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

Series Editor
Todd Lubart
Université Paris Cité
PARIS, France

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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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 complex unity*". 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)

Layer of complexity	*DUCP form*	*Creativity sense*	*Creativity form*
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 &

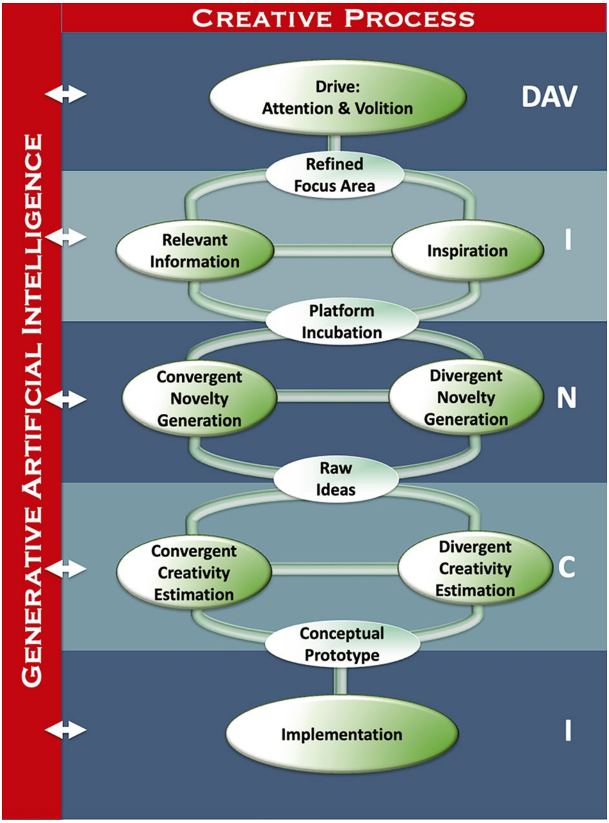

Fig. 1.1 The DA VINCI model for the creative process (modified from Corazza, 2019)