12.
35 E. Garroni, *Creatività* (Macerata: Quodlibet, 2010): 104-105.

Hybrid Creativity: Sougwen Chung's Human-Robot Artistic Collaborations

Inside what looks like an industrial laboratory, a woman and a robotic arm face each other. Between them, there is a blank canvas with a few hints of lines and color. Both are "holding" a brush – a metal giant opposed to a tiny figure hunched over herself, studying it intently from below with a pensive expression. This picture captures the essence of Sougwen Chung's work, a Chinese-Canadian artist and researcher, accompanied by her Drawing Operations Unit Generation (D.O.U.G), a robotic arm designed in various forms and "generations" to actively participate in the artist's creative act during improvising-ruled performances. The first generation of this technology, DOUG 1, is a small robotic arm that, thanks to a Computer Vision software and a camera, can execute real-time synchronous actions, thereby imitating the artist's gestures as she draws. Chung and DOUG 1 performed together in 2015 and in 2016, creating improvised live performances in which the artist did not follow a pre-determined gestural choreography. During the first New York performance, something unexpected occurred: the robot's strokes were not a mirror-like copy of the human agent's, but they took on divergent angles and directions. The artist had to respond with her own strokes, resulting in a sort of intense gestural dialogue:

> While in the simulation that happened on screen it was pixel–perfect, in physical reality it was a different story. It would slip and slide and punctuate and falter, and I would be forced to respond. There

was nothing pristine about it. And yet, somehow, the mistakes made the work more interesting.[36]

This reveals a process in which both the human and the mechanical entities continuously adapt their actions to each other, materializing "a rejection of needing to control the outcome or have a road map."[37] This aspect adds an unexpected depth to a performance similar to a game of mirrors at jammed frequencies, where the gestural behavior facilitates new kinds of action:[38] "collaboration extends the interaction of human and machine to that of a creative partnership."[39] This dialogue is particularly fascinating as it highlights a sharp discontinuity between both different gestural representations and various materialities. The feedback loops in which the two are immersed showcase the transitions from one state to another, moving from the material (the artist drawing on the canvas), to the opaque materiality of the abstract operation (the technological system analyzing, interpreting, and returning the drawing), and back to the material (the robotic arm drawing in turn). The entanglements that cut across the different materialities[40] could be interpreted as one of the conditions of reality for what Cecchi identifies as an "associated environment, within which interactivity can be cultivated not as mere program implementation but as a creative exercise."[41] The dissociated behavior of the mechanical arm, which indeed follows its own operating

36 S. Chung, "Why I draw with robots," filmed September 2020 at TED@BCG, Mumbai, https://www.youtube.com/watch?v=q-GXV4Fd1oA.
37 P. Bauman, "Sougwen Chung on Us in Another Form," *Le Random* (October 5, 2023), https://www.lerandom.art/editorial/sougwen-chung-on-us-in-another-form, accessed December 20, 2024.
38 J. Zylisnka, *AI ART: Machine Visions and Warped Dreams* (London: Open Humanity Press, 2020): 52.
39 "Vermilion Sands: Interview with Sougwen Chung," *Props Paper,* no. 12 (2018), https://propspaper.com/012, accessed July 3, 2024.
40 M. Zeilinger, *Tactical Entanglements: AI Art, Creative Agency, and the Limits of Intellectual Property* (Lüneburg: Meson press, 2021): 44.
41 D. Cecchi, "Intermedialità, interattività (e ritorno). Nuove prospettive estetiche," *Rivista di estetica*, no. 63 (2016): 3-11, https://doi.org/10.4000/estetica.1234.

rules, adapts its behavioral outputs through processes of reception and reinterpretation of the inputs, yet produces an unpredictability conditioned by an imperfect materiality by which the human agent interacts, reworking their own actions adaptively. This set of procedures identifies an additional level of interactivity, which makes explicit the procedural nature of creativity as "cognition that is distributed between the human artist and artificial intelligence."[42] Meta-interactivity is thus conceivable as the synthesis event that keeps entangled the systematic and the procedural moments of the artistic creative flow.

The second generation of DOUG, which introduces the theme of memory, is a fitting example of a more stratified concept of interactivity. The primary core of DOUG 2 consists of a Recurrent Neural Network (RNN), an artificial neural network where cyclical connections generate a behavioral output based on the training model.

> These recurrent connections carry information forward from previous timesteps, and allow the recurrent neurons to maintain an internal state. This enables RNNs to create and process memories from past inputs, learn temporal regularities and model non-linear dynamical systems.[43]

That is to say, the establishment of recurrent connections enables an adept system to register chronological regularities, which in turn allow it to create and process memories. In this case, the neural network is trained through the drawings that Chung herself has created over the course of twenty years. This is a highly specific methodology[44] that draws upon something private and intimately

42 M. Mazzone, "Le GAN e la questione della creatività nell'arte e nell'intelligenza artificiale," in A. Barale, ed., *Arte e Intelligenza Artificiale. Be my* GAN: 51-74, 68.
43 M. Akten, *Deep Visual Instruments*: 70.
44 For further information, see A. Ridler, "Set di dati e decadenza: *Fall of the House of Usher,*" in A. Barale, ed., *Arte e Intelligenza Artificiale*. Be my GAN: 111-128.

personal and discloses a valiant alternative contrasting with the generic nature derived from publicly accessible data repositories online. This significantly reduces the risk of biased datasets, the marginalization of the artist, and the reiteration of an impersonal and repetitive aesthetic. Chung's machine is endowed with a new "sensibility:" what it produces is not merely a simultaneous copy of an act unfolding in the present time of the performance, but rather an interactive reflection of fragments of the past. Thus, creativity emerges as the realization of a gesturality that is both learned and remembered. The shared space of the canvas becomes the manifestation of a collaboration whose endpoint is not the creation of something itself, but rather the materialization of a narrative that highlights new ways of creating from the human-machine interaction. I believe that much of the novelty of these new artistic pathways is due to the possibility that these systems open up to a mixture of different temporalities and ontologies.

> By bringing my own painting back to the process in this way, I'm exploring a mode of working with human–machine interconnections beyond mere extension to more of a feedback loop, a call and response that is made visible. [...] It's a process that foregrounds uncertainty at its very core and maybe a sense of playfulness too.[45]

Let's consider the subjects involved and the type of interaction that they enact. At a primary level of analysis, we can say that the machine and the artist engage in two types of actions: on the one hand, there is an individual action, tied to the different nature whereby their corresponding mechanisms rework contents; on the other hand, there is a collective action, where the two poles collaborate, producing together by "playing" with each other.

45 P. Bauman, "Sougwen Chung on Us in Another Form," *Le Random* (October 5, 2023), https://www.lerandom.art/editorial/sougwen-chung-on-us-in-another-form, accessed December 20, 2024.

The action is collective because it is never an ordinary one-to-one relationship. In the present case, the specificity of the training set enables a nearly phantasmagoric collaboration: the artist creatively adapts herself to a sort of emanation of her past self, which is simultaneously other than herself, a double emerging from the intersection of different temporal planes. Generally, the artist improvises and adapts her responses based on the feedback she receives. The system, for its part, reworks by transforming a visual input into a behavioral output, a process that highlights the operational quality of the images generated during the algorithmic dialogue and activates transitions from one state of the image to another. The reification of computational processes in the robot also grants it a corporeality designed for responsive gestures. All these elements lead to discuss not only "interacting agents"[46] that "can be 'designed' through external influences,"[47] but also interactions that occur within and based on other interactions, following an almost kaleidoscopic system of internal and scalar references. The third generation of DOUG opens up to the external world and introduces us to the conceptual category of vision, revealing an inherently multidimensional type of hybrid gaze. The relationship between the artist and the robot is not one-to-one, but involves a group of robots, a swarm of twenty units that draw alongside Chung and that the artist describes as "kinetic sculptures."[48] The swarm is equipped not only with a mnemonic system that allows it to express a style as an emanation of the artist's, but also incorporates and expresses external data. These data come from the surveillance system of New York City, from a

46 Proceedings of the 12th annual ACM international conference on Multimedia (2004): 628 - 635, https://doi.org/10.1145/1027527.1027674
47 Ibid.
48 A. Pranam, "Putting The Art In Artificial Intelligence: A Conversation With Sougwen Chung," *Forbes* (December 12, 2019), https://www.forbes.com/sites/aswinpranam/2019/12/12/putting-the-art-in-artificial-intelligence-a-conversation-with-sougwen-chung/, accessed December 20, 2024.

publicly accessible pool of footage of the urban movement, which is interpreted and rendered as strokes and lines on the canvas that the robots trace as they move. The swarm movement is the algorithmic expression of "the dynamic flow of a city."[49] Such an attempt highlights the profound sense of collaboration, which arises from the fact that the human agent, who is the bearer of semantic content, can strategically and virtuously exploit the properties of the technical system during their interactions, modulated in a broader project-oriented sense, displaying the meaning of a non-trivial form of engagement, which holds and implements "the open-ended capacity to accommodate new variables."[50] Chung's work is an extremely virtuous example: the technological apparatus, which is itself an intersection of *over* and *under* structures in the form of a "dependency" that does not limit but rather stimulates creative action, is the starting point for a path of co-evolution of the "artistic practice alongside expanding technological complexity."[51] New avenues of conceptual elaboration fully adhering to the complexity characterizing our hybrid world are thoroughly opened.

The contemporary dimensions of interactivity

GANs and Sougwen Chung's artworks were taken into account and analyzed to provide a perspective on what the contemporary dimension of interaction might mean. Specifically, what emerged is a feature of meta-interactivity, which establishes the increasingly complex layers characterizing not only of the human-machine relationship

49 "Omnia per Omnia," Sougwen Chung website, https://sougwen.com/project/omniaperomnia, accessed July 3, 2024.
50 R. Ascott, *Telematic Embrace*: 378.
51 "A discussion with Sougwen Chung about human-robotic collaborations," Nokia Bell Labs, https://www.bell-labs.com/institute/blog/discussion-sougwen-chung-about-human-robotic-collaborations/#gref, accessed December 20, 2024.

(Chung) but also of the machine-machine relationship (GAN). The two levels of interaction, the first systemic and the second procedural, could be further expanded if, by analyzing the circularity that connects the artwork and the artist, we also consider to reintegrate into the discourse the figure of the viewer. This process of stratification makes the debate around hybrid art even more stimulating, as to fully understand the conceptual depth of these works, inseparable from the 'tools' that realize them, the first step is to become aware of them and explicit that the creative process does not culminate in the artwork but extends itself beyond it. However, mere awareness might be insufficient, and we may need to systematically move from one layer to another. The idea is that future approaches to the analysis of these types of creative exercises could bear in mind meta-interactivity not only as the founding trait of the algorithmic age, but also as a transformative force necessary to fully understand the way it is now possible to think about cognition, creativity and human agency:

> What will happen, and is already happening, is the development of distributed cognitive environments in which humans and computers interact in hundreds of ways daily, often unobtrusively (...) Computers aren't just in boxes anymore; they are moved out into the world to become distributed throughout the environment (...) The effect of moving in these distributed cognitive environments is often to enhance human functioning, as the ordinary examples above illustrate. Of course, there is also a downside. As cognition becomes distributed, humans no longer control all the parameters, and in some situations, they don't control the crucial ones.[52]

Machines and humans are entangled in an increasingly complex relationship able to adjust our experience,

52 A. Borgmann, K.N. Hayles, "An interview/dialogue with Albert Borgmann and N. Katherine Hayles on humans and machines," University of Chicago, https://press.uchicago.edu/Misc/Chicago/borghayl.html, accessed December 20, 2024.

and the artistic framework, enriched by a theoretical model that incorporates the concept of meta-interactivity, seems to be one of the best ways to realize it. This human-machine interaction is so profound that it is not always possible to understand who did what within the creative process: "the way things are done" is ever increasing opaque, and I believe that this ambiguity is one of the most challenging points to reflect on in the future.

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