



THE SEVEN C'S OF CREATIVITY

The Cyber-Creativity Process

How Humans Co-Create with
Artificial Intelligence

Edited by
Giovanni Emanuele Corazza



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The Seven C's of Creativity

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This series explores a new framework for understanding creativity based on seven “C’s”: Creators (characteristics of creative people), Creating (the process of creating), Collaborations (creativity in dyads, teams, groups), Context (the environment for creativity), Creations (the nature of creative productions), Consumption (the uptake of creative productions, adoption of creative ideas by the public), Curricula (the development and teaching of creativity).

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Giovanni Emanuele Corazza
Editor

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To Susy, Emanuele, and Martina

PREFACE

Among the 7C's model for creativity, as proposed by the Editor of this series Todd Lubart, the "C" of *Creating* represents the process through which the creativity phenomenon takes life. This book focuses on the creative process, involving the whole chain of events from focus conception, information gathering, idea generation, idea estimation, and implementation, by first of all defining creativity in a dynamic fashion, one that allows for creativity to exist even when the value of the process outcomes fails to be recognized, perhaps momentarily, or in the absence of creative products altogether. In treating this crucial subject, a key decision had to be made based on the historical moment we are witnessing: the coming of age of artificial intelligence (AI). For many years it was believed that AI would have been replacing routine jobs first, trusting that the more intellectually demanding and creative professions would remain the sole domain of human minds for several decades, or perhaps forever. The advent of Generative AI (Gen-AI) has changed this perspective dramatically. We now know that Gen-AI must be considered as a perfectly accredited actor in the creative process, so much so that it is today necessary for completeness to speak of cyber-creativity, and go deep into how human and machines can cooperate in the process. Therefore, at the end of 2023 I decided that the book would be devoted to an in-depth description and analysis of the cyber-creativity process, exploring several nuances that should show both resonance as well as departure from a purely human creative process.

The structure of the book is as follows: Chapter 1 has an introductory nature, providing the reference theoretical basis for the rest of the book. It introduces the dynamic definition of creativity and the dynamic universal creative process, before moving on to describing the DA VINCI model for the cyber-creative process. Through a fully developed exercise, aided by the DA VINCI custom GPT, the reader is given the chance to follow step-by-step an example of co-creativity between a human and Gen-AI. This is followed by seven core chapters. Chapter 2 gives solid foundations on Gen-AI algorithms, in a way that should be accessible to non-expert readers, but without sacrificing depth. Chapters 3 to 7 concentrate their focus on very important cyber-creative application fields: education, journalism, design, fashion, and music, respectively. Chapter 8 dwells on ethical and legal aspect of Gen-AI, a crucial topic for these algorithms that are trained on previously generated creative products, begging the question of intellectual property attribution. Finally, Chap. 9 provides a rather unusual form of conclusion: it is an exercise in future thinking, imagining we live in the year 2100 and by chance we encounter the very book that is in your hands: what could our future successors draw out of it?

I wish to thank all the chapters co-authors, the series editor Todd Lubart, as well as my collaborator Irene Coletto for their help in putting this work together as quickly as possible, a necessity given the fast pace of evolution of Gen-AI technology.

It is my hope that this book can serve as a source of inspiration for new forms of creativity, always remembering that alignment with human values should be held at the highest possible rank, and that the creative process is an experience that can produce long-lasting happiness in terms of coherence with our past, significance of our present, and purpose of our future.

San Lazzaro di Savena, Italy
December 23, 2024

Giovanni Emanuele Corazza

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CONTENTS

1	The Cyber-Creative DA VINCI Process	1
	Giovanni Emanuele Corazza	
2	The Design Principles of Gen-AI Algorithms	33
	Davide Maltoni, Lorenzo Pellegrini, and Matteo Scucchia	
3	A Principled Approach to Human Creativity x AI in Education	71
	Ronald A. Beghetto and Felipe Zamana	
4	Pivoting to Land Co-Creative AI Tools in Newsrooms	99
	Konstantinos Zachos, Neil Maiden, and Mark Dowsett	
5	The Three Waves Paradigm: Tracing the Evolution of Artificial Intelligence in Design	129
	Carmen Bruno, Marita Canina, and Michael Mose Biskjaer	
6	The Transformative Influence of Artificial Intelligence on the Fashion Industry	163
	Mariachiara Colucci, Alessandra Vecchi, and Francesca Bonetti	

7	Co-creating Music with Machines: Some Possibilities	203
	Shelly Knotts and Ivan Paz	
8	Human, All Too Human: A Philosophical Investigation on Intellectual Property Rights for AI-Based Creativity	239
	Antonino Rotolo	
9	Conclusion: Looking Back from 2100	265
	Giovanni Emanuele Corazza and Irene Coletto	
	Index	271

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LIST OF FIGURES

Fig. 1.1	The DA VINCI model for the creative process (modified from Corazza, 2019)	6
Fig. 2.1	An artificial neuron takes in input a vector $[x_1, \dots, x_n]$ (composed of raw data or the outputs of previous neurons) and computes a weighted sum by multiplying each input x_i by the corresponding weight w_i and summing all the terms. Another parameter known as bias, ($w_0(t)$ in the image), can be added as well. To compute the output, the neuron applies a non-linear function f such as the Rectified Linear Unit (ReLU)	34
Fig. 2.2	The supervised training of a NN. Each data sample is presented to the NN in a forward step leading to an output prediction. The error, that is the misalignment between the actual output and the desired one is computed and backpropagated. During backpropagation, the weights of the connections responsible for the misalignment are adjusted (red arrows in the image). This process is repeated until the network predictions become accurate	35
Fig. 2.3	Common neural networks architectures	36
Fig. 2.4	Example of a CNN. The network takes raw images as input and extracts features that are aggregated through the network's layers, creating powerful invariant representations that are exploited for the final classification	38
Fig. 2.5	Example of Neural Style Transfer. On the left, the image depicts the well-known Golden State Bridge, which represents the content image C . In the central column, there are three paintings by three famous artists: Monet's Water Lily Pond, Van Gogh's Starry Night, and Munch's The Scream (from top to bottom) which represent the style images S . On the right, the results (M) of Neural Style Transfer	39

Fig. 2.6	GANs architecture. Starting from random input, the generator creates fake images, while the discriminator takes both fake and real images as input and has to learn to discriminate between them	41
Fig. 2.7	VAEs architecture. During training, the encoder performs a compression of the input, creating a succinct representation of the original data, while the decoder performs the inverse operation, trying to recreate images as close as possible to the original ones, as shown in (a). The compression inevitably causes a loss of information, resulting in images that are never exactly identical to the originals. Once the VAE is trained, starting from a random sampling in the latent space, the decoder can be used for the generation of totally new images, as shown in (b)	43
Fig. 2.8	Examples of geometric figures representation in the latent space. (a) Shows an irregular latent space, where points that are close to each other can lead to different results once decoded, such as blue and purple points, which encode a square and a triangle respectively. Furthermore, sampling a random point can lead to meaningless results, such as the green point, which does not encode a geometric figure. (b) Depicts a regular latent space, where points that are close to each other lead to similar results once decoded: a square is closer to a trapezoid than to a circle or a triangle, a circle is closer to a semi-circular shape than to a square or a triangle and so on	44
Fig. 2.9	(a) Shows a latent space that is complete and continuous, with distributions for each class instead of single points, and points in the same distribution encode different possible representations for the same class. (b) Highlights how the sampling occurs in such a latent space. The sampling of random points leads to the creation of objects that are similar to the corresponding distributions and therefore exhibit properties common to these distributions. Consequently, sampling is smooth, because as one moves toward a particular distribution, the decoded objects exhibit more and more properties of the corresponding class	45
Fig. 2.10	Autoregressive image generation by sequential prediction of pixels. In the beginning, the first pixel is predicted, then the second pixel is predicted given the first one, the third pixel is predicted given the first two, and so on. In this example, the pixel to predict is highlighted in red, while pixels in the context window are colored in blue. The light blue arrows indicate the direction of the autoregressive predictions	47

Fig. 2.11	Example of GPT-4 tokenization. Each color highlights a different token	51
Fig. 2.12	Training and inference steps in a language model. Here, for simplicity, tokens correspond to single characters. During training, the model is trained to predict the next token of a known text. Once trained, the model is put in inference mode to generate new text. It must be noted that language models have a limited context window which contains a fixed number of previous tokens (36 in this example). This context is the basis that conditions the generation of the next token: during training, the context window consists of the previous part of the given text. When in inference mode, the initial part of the window consists of the user prompt and previously generated tokens. If the context window is too small, the window is shifted forward to include the newly generated tokens discarding the earliest ones	52
Fig. 2.13	Image generation using conditioned diffusion models. In the first step, a compressed random image is generated made of random noise. This image is passed multiple times inside an encoder-decoder model, text conditioned by a user prompt, which removes a small portion of the noise at each step. Finally, the compressed image obtained at the desired step is passed through a final decoder (on the left) to obtain the final high-resolution result. Here we show how the choice of the number of steps impacts the result	56
Fig. 2.14	Conditional VAE. In this variation of the original VAEs, the encoder is designed to take both an image and the corresponding class label as input while the decoder is designed to receive both a latent representation and a class label	59
Fig. 2.15	Algebraic manipulation of concepts. The images show how to use simple vector operations in the latent space to manipulate the images	60
Fig. 2.16	Results on the same prompt (Prompt: beautiful flower field with a cottage in the distance, close-up shot, rocky, at dusk, distant mountains, 4k, rule of thirds, extreme detail, hazy, intricate ink illustration, surreal, surrealist, trending on artstation, cgsociety, hd, calm, complimentary colors, realistic lighting, by Albert Bierstadt, Frederic Edwin Church) with increasing values of Classifier-Free Guidance. Top row: values 1, 3, 5, 7, 9. Bottom row: values 11, 13, 15, 17, 19. Higher values are associated with more adherent and cleaner outputs. However, this usually comes at the expense of creativity and diversity	61

Fig. 2.17	In-painting example with Stable Diffusion. Initially, the model is prompted to create a purple dress and both the girl and the dress in the image are generated. In the second step, a simple user interface allows you to highlight the portion of the image you want to change and in the third step you can prompt the model again to specify how/what to change in the image portion selected. In this example, the prompts are very simple and generic, but you can provide more specific details to guide generation	64
Fig. 2.18	Sketching examples generated by DALL-E 2. Starting from simple sketches and prompt instructions, DALL-E 2 generates text-conditioned realistic images	65
Fig. 4.1	The desktop interface of the web application of the JECT.AI product	107
Fig. 4.2	The interface of the original JECT.AI plug-in as it appears on the right side of the WordPress text editor page	110
Fig. 4.3	The interface of the original JECT.AI plug-in to one commercial content management system used in large numbers of newsrooms	112
Fig. 4.4	The new home page for the JECT-CLONE-funded service on the JECT.AI home page	116
Fig. 4.5	A screen grab from the second of three stages during which the user can define their personalised morning email preferences	117
Fig. 4.6	Two examples of personalised emails generated by the JECT.AI service	121
Fig. 5.1	The creative design process framework conceptualized by Bruno (2022). The design process has been deconstructed in stages, steps, activities, and factors of creativity	134
Fig. 5.2	The three waves of human and AI creativity relationship in design. Developed by the authors	137
Fig. 6.1	The implementation of AI in the fashion industry	165
Fig. 6.2	The implementation of AI in Fashion Operations	167
Fig. 6.3	The implementation of AI in Fashion Supply Chain Management	178
Fig. 6.4	The implementation of AI in Fashion Marketing	183

LIST OF TABLES

Table 1.1	DUCP layers of complexity and creativity forms (Corazza, 2019)	4
Table 1.2	DAV state: DV-GPT as an Assistant	14
Table 1.3	I state: DV-GPT as an Assistant to collect Relevant Information in the form of megatrends, trends, and small signals	16
Table 1.4	DAV state: DV-GPT as an Inspirational Source	17
Table 1.5	N state: DV-GPT an Assistant in Novelty generation	18
Table 1.6	C state: DV-GPT as an Assistant in Creativity estimation	20
Table 1.7	I state: DV-GPT listing Assistors and Resistors	21
Table 3.1	Bot generated summary of the discussion	87
Table 3.2	Bot generated summary of the conversation	92
Table 7.1	Systems for automating musical tasks	214
Table 7.2	Systems intended to expand human creativity	228



CHAPTER 1

The Cyber-Creative DA VINCI Process

Giovanni Emanuele Corazza

ABBREVIATIONS

AI	Artificial Intelligence
AUT	Alternative Uses Task
CT	Convergent Thinking
DA VINCI	DAV: Drive—Attention & Volition, I: Information, N: Novelty generation, C: Creativity estimation, I: Implementation
DT	Divergent Thinking
DUCP	Dynamic Universal Creative Process
Gen-AI	Generative Artificial Intelligence
HCI	Human-Computer Interaction
RFA	Refined Focus Area

DEFINING CREATIVITY AS A DYNAMIC PROCESS

Humanity is endowed with the necessary intelligence and creativity to reflect and act upon itself and upon the universe in which we are immersed. Through language, memory, imagination, and action we have developed

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a creative process that produced social systems with shared cultures and myriad technologies, greatly expanding our natural individual characteristics. As a result, whereas all species have culture (Boyd & Richerson, 1996), we are the only ones who have seen the exponential evolution of our cumulative culture (Lehman, 1947), and this can be explained by our social exploitation of creativity (Enquist et al., 2008; Glăveanu, 2011).

But how can creativity be defined? According to Runco and Jaeger (2012), the “standard definition” requires the recognition of both *originality* and *effectiveness* in order for creativity to exist. In the creativity studies literature, originality is often reduced to novelty, whereas effectiveness is frequently intended as appropriateness, or utility, or meaningfulness. I identify this standard definition as *static*, as it corresponds to a snapshot event of success or achievement, in which the two fundamental attributes of originality and effectiveness are indeed agreed upon for a specific product by a determined group of people at a defined time (Stein, 1953). In other words, this definition covers instances of creative achievement, and it is product oriented.

But this static definition is far from sufficient: the creativity phenomenon is not a collection of disjoint snapshots, but a continuous dynamic process. Before any form of success can emerge, the process must undergo extensive periods of what I identify as *creative inconclusiveness* (Corazza, 2020), which from the point of view of determining the characteristics of the creative person is arguably even more important, for example in terms of tolerance of ambiguity (Zenasni et al., 2008) and self-regulation (Ivcevic & Nusbaum, 2017; Zielińska et al., 2023). In the history of science, arts, or technology, there are uncountable instances in which ideas or artifacts were not understood, ridiculed, discarded, only to be rediscovered later in time (sometimes much later), to become seminal milestones in the development of our civilization. This constitutes definitive proof of the fact that the creative process is dynamic. Further, there are instances in which the outcomes of a creative process are totally unimportant: this is for example the case of creativity used as therapy (Bertman, 2018; Chiang et al., 2019).

For all the above reasons, in order to understand the multifaceted creativity phenomenon (Lubart, 2017) it is necessary to focus on the creative *process* and not on the creative product, by adopting the dynamic definition of creativity, that covers both creative achievement and creative inconclusiveness: *creativity requires potential originality and effectiveness*

(Corazza, 2016). The added word “potential” yields the wanted extension from a static to a dynamic view, from a product-oriented to a process-oriented perspective. The adoption of this definition brings as a consequence the possibility to study the phenomenon under the light of the dynamic creativity framework (Beghetto & Corazza, 2019; Corazza et al., 2022; Corazza & Glăveanu, 2020), with both theoretical and empirical implications. For the purposes of this chapter, the most relevant consequence is that the dynamic definition of creativity opens the way to the introduction of the dynamic universal creativity process (DUCP).

THE DYNAMIC UNIVERSAL CREATIVITY PROCESS

Creativity Episodes Are Interconnected in the DUCP

Let’s define a specific instance of a creative process as a creativity *episode*. In creativity studies, episodes are usually studied in isolation for pragmatic reasons, but in reality they have indefinite connections to the past and no rigidly defined ending. Several models for the creative process have been proposed (Corazza & Agnoli, 2022; Glăveanu, 2011; Kaufman & Baer, 2004; Lubart, 2001; Mumford et al., 1991; Wallas, 1926), and they all focus on a single creativity episode. However, creativity episodes do not start ex-nihilo: they use extant reality and information as a starting point, and they can become ingredients for future episodes; hence, they are connected to the past and projected into possible futures, in ways that can range from very straightforward to very complex. Even considering creativity episodes that appear to be completely unrelated, by going back in time it is always possible to find a common root. This is particularly evident in the history of ideas (Betti & van den Berg, 2014). Extending the consequences of this observation to the entire history of our universe, I posit the hypothesis that throughout cosmic evolution all creativity episodes are interconnected, thus forming a single macroscopic process which I identify as the Dynamic Universal Creative Process or DUCP (Corazza, 2019; Corazza & Lubart, 2020). The DUCP is defined as: “*The active ensemble of all creativity episodes in the course of cosmic evolution*”. The existence of the DUCP is identified here as the DUCP hypothesis.

Layers of Complexity in the DUCP

By accepting the DUCP hypothesis, in opposition to the prevailing anthropocentric position, creativity is not a reserved playground for humanity. This is also a central tenet in Whitehead’s process philosophy (Corazza, 2022). In “Process and Reality”, Whitehead (1929) describes a cosmology in which creativity is the ultimate metaphysical principle (p. 21): “*Creativity is the universal of universals, characterizing ultimate matter of fact. It is the ultimate principle by which the many, which are the universe disjunctively, become the one actual occasion, which is the universe conjunctively. It lies in the nature of things that the many enter into complexity*”. Undoubtedly, humanity has shown to be capable of very high levels of creative achievement, both at individual and social levels (Glaveanu et al., 2020), forming a rich psycho-social layer of complexity in the DUCP. But the origin of the DUCP is posited to precede the advent of Homo sapiens, as we can recognize creative activities in hominids, the most prominent being the stone tool industry (Harmand et al., 2015). Further, the emergence of creative trajectories of evolution can be recognized also in non-human forms of life, in the biological layer of complexity, as well as in inanimate matter that is kept far from equilibrium (Loreto et al., 2016; Prigogine, 1961), forming a material layer of complexity in the DUCP. Furthermore, in the last decades humanity has been developing the necessary technology to imitate and extend human intelligence via artificial electronic circuits. As I will discuss later in more detail, this *artificial intelligence* (AI) is becoming capable of generating content with surprising efficiency, to the point that a Gen-AI layer of complexity can be recognized in the DUCP. As a consequence of this discussion, the DUCP is posited to contain four layers of complexity, as represented in Table 1.1.

Table 1.1 DUCP layers of complexity and creativity forms (Corazza, 2019)

<i>Layer of complexity</i>	<i>DUCP form</i>	<i>Creativity sense</i>	<i>Creativity form</i>
Material layer	Material creativity process	Wide-sense	Emergent and energy-driven
Biological layer	Biological creativity process	Wide-sense	Emergen and adaptive
Psycho-social layer	Psycho-social creativity process	Strict-sense	Intelligent and goal-driven
Gen-AI layer	Artificial creativity process	Wide-sense	Cybernetic

It is important to note that each layer of complexity builds on the previous one, but cannot be reduced to it. In this sense, the DUCP should be considered to be a unified theory and not a final theory of the universe (Corazza, 2023), because each layer maintains fundamentally distinct properties. In particular, assuming that intentionality and free will are peculiar characteristics of humanity, only the psycho-social layer is characterized by strict-sense creativity in Table 1.1, all others being wide-sense. Wide-sense creativity can be understood as the fundamentally unpredictable emergence of original trajectories out of a layer of complexity (be it material, biological, or artificial).

I point the interested reader to (Corazza, 2019) for further details about creativity at the material and biological layers; suffice it to say that this is a coherent way to describe the exponential growth in complexity in the universe, from the Big Bang to the present day, including the evolution of different life forms on earth. From this point on, I concentrate my attention to human creativity, occurring at the psycho-social layer, along with wide-sense artificial creativity occurring at the Gen-AI layer, and cyber-creativity, intended as the interaction between humans and machines in the more recent layers of the DUCP.

In order to proceed, it is important to have a model for a creative episode that is capable of describing the relevant stages and the components for cyber-creativity.

MODELING THE CREATIVE PROCESS: DA VINCI

From now on, “creative process” identifies the portion of the DUCP referring to a single creative episode, with implied interconnections into the past and implications for the future. The DA VINCI model was introduced in (Corazza & Agnoli, 2022) as an alternative to other existing models for the creative process occurring in an episode. Indeed, several models for the creative process have been proposed in the literature (e.g., Finke et al., 1996; Mumford et al., 1991; Wallas, 1926) and discussed by Lubart (2018). The DA VINCI model is useful because it can be shown to reduce to other models as particular cases, while adding some specific features. The model is clearly dedicated to Leonardo Da Vinci, but at the same time “DA VINCI” represents a five-part acronym (DAV + I + N + C + I) that identifies the key mental states in the creative process: DAV (Drive—Attention & Volition), I (Information), N (Novelty generation),

C (Creativity estimation), I (Implementation). A graphical representation is provided in Fig. 1.1. Let’s give a brief description of each state.

DAV—Drive: Attention and Volition is the entry point into the creative process. “Drive” highlights the need for an energy and time investment beyond basic survival levels, in order to engage in creativity. This conflicts with the principle of cognitive economy (Rosch, 2002), which favors efficiency. Creativity demands this extra effort; without it, it cannot go beyond existing knowledge. Creativity is an investment (Sternberg &

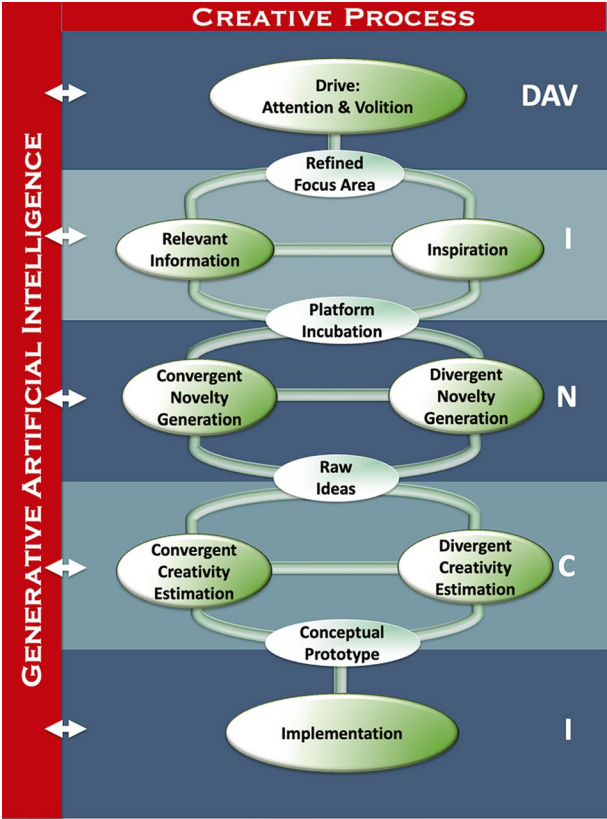


Fig. 1.1 The DA VINCI model for the creative process (modified from Corazza, 2019)