Inside the Solution Diamond: The Role of CSTs Supporting Divergent and Convergent Thinking

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Abstract

Inspired by the growing development of Creativity Support Tools (CSTs) to enhance creative work over the past ten years, we investigate the evolution of these tools in supporting divergent and convergent thinking based on the Double Diamond model. However, the approaches developed so far do not represent the complete design space, indicating the existence of a limitation during the creative process. This article presents the Divergent-Convergent Thinking Framework (DCTF) to support an understanding of the composition of the creative spectrum. Based on a literature review (N=96), our framework synthesizes key categories of creativity and, particularly, research on CSTs. We propose six dimensions and four challenges and opportunities to guide the analysis of already developed CSTs, the development of future CSTs, and how to integrate them into users' workflow. To test its relevance, we present a possible scenario for the framework's applicability in the context of sustainable design-oriented creativity. We demonstrate how the framework guides the selection of ideas, supporting the cyclical transition between divergent and convergent thinking.

CCS Concepts

• Human-centered computing; **• Human-computer interaction (HCI)**; **• HCI theory, concepts and models**; **• Interactive systems and tools**;

Keywords

Creativity, Divergent Thinking, Convergent Thinking, Double Diamond, Creativity Support Tools

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1 Introduction

A saying by two-time Nobel Prize winner Linus Pauling states, "If you want to have good ideas, you must have many ideas and learn to throw away the bad ones" [1]. Exploring multiple ideas profoundly impacts society, leading to creativity having many facets and being freely used to describe various outcomes ranging from playing, dancing, painting, and making music to exploring and experimenting with science and technology. Ben Shneiderman [2] argues that creativity spans a spectrum from original work to evolutionary creative events, playing an essential role in problem-solving, design, and scientific discovery. This approach has been classified as a creative process [3], following the Double Diamond model [4–6], alternating between moments of divergence (exploration of ideas) and convergence (selection of ideas), as represented in Figure 1. In this context, Creativity Support Tools (CSTs) emerge as computational tools that can enhance human creativity during the creative process [7]. As they cover the different stages of the creative process (i.e., divergent and convergent thinking), these tools directly support the dynamics present in the Double Diamond model [5], facilitating the exploration of the entire continuum of the design space (i.e., conceptual space that allows the investigation of multiple solutions throughout the creative process [8–10]). A recurring limitation of these tools is that they address the phases of the creative process in isolation. Some investigations focus on supporting only the divergent process, while others, in the minority, focus on supporting only the convergent process. This limitation may occur due to an incomplete understanding of the design space. Given this gap, this work proposes to develop a new perspective on the creative process centered on the design space. To this end, we conducted a literature review on CSTs developed between 2012 and 2024, obtaining a sample of 96 tools. Based on our analysis, we identified six coded dimensions that define our design space, covering the contexts of applying the tools in each stage of the creative process. Finally, we present an illustrative scenario demonstrating how the theoretical framework, Divergent-Convergent Thinking Framework (DCTF), can be applied by different creative workers (e.g., researchers and designers). Our main contribution is the framework presentation that aims to support the development of future CSTs.

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2 Related Work

2.1 Divergent and Convergent Thinking during the Creative Process

One of the most significant resources of human beings is their creative capacity [11], so much so that its research spans more than a century, having started in psychology and continuing into the area of Human-Computer Interaction (HCI). On September 5, 1950, J.P. Guilford [12] gave a very influential presidential address to the

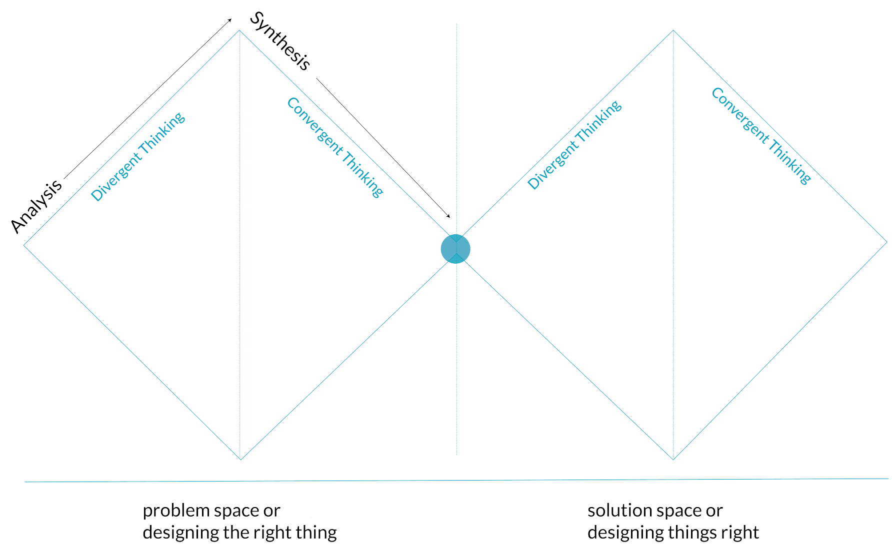

Figure 1: Model Double Diamond through the creative process

APA (American Psychological Association), in which he asked his colleagues to consider creativity a critical challenge and difficult to characterize. However, a consensus was reached in describing creativity as manifesting innovative and valuable ideas, interpreted as "new and useful" in their context [13]. In this context, cognitive psychology defines an "idea" as the essential element of thought and can be expressed in various ways, such as language, images, or even sensory perception [14]. Creativity is composed of two distinct [12] and interrelated [15] cognitive processes: divergent thinking (i.e., corresponding to the idea generation phase, where the maximum number of possible solutions, paths, and alternatives are considered) and convergent thinking (i.e., corresponding to the evaluation and selection of the ideas initially generated), respectively. According to Frich et al. [15], these processes are not linear but cyclical and interdependent, acting interactively during problem-solving. In our work, we seek to explore the relationship between the creative phases across the continuum of the creative process.

2.2 Double Diamond Review

Double Diamond is a visual model representing a creative and iterative design process focused on identifying problems and developing appropriate solutions for the user [17]. This method guides the development of creative ideas, aligning product quality, efficiency, and effectiveness of ideas in their use context. It is defined as "... a simple way to describe the steps taken in any design and innovation project, regardless of the methods and tools used" [18]. It can be applied in any domain or multidisciplinary environment, as it addresses the exploration, generation, and selection of solutions. It is related to systems thinking and has historical roots dating back to 1953, when Alex Osborn coined the term "brainstorming" and presented his understanding of the creative process as a diamond (Figure 2A), in which the flow starts at the top (divergent stage – generating options) and narrows towards the base (convergent stage – focusing on options) [4]. Years later, Bela H. Banathy presented an evolution of the model, applying it to systems design [5] composed of two dynamics. First, the design dynamics comprises five spaces: Exploration and Image Creation Space, Design Information and Knowledge Space, Design Solution Space, Evaluation and Experimentation Space, and Modeling Space. The second dynamic is the interactive dynamics of divergence and convergence. This dynamic operates in the exploration and creation of design images. These dynamics represent the new characterization of the model (Figure 2B), where we first diverge by creating a series of alternatives to the problem and then converge by evaluating and selecting the alternatives. In the 2000s, the British Design Council [6] consolidated and formalized the previous models in the design context, resulting in the Double Diamond model most widely used today (Figure 2C). The creative process is divided into four stages - Discover, Define, Develop, and Deliver, thus facilitating the understanding of which part corresponds to the divergent process and which to the convergent process.

The three models equally describe the presence of a duality between divergent and convergent thinking. However, a limitation still present during the creative process is the lack of engagement between and within each phase. Our research develops a theoretical framework incorporating the missing iteration in current models, allowing for more relevant support throughout the process.

2.3 Creativity Support Tools for Creativity-Oriented HCI

Many visionary thinkers have explored the potential for increasing human creativity over the decades. In 1973, Edward De Bono [19] introduced the concept of "lateral thinking," which led to new perspectives on approaching problems in innovative ways. In 1996, Dan Couger [20] presented 22 creativity methods, making significant contributions to the systematization of the topic. In the same year and the following year, psychologist Mihaly Csikszentmihalyi [21, 22] presented two significant contributions to the area: the

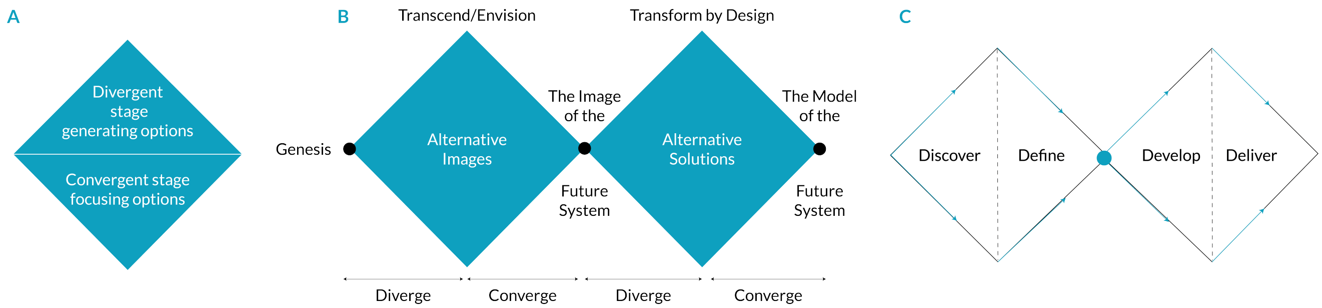

Figure 2: Model Double Diamond Evolution: A – Alex Osborn theory; B – Bela H. Banathy theory; and C – British Design Council theory

characterization of creativity based on three components – Domain, Field, and Individual and the concept of "flow," defined as the experience of complete and almost unconscious immersion while performing a task. These theories claim that creativity can be studied through scientific methods [23] and expanded through technological resources (similar to computers) [2]. A significant contribution in this last direction was the GENEX framework proposed by Ben Schneiderman [2, 11]. The theoretical framework comprises four phases (Collect, Relate, Create, Donate), which strengthens personal and collaborative creativity, with the central idea that creativity encompasses a spectrum that goes from original work to innovative and creative events. With the introduction of GENEX, a field of study that investigates how interfaces and technologies can directly impact human creativity emerged, and since then, literature reviews on CST have discussed the different perspectives on creativity, how it is interpreted, the role of technological tools, and their respective variations.

Frich et al. [24] conducted a historical review on creativity in the field of HCI, highlighting the evolution of CSTs. The research identified trends and patterns through three categories of analysis: creativity framework, subject focus, and research approach. They also highlighted how challenging it is to define the concept of creativity due to the diversity of approaches present in CSTs and the relevance of developing new tools, highlighting the complexity of the interaction between humans and technological tools (such as computers). Another literature review conducted by the researchers [15]complements the previous analysis but with a detailed view of the current state of CSTs. They present a mapping of the current scenario of CSTs through six trends: maturity, part of the supported process, devices, complexity, availability, and expertise. Based on the analysis, they proposed a definition of CST - A Creativity Support Tool that runs on one or more digital systems, encompasses one or more creativity-focused resources, and is used to positively influence users with different expertise in one or more distinct phases of the creative process. Still, on the same wave, Hsueh et al. [25] developed research addressing how technologies impact creative work, even with the different definitions of creativity. The researchers present the idea that the definitions of creativity directly shape the design and use of CSTs through four epistemological approaches that reflect the problem-solving view, the cognitive emergence view, the bodily action view, and the specialized attitude mediated by tools. They also suggest that, instead of a one-size-fits-all approach, future researchers should apply a pluralistic and contextual perspective inspired by feminist epistemology to help understand that CSTs are not neutral but reflect the values and practices of the people who create them.

These reviews focus primarily on theoretical definitions of creativity and CSTs but do not explore the space of these dynamics. Our approach seeks to understand the complexity of divergent and convergent thinking in a CST by developing a framework that addresses the entire space of dynamics present in the spectrum of the creative process.

3 Methodology

To achieve the objectives presented in section 1, we improved the preliminary review presented by Rodrigues et al. [26]. The researchers analyzed 90 publications between 2012 and 2022, of which 80 support divergent thinking and 10 support convergent thinking. In addition to applying the same research method presented in [26], we updated the research and included publications from 2023 and 2024. In the new analysis, we excluded nine articles from the divergent thinking sample (seven articles did not present the development of a CST, and two were duplicates). We included fifteen articles (seven articles on divergent thinking and eight on convergent thinking), resulting in a sample of 96 articles. We applied an iterative coding analysis to identify the characteristics of the design space of the sampled tools. The coding covered six defined and coded dimensions, as shown in Table 1.

3.1 Creative Process Analysis

3.1.1 Ideas Generation. The first stage of the process incorporates tools that support the formulation of broad and flexible ideas without the immediate restriction of specific criteria [], 40 CSTs were obtained that vary in their approaches. The analysis of the tools revealed how the different interaction approaches, levels of abstraction, and sensory stimuli shaped the generative process, with reactive interaction tools predominating, in which the system responds to the user without anticipating their needs.

Solutions such as Crowdboard [34], Conversation with Materials (CWM) [35], MoodCubes [36], a tool developed by Wolf et al. [37] and Rooij et al. [38], and stimulate generation through multisensory stimuli (visual, auditory and haptics), operating through high

Table 1: Presentation of the different parameters, respective codes, and definitions used to encode the sample

Dimensions	Codes	Definition
Cognitive Process	Generation / Filtering	Non-linear process that allows a spontaneous and fluid exploration of ideas, and the linear process follows a structured and sequential path, as described in [27]
	Evaluation / Selection	Composed of sensemaking [28] which allows critical reflection, analysis of ideas and understanding of complex and ambiguous situations, and decision-making [29], which allows a choice between possible alternatives, based on criteria and pre-analyzed information
Domain	Ideation, Storytelling, General Design, Writing, Learning, Artistic, Collaboration, Sound, Emergent	Context in which each tool is inserted, as described in [26]
Conceptual Process	General Ideas Specific Ideas	Transition between the general and the specific throughout mental development, evolving from general to specific ideas, as presented by [30]
Abstraction Level	High Abstraction Medium Abstraction Low Abstraction	Degree of abstraction of ideas throughout the conceptual process [31]
Stimulus Type	Vision Audition Haptic Olfactory	Interaction through different channels, such as speech, pen, touch, hand gestures, gaze, head and body movements — in a coordinated manner with the output of the multimedia system [32]
System/User Interactions	Reactive	The system reacts to user interactions, offering support based on input provided Proative Passive [33]
	Proative	The system anticipates the user's needs and proposes ideas [33]
	Passive	The system provides support to the user without taking any initiatives, simply responding to what is requested [33]

abstraction of ideas, favoring a free flow of ideas, without rigid direction. In contrast, the BI-CST tool [39], which incorporates AI techniques to suggest inspiring images, integrates proactive interaction elements, reducing the randomness of the generation process.

Tools focused on developing narratives are distinguished by the progressive evolution of ideas through reactive interaction. The StoryDrawer [40] and CharacterChat [41] tools engage users in collaborative processes through visual, auditory, and haptic stimuli. The tools EmoG [42], StorySketch [43], and XCreation [44] apply AI techniques to suggest inspiration, promoting a transition between low abstraction and medium abstraction, where ideas begin to gain consistency.

In general design, the presence of proactive interaction is more striking, as the tools ImageSense [45], SemanticCollage [46], Cobbie [47], Drawing Apprentice [48], Prism [49], I++ [50], Sketchy [51], IdeateRelate [52], and Portrayal [53] use AI techniques to suggest visual inspirations, anticipating users' needs. The use of generative models, such as in the tools DynamicBrushes [54], DesAIner [55], Calliope [56], and Dazzle [57], demonstrates an advance in which the system not only responds but actively proposes ideas.

Writing is different because it incorporates multiple sensory stimuli in addition to visual and auditory stimuli. Tools developed by Gonçalves et al. [58], SonAmi [59], Second Look [60], and CreaTable [61] support olfactory and haptic stimulation, respectively. We also see passive interactions through the tools developed by Biskjet et al. [62], Gonçalves et al. [63], Gero et al. [64], and reactive interactions using the Ject.AI tool [65] and highlighting the importance of visual elements in the textual composition of this domain, reinforcing the multimodality and high abstraction of ideas.

In the learning domain, tools such as MetaMorphe [66], Scratch Community Blocks [67], and Switch [68] combine reactive interaction and multimodal exploration, allowing users to experiment with both visual and haptic concepts. The use of materiality also stands out with the Calligraphic [69], Joinery [70], and Sense-Seat [71] tools when integrating materials with multiple meanings, reducing the level of abstraction of ideas.

Finally, in the artistic domain, the tools developed by Fu et al. [72] and by Griffin et al. [73] support the evolution of ideas through reactive and proactive interactions, respectively, integrating visual and auditory stimuli, working with ideas at a medium level of abstraction.

3.1.2 Ideas Filtering. According to Childs et al. [74], the history and research on creativity indicate the importance of exploring an idea space before moving forward on the creative spectrum, highlighting the disconnect between idea generation and idea evaluation. This section presents this connection, identifying the transition between the two thoughts. In this context, 38 CSTs stood out, supporting users to reflect on ideas and highlighting different approaches.

In the General Design domain, the tools presented variations between reactive and proactive interactions, adapting to different users. Tools such as the one developed by Lundquist et al. [75], Broonie Experience [76], and CollArt [77] implemented reactive interactions, where the system responded to users' actions and supported the filtering of medium abstraction ideas through visual and haptic stimuli. The Drawing Apprentice [78], IdeaHound [79], and DrawMyPhoto [80] tools have maintained reactive interaction but support the filtering of low-abstraction ideas, favoring clarity during the refinement process. On the other hand, the tools C2Ideas [81], Decipher [82], idAnimate [83], Design Adjectives Framework [84], SketchTivity [85], and the tool developed by Maleki et al. [86] adopted proactive interactions, which allowed for more targeted support and operating with medium-abstraction ideas.

In the Collaboration domain, reactive interactions predominate through the tools Directed Diversity [87], InspirationWall [88], IdeaExpander [89], Knotation [90], and iDanceForms [91], stimulating the visual, auditory, and haptic process, supporting users to filter and prioritize ideas. In the Sound domain, the tools SounTraveller [92], ChordRipple [93], Polyphony [94], and the tool developed by Martin et al. [95] work with different levels of proactive interaction, helping users explore timbres and chords more efficiently, with a medium abstraction of sound ideas. The BlendWave [96] and VoiceAssist [97] tools use algorithms to support proactively filtering ideas, adapting to the evolution of the idea.

In the Artistic domain, the tools Mosaic [98], Comic Spin [99], and the tool developed by Koch et al. [100] operate with reactive interactions, where ideas are shaped from visual and algorithmic elements without anticipating the user's needs, stimulating the visual and auditory process contributing to ideas with medium abstraction.

In the Writing domain, reactive interactions predominate with the tools Inject [101, 102], Sparks [103], Metaphorian [104], Yarn [105], Sparkfolio [106], and MakeWrite [107], offering structural feedback through the visual process, in a space of medium abstraction ideas – ideas are organized and refined for greater clarity and coherence.

In the Emergent domain, tools such as Crea.blender [108], CrowdJump [109], ReelFramer [110], PromONTotion [111], and the tool developed by Rooij et al. [112] support the creation of creative games, news organizations, and the creation of creative advertisements by enabling a process of filtering and prioritizing ideas through proactive interactions. These tools stimulate visual and auditory processes with a medium level of abstraction.

3.1.3 *Evaluation and Selection Ideas.*

Stage of applying specific criteria to transform solutions into specific and contextualized solutions [13]. From our sample, 18 CSTs were obtained that support idea evaluation and guide idea selection.

In the ideation domain, the tools developed by Rooij et al. [113], Rooij et al. [114], IdeaMachine [115], Diverge-Bag-of-Lemons (DBoL) [116], and OutlineSpark [117] present a reactive interaction, stimulating only the visual process and operating between a medium and low level of abstraction, since ideas are evaluated based on criteria implemented in the systems and subsequently selected based on the evaluations.

In the General Design domain, the presence of primarily reactive interactions was observed, with tools such as IntuModels [118], GanCollage [119], LumiMood [120], GenQuery [121], MetaMap [122], FashionQ [123] and ContextCam [124], stimulating visual processes to support the evaluation of ideas through subjective criteria for automatic adjustments, allowing users to evaluate the aesthetics and functionality of each idea at low levels of abstraction. The AdoMC [125] and generative.fashion [126] tools present evaluative recommendations through machine learning algorithms, presenting proactive interactions, anticipating user preferences, suggesting directions, equally stimulating the visual process, and operating on ideas with low levels of abstraction.

In the collaboration domain, the tool developed by Mackeprang et al. [127], Rodrigues et al. [128], and the first approach tool [129] promote proactive interactions, stimulating the visual process. The systems promote iterative cycles, where the high abstraction of ideas passes to lower levels as the ideas are evaluated and selected for implementation.

In the sound domain, the tool developed by Zhou et al. [130] stands out by balancing reactive and proactive interaction through the iterative exploration of melodies, stimulating only the visual process.

3.2 Concluding Remarks

Based on the coding presented in Table 1, our analysis revealed that CSTs are not just auxiliary tools of the creative process but transformative agents that shape how ideas emerge, engage, and are selected for implementation (Table 2).

The idea generation stage is characterized as a non-linear cognitive process associated with ideas with a high level of abstraction, supported by reactive, proactive, and passive interactions. Tools at this stage stand out for exploring multiple domains (i.e., Ideation, Storytelling, General Design, Writing, and Learning). An essential connection between divergent and convergent thinking is evident, challenging the traditional view that they are distinct processes. Filtering ideas expands the initial phase through structured support without restricting creativity, avoiding blocks and cognitive biases. It is characterized as a linear cognitive process associated with ideas with a medium/low level of abstraction, operating with reactive and proactive interactions and equally combining multimodal stimuli in several domains (i.e., General Design, Collaboration, Sound, Artistic, Writing, and Emergent). The evaluation stage is characterized as a sensemaking process associated with ideas with a low level of abstraction, presenting objective guidelines that increase analytical rigor and mitigate bias through reactive and proactive interactions between the system and the user. This stage operates on unimodal stimulation through the visual process and combines a low range of domains (i.e., Ideation, General Design, Collaboration, and Sound). Finally, the selection of ideas is associated with decision-making, where emotional and intuitive factors play a determining role. At

Table 2: Dimensions of the creative process supported by sampled CSTs

Stages of the Creative Process	Domain	Cognitive Process	Conceptual Stage	Abstraction Level	Stimulus Types	Interaction Type
Generation	Ideation, Storytelling General Design, Writing, Learning	Non-linear	General Solutions	High	Multimodal	Reactive, Proactive, Passive
Filtering	General Design, Collaboration, Sound, Artistic, Writing, Emergent	Linear	General Solutions	Medium/Low	Multimodal	Reactive, Proactive
Evaluation/Selection	Ideation, General Design, Collaboration, Sound	Sensemaking/ Decision-making	Specific Solutions	Low	Unimodal	Reactive, Proactive

this stage, the role of CSTs is indirect, providing analytical support and helping users base their choices on the evaluation stage.

4 Framework Design and Rationale

The analyzed tools actively reconfigure how ideas are generated, filtered, evaluated, and selected. However, we observed limitations in the complete coverage of the design space, which is essential for users to systematically explore possibilities and different creative directions [131, 132]. A complete understanding of the design space involves identifying how tools facilitate the flow between idea generation, evaluation, and selection; how they influence users' cognitive processes at different levels of abstraction; and how types of interaction (reactive, proactive, passive) and multimodal stimuli enable or limit exploration. In this sense, technology should support tasks and actively shape and expand creative possibilities, transforming linear processes into dynamic and adaptive flows that foster innovation. We also identified a fragmentation between divergent and convergent thinking, often treated as separate and sequential steps. Our analysis shows that this separation is artificial since the transition between both types of thinking is dynamic, and few tools offer explicit support for this flow. Another gap is the lack of dynamic adaptation – most tools operate with predominantly reactive and proactive interactions, without a mechanism that can adapt to the problem or task to be solved, compromising the flexibility of the support. Given that the impact of CSTs in the Double Diamond model occurs mainly in the second half of the process, we propose the Divergent-Convergent Thinking Framework (DCTF). This framework, composed of three key variables (idea space, solution space, prototyping, and optimization), organizes and expands the design space by framing divergence and convergence in both the design space and the solution space (Figure 2), thus aligning with the research presented in [133].

The first key variable: Idea Space - corresponds to the idea generation and filtering phases, where exploration occurs, and the first refinement and organization criteria emerge with and without the support of tools. This space is composed of linear and non-linear thinking in each phase, respectively, which gives rise to ideas from the most general to the most specific with different levels of abstraction and different types of interaction (reactive, proactive, and passive), but also presents multimodal stimulation (Figure 3A).

The second key variable, Solution Space, corresponds to the idea evaluation and selection phases, where evaluations guide decision-making. This space comprises sensemaking that guides decision-making, ending in specific solutions, with a low level of abstraction, with two types of interaction (reactive and proactive) and unimodal stimulation (Figure 3B).

Finally, the third key category, Prototyping and Optimization, is the moment to develop the selected ideas through prototyping tools (e.g., Figma or InVision) (Figure 3C). However, as it is not the focus of this study, it was not explored in depth.

5 Challenges and Opportunities

In light of the analysis presented, the framework supports the creative process through five dimensions (cognitive process, conceptual stages, level of abstraction, stimulus type, and interaction type) that provide a detailed view of the design space. Based on this theory, we propose four challenges and opportunities.

Transition between divergence and convergence: As mentioned by [26], allowing a cyclical interaction between divergent and convergent thinking is essential.

Expansion to new domains and audiences: In line with [26], CSTs should be adapted to areas such as engineering, healthcare, or social sciences, as well as to different levels of user experience and needs.

Human-AI collaboration: It has become common for humans to collaborate with AI in creative tasks, as observed, for example, through neural networks, generative adversarial networks (GANs), and up to large language models (LLMs). AI techniques are now seen as co-creators, suggesting unique concepts or combinations of ideas.

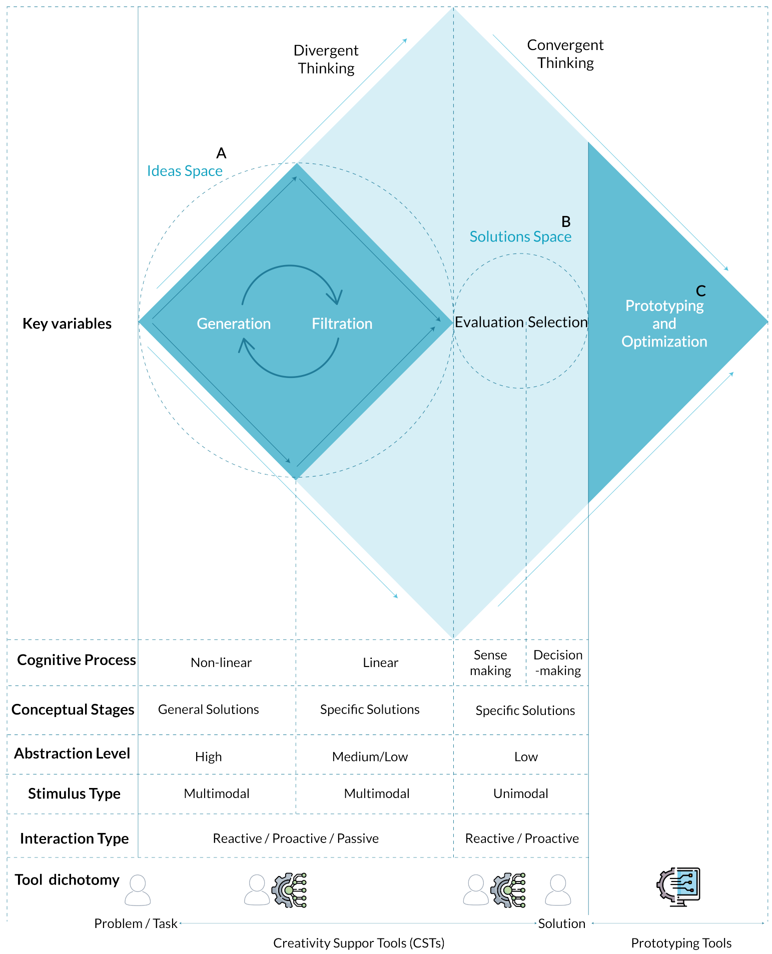

Figure 3: Visual presentation of the Divergent-Convergent Thinking Framework (DCTF)

Multisensory and multimodal exploration: The analyzed CSTs explored various visual and auditory stimuli. However, we observed that we could integrate other stimuli (e.g., haptic interfaces or interactive surfaces) and other modes of input of ideas (e.g., voice, writing, or gestures), which allows the user to "feel" the process through textures or shapes associated with ideas, both in divergent and convergent thinking and improve the support of the prototype. Although what works for divergent thinking may not work for convergent thinking, as observed in our analysis, we can present a variety of stimuli in divergent thinking. In contrast, excessive multimodality can introduce overload or distraction in convergent thinking.

5.1 Application Scenario

The DCTF and its five dimensions can reshape and expand many ways of working during the creative process. It supports the migration between divergent and convergent thinking in the design space, while supporting the dynamics between the context of use of the CST and the user. The following scenario presents the development of a creative process, exemplifying how the five dimensions of the DCTF (Cognitive Process, Conceptual Stages, Abstraction Level, Stimulus Type, and Interaction Type) support the creative process of a potential user of the framework. This scenario assumes that the DCTF enables an environmental engineer to make more efficient and effective decisions.

Imagine a designer from a Marketing & Communication department in the Government department, named Sarah, who is in charge of developing a campaign about the city's unsustainability. Sarah was given a multidisciplinary team, technological resources, and materials. Sarah started the campaign through brainstorming sessions, using a creativity support tool to guide them through the creative process. In the first phase of the sessions, the team generated several ideas (non-linear cognitive process). Then, to synthesize the ideas, Sarah and her team applied filtering criteria (linear cognitive process), managing to reduce the number of ideas, thus ending the divergent process. The team started the convergent process with the support of the creativity support tool that incorporated information visualization techniques based on artificial intelligence (stimulus type). Thus, it was possible to analyze the impact of each idea. The tool then presented a contextualized (see example, [134]), presenting a brief textual description and a score for each idea, ending the session with only three ideas (sensemaking). Finally, they selected the most efficient and effective idea based on the assessment presented by the creativity support tool and the team's analysis (decision-making). Sarah ended the session by presenting the final idea to the client. Sarah closed the project by presenting the final idea to the department head.

The scenario highlights the framework's applicability and dimensions, illustrating the continuous transition between divergent and convergent thinking.

6 Conclusion and Future Work

This paper presents a framework contextualizing the creative process through five main dimensions, Divergent-Convergent Thinking Framework (DCTF). This research has contributed to advancing the creativity-oriented HCI field by offering theoretical and practical dimensions applicable to the creative process. However, we acknowledge that empirical validation of the framework is lacking, which may be susceptible to limitations. As future work, we plan to develop a prototype based on the DCTF and subsequently apply user testing with multiple users, allowing for practical validation of the framework.

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