Frictions in the Cyber-Creative Process: the DA VINCI Model and Method*

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Abstract

The integration of Generative AI into creative processes presents both opportunities and challenges for human creativity. While AI can augment creative capabilities, over-reliance can risk diminishing creative self-beliefs and human agency. This paper introduces a friction-by-design approach through the DA VINCI model, proposing purposeful micro-interventions that slow human-AI interactions at critical decision points. We present a friction-by-design approach to each mental state of the creative process, designed to prioritize human agency while leveraging AI capabilities that embodies context-adaptive friction to support meaningful human-AI co-creation.

Keywords

Human-AI collaboration, Creative AI, Friction design, Cyber-creativity, DA VINCI model

1. Introduction

Creativity, defined as the contemporaneous existence of potential originality and effectiveness which may or may not turn into creative achievement [1], inherently requires substantial time and energy investment to endow processes with the necessary potential to yield tangible products [2]. However, contemporary society's emphasis on efficiency has progressively compressed creative time frames [3], a trend significantly accelerated by the advent of Artificial Intelligence (AI), particularly Generative AI (Gen-AI). This technological shift has catalyzed the emergence of cyber-creative processes—characterized by varying degrees of human-machine interaction—with profound implications for creative professions [4, 5, 6].

Current research identifies multiple scenarios for cyber-creative processes [7]; in particular, the Co-cre-AI-tion scenario entails a collaborative creative framework involving humans and Gen-AI with explicit mutual recognition. Within this paradigm, human agency should remain central while creativity would become augmented through AI partnership [8]. This cyber-creative turn presents both opportunities and threats. Opportunities include AI's capacity to enhance human creativity through collaborative partnerships, democratizing creative domains by reducing expertise barriers, while maintaining human centrality in creative processes. However, significant threats also emerge, particularly the risk of over-reliance on AI through excessive offloading [9, 10]. Continuous dependency on AI can reduce sensitivity to internal creative cues, while uncritical acceptance of AI outputs threatens to erode critical thinking and decision-making capabilities, as users increasingly favor AI-generated shortcuts over independent reasoning [6]. Human creative potential fundamentally depends on individuals' motivation to initiate creative activities and their perceived capability to engage meaningfully in such processes. In fact, recent research emphasizes the crucial role of motivational and self-perceptive factors, collectively termed creative self-beliefs [11, 12], in explaining individual differences in creative activity and achievement.

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However, Gen-AI tools usage may systematically diminish these creative self-beliefs [13, 8], potentially altering how individuals perceive and engage with creativity itself.

To address these challenges, we introduce a ´´friction-by-design" approach to cyber-creative processes within the DA VINCI model framework [14]. Frictions can be defined as purposeful, pro-social micro-interventions, including strategic pauses, reflective prompts, verification checks, and comparative justifications, that deliberately slow interaction at critical decision points to surface user intentions, stimulate cognitive activation, and counter automation bias [15, 16, 17, 18, 19]. Note that we are excluding anti-social forms of friction, which can be used for malevolent nudging or frauds [20, 21]. At the same time, in order for a friction-by-design approach to be useful, we believe that the specific form of friction and its intensity should be context-adaptive, responding to specific creative scenarios and user needs. The one-size-fits-all approach would be counterproductive. However, calibrating friction is not addressed here, but left for future work.

Our approach aims at fostering more conscious and meaningful human-AI interactions, ultimately enhancing creative engagement and agency while mitigating risks of over-reliance. By strategically decelerating the cyber-creative process at key junctures, we intend to enable fuller expression of individual creative potential.

In this article, we present practical implementation guidelines through the DA VINCI model for cyber-creative processes, specifically focusing on a friction-by-design approach. Originally designed to support human creativity, the DA VINCI model has been extended in 2023 as a framework for Co-cre-AI-tion. This model employs a five-part acronym identifying key mental states in creative processes: DAV (Drive, Attention & Volition) emphasizes energy investment, attention, and motivation in initiating creativity; I (Information) encompasses both gathering of relevant knowledge and the introduction of apparently irrelevant sources of inspiration; N (Novelty generation) focuses on idea creation with both convergent and divergent modalities; C (Creativity estimation) involves evaluating generated ideas' potential value, with an open mind towards serendipity; and I (Implementation) addresses creative concept realization. The model's dynamic structure allows iterative movement between different states [14].

2. Friction-by-design for the DA VINCI model

As indicated before, the DA VINCI model structures creative cognition into five interlinked mental states: DAV—Drive, Attention & Volition; I—Information; N—Novelty generation; C—Creativity estimation; I—Implementation. Each state may incorporate specific micro-interventions of the cyber-creative frictions, stimulating deliberate design choices, fostering reflection and cognitive engagement, while potentially reducing processing speed. These programmed hurdles aim to stimulate human cognitive activation and mitigate over-reliance on automated systems [16, 17, 22], decelerating processes and encouraging reflection [18]. Applying these principles within the DA VINCI framework should help humans to remain active participants rather than passive operators.

In Table 1 the friction-by-design approach is presented in a unified way. These are the questions that form the micro-interventions aiming at preserving human agency.

2.1. DAV (Drive: Attention & Volition)

The core of this mental state is the entry point into the creative process, characterized by the necessary investment of energy and time beyond basic survival levels. It is built on both cognitive (Attention) and motivational (Volition) elements. Attention focuses on a problem, while volition provides the crucial motivational drive.

Drive friction may prompt an individual to question why they are pursuing a specific path and whether it is truly meaningful or simply convenient. This friction can invite the consideration of multiple directions, not just the easiest, and reinforce a sense of agency in defining one's creative trajectory.

Table 1
DA VINCI Mental States, Frictions, and Guiding Questions.

DA VINCI Mental state	Friction name	Friction questions
DAV (Drive: Attention & Volition)	Drive friction	What are multiple refined focused areas (RFAs), or directions, I could pursue — not just the easiest one? Am I choosing this path because it's meaningful, or just because it's convenient? Do I feel agency in defining my own creative direction?
I (Information)	Information friction	Have I verified the information, or am I accepting it just because it's given (by AI or system)? Are my sources diverse, reliable, and relevant? What happens if I include irrelevant, absurd, or paradoxical information — does it spark new insights? Does this input challenge my assumptions, or just reinforce them?
N (Novelty Generation)	Generation friction	Can I generate ideas independently before seeing suggestions? How might an unexpected constraint reshape this idea? Can I form unusual associations between concepts, even if they seem illogical? Which idea surprised me most — and why?
C (Creativity estimation)	Estimation friction	Why am I choosing one idea over another — can I justify it? Can I extract hidden potential from a weak idea by reframing it in another context? What would this idea look like from a completely different perspective? Am I critically assessing or just defaulting to the "most polished" suggestion?
I (Implementation)	Implementation friction	Have I iterated enough, or am I accepting the first viable version? At each stage, do I approve, refine, and adjust — or just let it pass? What feedback or reflection checkpoints can I add before finalizing? Does this outcome still align with my original motivation and values?

2.2. I (Information)

This state provides the essential elements for creative thinking, consisting of two components: Relevant Information from existing knowledge, and Inspiration, which includes information that might seem irrelevant or absurd but can spark non-linear thinking. Together, these components form the mental ´´Platform" for new ideas.

Information friction might serve as a mechanism to reduce misleading or ungrounded outcomes like AI hallucinations. It encourages a critical verification of information and a deliberate openness to unconventional viewpoints that challenge assumptions, thereby increasing the potential for originality.

2.3. N (Novelty Generation)

This is the core of the creative process, where novel ideas are generated from the platform. It employs two thinking styles: convergent, which uses available elements synergistically to allow a new idea to emerge, and divergent, which requires generating multiple alternatives from a common root.

Generation friction may push the human to generate ideas independently before seeing suggestions. It encourages the use of unexpected constraints and the formation of unusual, illogical associations to reshape ideas and preserve the human's role and sense of ownership in the creative process.

2.4. C (Creativity estimation)

This state is where the value of generated ideas is estimated. For a truly original idea, its value cannot be judged statically but must be estimated by projecting it into a vision of the future. This is done through both convergent estimation, which assesses relevance to the initial problem, and divergent estimation, which explores value outside the original boundaries.

Estimation friction is intended to compel agents to justify their choices and critically assess ideas, rather than defaulting to the most risk-free suggestion. It encourages extracting hidden potential from a ´´weak" idea by reframing it from different perspectives.

2.5. I (Implementation)

This state is the final action-oriented phase where a creative episode becomes a visible, audible, or tangible result. It involves selecting and refining ideas that align with practical constraints and transforming them into early prototypes to be tested in the real world. It is the pathway that bridges creativity into innovation.

Implementation friction might encourage a creator to question whether they have refined their idea enough or are accepting the first viable version. It prompts the addition of reflection checkpoints before finalizing and ensures the outcome still aligns with the original motivation and values.

This friction-by-design approach framework aims to clarify friction introduction points and significance, in order to align cyber-creative trajectories with human goals rather than speed and optimization by default [16, 17, 18, 15]. Furthermore, the architecture of the friction approach reflects the DA VINCI model's theoretical foundation as interconnected mental states rather than sequential stages. Users might choose to navigate flexibly between these states based on emerging creative needs, whether jumping directly to Information gathering when Drive is already clear or returning to Direction refinement when Novelty generation reveals gaps in initial framing. This flexibility extends to within-phase iteration, allowing users to explore multiple approaches before progressing. The implementation of these frictions in practice, for example, in the case of a custom GPT, requires careful calibration to match user context and creative constraints while maintaining the essential balance between efficiency and reflective engagement.

3. Future Directions

Future work will focus on implementing the friction approach into a customized GPT system, DA VINCI 2.0, building on the previous DA VINCI custom GPT [5], designed as a proof of concept for integrating systematic cognitive frictions into Gen-AI interfaces. A key component of this implementation will be the Pre-Session Friction Calibration (PSFC), which would allow users to calibrate friction intensity according to their situational constraints, energy levels, and creative objectives. This calibration would provide four distinct interaction scenarios that combine time (fast vs. slow exchanges) with space (focused refinement vs. expansive reflection) [23], aiming to ensure that intervention strategies are contextually adaptive rather than one-size-fits-all.

In addition, mid-session recalibration is planned to occur after the Novelty stage through targeted queries about pace preference and exploration depth. This step acknowledges that optimal friction levels may evolve as creative work progresses and as users gain clarity about their goals. Sessions conclude with momentum-preserving prompts that encourage immediate action while leaving pathways for future refinement.

Once calibrated, DA VINCI 2.0 could dynamically monitor engagement patterns to sustain creative flow, reducing resistance when users exhibit signs of overload. By combining structured calibration with adaptive modulation during interaction, DA VINCI 2.0 could serve as a future model for how generative systems balance efficiency with deliberate resistance, supporting creativity while maintaining human agency.

Furthermore, a promising avenue for future work lies in refining and expanding the current set of frictions. While we introduce one primary friction per mental state, it is possible that multiple, more fine-grained frictions could exist within each stage of the creative process. For instance, the broad category of "assessment friction" might be further decomposed into frictions targeting self-evaluation, peer feedback, or long-term value reflection. Such reconfigurations may help tailor friction-by-design interventions to specific contexts, user profiles, or creative domains.

4. Conclusion

This paper describes an approach to the challenges of human-AI collaboration in creative processes through the introduction of systematic friction design. The DA VINCI model framework, combined with a context-adaptive friction approach, provides a structured methodology intended to maintain human agency while drawing on AI capabilities in cyber-creative settings.

The friction-by-design approach is positioned as a response to a gap in current human-AI interaction paradigms, where decision-making processes are intentionally slowed at certain points. Instead of emphasizing speed and efficiency, the proposed frictions are oriented toward reflective engagement, cognitive activation, and the support of creative self-beliefs. The DA VINCI model structure is outlined as a framework through which these interventions may be placed across the creative process.

The implications of this work are framed as extending beyond individual creative tools to broader considerations of human-AI collaboration design. As AI systems become more sophisticated and present across creative domains, concerns around diminished human agency and creative self-efficacy appear more relevant. The approach outlined here positions purposeful inefficiencies and reflective pauses not as limitations, but as features that may help preserve human creativity in the context of AI integration.

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Declaration on Generative AI

During the preparation of this work, the authors used GPT-4 in order to: grammar and spelling check; and sentence-level proofreading and occasional rephrasing to improve clarity and correctness. All such suggestions were critically reviewed and edited by the authors. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the publication's content.

References

[1] G. E. Corazza, Potential originality and effectiveness: The dynamic definition of creativity, Creativity Research Journal 28 (2016) 258–267. doi:10.1080/10400419.2016.1195627.

[2] R. J. Sternberg, T. I. Lubart, An investment theory of creativity and its development, Human Development 34 (1991) 1–31. doi:10.1159/000277029.

[3] R. Hassan, Empires of Speed: Time and the Acceleration of Politics and Society, volume 4, Brill, Leiden, 2009.

[4] N. Anantrasirichai, F. Zhang, D. Bull, Artificial intelligence in creative industries: Advances prior to 2025, 2025. arXiv:2501.02725, arXiv preprint arXiv:2501.02725.

[5] G. E. Corazza (Ed.), The Cyber-Creativity Process: How Humans Co-Create with Artificial Intelligence, Springer Nature, 2025.

[6] G. E. Corazza, S. Agnoli, A. Jorge Artigau, R. A. Beghetto, N. Bonnardel, I. Coletto, A. Faiella, K. Gerardini, K. Gilhooly, V. P. Glăveanu, M. H. Hanson, H. Kapoor, J. C. Kaufman, Y. N. Kenett, A. V. Kharkhurin, S. Luchini, M. Mangion, M. Mirabile, F.-K. Obialo, C. Phelps, R. Reiter-Palmon, J. S. Puryear, E. D. Sarcinella, M. Tang, G. M. Vavassori, F. Vinchon, I. Viskontas, S. Weiss, D. Zbainos, T. Lubart, Cyber-creativity: A decalogue of research challenges, Journal of Intelligence 13 (2025) 103. doi:10.3390/jintelligence13080103.

[7] F. Vinchon, T. Lubart, S. Bartolotta, et al., Artificial intelligence & creativity: A manifesto for collaboration, Journal of Creative Behavior 57 (2023) 472–484. doi:10.1002/jocb.597.

[8] R. Watkins, E. Barak-Medina, Ai's influence on human creative agency, Creativity Research Journal (2024) 1–13. doi:10.1080/10400419.2024.2437264.

[9] M. Fasoli, G. Cassinadri, M. Ienca, The dark side of cognitive enhancement: A framework for the technologically induced cognitive diminishment, Journal of Cognitive Enhancement (2025) 1–14.

[10] C. Zhai, S. Wibowo, L. Li, The effects of over-reliance on AI dialogue systems on students' cognitive abilities: A systematic review, Smart Learning Environments 11 (2024). doi:10.1186/s40561-024-00316-7.

[11] M. Karwowski, J. C. Kaufman, The Creative Self: Effect of Beliefs, Self-Efficacy, Mindset, and Identity, Academic Press, 2017.

[12] M. Karwowski, I. Lebuda, R. A. Beghetto, Creative self-beliefs, in: J. C. Kaufman, R. J. Sternberg (Eds.), The Cambridge Handbook of Creativity, 2nd ed., Cambridge University Press, Cambridge, 2019, pp. 396–418. doi:10.1017/9781316979839.021.

[13] A. Faiella, A. Zielińska, M. Karwowski, G. E. Corazza, Am i still creative? the effect of artificial intelligence on creative self-beliefs, The Journal of Creative Behavior 59 (2025) e70011. doi:10.1002/jocb.70011.

[14] G. E. Corazza, S. Agnoli, The DA VINCI model for the creative thinking process, in: T. Lubart, et al. (Eds.), Homo Creativus: Creativity in the Twenty First Century, Springer, Cham, 2022. doi:10.1007/978-3-030-99674-1_4.

[15] A. L. Cox, S. J. J. Gould, M. E. Cecchinato, I. Iacovides, I. Renfree, Design frictions for mindful interactions: The case for microboundaries, in: Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems, ACM, New York, NY, 2016, pp. 1389–1397. doi:10.1145/2851581.2892410.

[16] C. Natali, Per aspera ad astra, or flourishing via friction: Stimulating cognitive activation by design through frictional decision support systems, in: CEUR Workshop Proceedings, volume 3481, 2023, pp. 15–19.

[17] F. Cabitza, C. Natali, Open, multiple, adjunct. decision support at the time of relational AI, in: HHAI2022: Augmenting Human Intellect, IOS Press, 2022, pp. 243–245.

[18] B. Grosse-Hering, J. Mason, D. Aliakseyeu, C. Bakker, P. Desmet, Slow design for meaningful interactions, in: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, ACM, New York, NY, 2013, pp. 3431–3440. doi:10.1145/2470654.2466472.

[19] S. M. Jones-Jang, Y. J. Park, How do people react to AI failure? automation bias, algorithmic aversion, and perceived controllability, Journal of Computer-Mediated Communication 28 (2023).

doi:10.1093/jcmc/zmac029.

[20] P. Kuyer, B. Gordijn, Nudge in perspective: A systematic literature review on the ethical issues with nudging, Rationality and Society 35 (2023) 191–230. URL: https://doi.org/10.1177/10434631231155005. doi:10.1177/10434631231155005. arXiv:https://doi.org/10.1177/10434631231155005.

[21] M. Padigar, Y. Li, C. N. Manjunath, "good" and "bad" frictions in customer experience: Conceptual foundations and implications, Psychology & Marketing 42 (2025) 21–43. URL: https://onlinelibrary.wiley.com/doi/abs/10.1002/mar.22111. doi:https://doi.org/10.1002/mar.22111. arXiv:https://onlinelibrary.wiley.com/doi/pdf/10.1002/mar.22111.

[22] M. Cremaschi, M. Dorfmann, A. De Angeli, A steampunk critique of machine learning acceleration, in: Proceedings of the 2024 ACM Designing Interactive Systems Conference, DIS '24, Association for Computing Machinery, New York, NY, USA, 2024, p. 246–257. URL: https://doi.org/10.1145/3643834.3660688. doi:10.1145/3643834.3660688.

[23] G. E. Corazza, R. Reiter-Palmon, R. A. Beghetto, T. Lubart, Intelligence and creativity in the space-time continuum for education, business, and development, Journal of Creativity 31 (2021) 100003. URL: https://www.sciencedirect.com/science/article/pii/S2713374521000030. doi:https://doi.org/10.1016/j.yjoc.2021.100003.