Technology-mediated Group Idea Generation and Evaluation for Artistic Creations Across Disciplines

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

ABSTRACT

Collaborative problem-solving often relies on a combination of interconnected divergent (e.g., ideation) and convergent (e.g., evaluation) creative processes. Where current practices in art are increasingly more collaborative and interdisciplinary, exploring group ideation and evaluation with creative artists is particularly relevant. Mediating these processes through technology has been shown to be an effective strategy to boost performance. However, existing Creativity Support Tools (CSTs) have primarily focused on divergent creativity. This work investigates the divergent and convergent processes of arts practitioners in collaborative settings through 20 semi-structured interviews, and understands how the intervention of technology can facilitate these processes through 6 group prototype evaluations of a novel CST, *deliberarts*. I contribute design implications for developing collaborative CSTs with both convergent and divergent creativity in mind, and a bespoke CST for group problem-solving processes in the creative arts.

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1

INTRODUCTION

Group ideation and evaluation are creative and collaborative processes used to generate ideas and make decisions related to a problem or context. Where ideation can be viewed as a *divergent* process (i.e., searching for variety in ideas [27]) and evaluation as *convergent* (i.e., leading to a single solution or outcome), both are argued to be factors of one another [59]. In practice, these processes employ multiple strategies and forms (e.g., brainstorming and brainwriting [41] as used in idea generation) across scientific, technological, and artistic domains. Mediating decision-making or problem-solving through technology is argued to be an effective strategy to boost group performance [50, 51]. As such, virtual collaborative whiteboarding (e.g., Miro) or web-based What-You-See-Is-What-You-Get (WYSIWYG) document platforms (e.g., Google Docs) are often used by groups in idea generation, selection, and evaluation in synchronous and asynchronous settings.

Collaborative art spaces across disciplines act as an interesting domain to explore these convergent and divergent problem-solving processes. There is a growing interest in the contemporary artworld for more participatory production of artwork and engaging in collective, socially engaged art [34]. In performance spaces, theatre embraces participant involvement in both performance and process through co-ownership [1], and recent research in collaborative music has explored how collaboration may exist outside of top-down hierarchies [8]. Exploring how ideas are generated (a divergent process) and related to a common goal or theme (a convergent process) is relevant given current collaborations in art are increasingly interdisciplinary and often focus on the cultural and social context of the artwork [6].

Previous research in Human-Computer Interaction (HCI) has explored ideation, selection, and evaluation mediated through technology. *Creativity Support Tools* (CSTs) are any tool which can be used to support an open-ended creative task [18]. Existing work in CSTs has been largely dominated by technologies that support *divergent* thinking [55]; exploring how practitioners across creative domains use existing technologies to generate and develop ideas [58] or novel digital tools created for individual [67] and group [40, 53] ideation. Where idea generation is a key part of creative processes, *convergent* processes of selection and evaluation are necessary for implementation [57]. Acknowledging the importance of both convergent and divergent thinking in creative tasks, and the interrelations between the processes [59], this suggests a need to further explore the design of CSTs supporting both tasks on one platform.

Thesis Statement. Collaborative problem-solving involves both convergent and divergent processes, with challenges in when, how, and what group members contribute. Nowadays, art-making has embraced collaborative practices, necessitating an exploration into how problem-solving occurs in these groups. Through a study of the current practices of art practitioners, I argue that digital technologies can be used to augment group problem-solving processes in the creative arts and beyond by directly surfacing and supporting divergent and convergent creativity in features.

To defend this statement, I explored the following research questions:

RQ1: What are the current divergent and convergent creative problem-solving processes of arts practitioners (e.g., musicians, visual artists, performing artists) when working in collaborative settings?

RQ2: How can the intervention of technology help to facilitate both divergent and convergent collaborative creative problem-solving processes?

To address these questions, I first conducted 20 semi-structured interviews with creative artists, directors, and curators from a variety of disciplines (Chapter 3). In this study, I explored the convergent and divergent problem-solving or decision-making processes used by participants and the technological requirements and needs of artists when collaborating creatively. Through a reflexive thematic analysis of the interview data and prior literature on modelling creative problem-solving, I provide broad design implications for creating collaborative CSTs with artists in mind. First, creative problem-solving can be understood as *multi-levelled* and iterative, combining both convergent and divergent creativity. Second, convergent creativity in the arts can be understood through the notion of a central "vision" (oftentimes guided by a director), and platforms should support the convergence of divergent "ideas" through features. Last, CSTs made for artists should adapt or mirror existing technologies not necessarily made for artistic tasks.

I then developed a bespoke CST, *deliberarts*, drawing from these design implications (Chapter 4). *deliberarts* is a collaborative, real-time WYSIWYG document editor, augmented through the addition of a "project values" feature acting as a central space for the group's "vision". After development, I conducted a prototype evaluation of the tool with 6 groups of 2-3 artists from various disciplines (Chapter 5). Through this tool, I explored how artists from different creative disciplines collaborate through a technological medium, how they contribute to the creation of a central vision for creative works, and how the tool itself acted as a digital, collaborative CST.

Finally, I conclude through a discussion of the design implications in context of the results of the evaluation (Chapter 6). I understand and point

towards future work related to how divergent and convergent creativity can be mediated through the introduction of "values" in the technology and specifics related to designing digital platforms with creative artists in mind.

Positionality. In line with contemporary commentary on good practices for work using Reflexive Thematic Analysis [12], author positionality should be described and linked to their analytic process. I am a graduate student in HCI with a professional background in user experience, graphic, and product design, and a hobbyist digital artist and creative coder. Being the primary qualitative coder, my experience working in teams of designers and researchers granted both benefits (an understanding of collaboration in creative contexts) and challenges (a lack of breadth beyond visual and design disciplines). This contextualizes the meaning-making process of analysis and direction of the research.

2

RELATED WORK

2.1 GROUP IDEATION, EVALUATION, AND CREATIVITY

Group ideation is an complex and creative process. Using collaborative brainstorming as a model, Paulus and Brown [50] outline a social-cognitive-motivational view of group creativity. In this view, both individual and social processes influence the groups' motivation and creative problem-solving process for the task. Similarly, Csikszentmihalyi and Wolfe [21] argue a systems model of creativity; this consists of interactions between three subsystems: (1) an individual (with their own background) takes and contributes from a (2) cultural domain, who interacts with a broader (3) field or society setting standards for culture. Thus, creativity and creative problem-solving processes always engage with an individual's and the group's or broad socio-cultural context.

Idea generation is often viewed as a *divergent* process [28], seeking a variety of thoughts and ideas [27]. However, creative problem-solving in groups often includes *convergent* processes such as idea evaluation, elaboration, and implementation [51], focused on generating or seeking a solution from a set of ideas. These divergent and convergent processes often occur together [26], where ideation acts as a factor for both definition and evaluation and evaluation acts as feedback for further ideation [59]. Various work has modelled the relationship between divergent and convergent processes. The Divergent-Convergent Thinking Framework [56], drawing from The Double Diamond Model [66], posits two spaces where divergent processes transition to convergent: an iterative idea space consisting of idea generation and filtering, and a solution space where ideas are evaluated and selected prior to development. Zhang, Sjoerds, and Hommel [70] adapt Hommel [31]'s Metacontrol State Model, a multi-level model of cognitive control, to divergent and convergent thinking. In this model, divergent and flexible alternative states (e.g., ideas) are in competition, biased by a top-down, persistent and convergent goal. Understanding divergent and convergent creativity as iterative and multi-level processes, this work draws from these models in an understanding of creative problem-solving, and shapes the design and feature set of the platform.

Various paradigms for collaborative creative problem-solving have been explored in research. Paulus and Kenworthy [52] discuss various paradigms of idea generation: face-to-face verbal interaction, physically writing down ideas on paper, and mediating collaboration through technology, determining that the latter two are more effective than verbal interaction for ideation. Work mediating group idea generation or eval-

uation with technology spans early work on digital approaches to brainstorming [33] and mind-mapping [62], to modern approaches involving Large Language Models (LLMs) [61, 71]. While I expand on additional technologies for creative tasks in Section 2.3, this work positions itself as a digital tool for collaborative creative problem-solving; supporting divergent (e.g., idea generation and brainstorming) and convergent (e.g., idea evaluation and elaboration) processes in an artistic context.

2.2 COLLABORATIVE PROCESSES IN THE CREATIVE ARTS

While creative problem-solving exists across scientific and humanistic domains, Guilford [26] hypothesizes that creativity as demonstrated by creative artists (e.g., musicians, graphic artists) is more nuanced than others. Glaveanu et al. [25] expand on this, describing how creative activity changes across domains; for example, the impulsion to create in art is driven by the desire to create or express, while science is driven by the urge to solve and learn about the world. As such, I explore work particularly related to collaborative creativity in artistic domains.

Community arts (also referred to by the specific domain, e.g., community *music*) is the act of creative making with and for a group of people, often with a goal of fostering a sense of community [13]. Examples such as applied or community theatre embrace participant or audience involvement in the creative process. Theatrical production involves divergent processes such as staging, preparation, or organic development of work, and convergent processes such as verification or revision [9]. Community theatre further embraces collaboration through co-ownership and social engagement [1]. Collaborative processes and participatory practices also occur beyond community arts settings. Barrett, Creech, and Zhukov [8] discovered that in collaborative music contexts (the majority being jazz or popular music) there exists a balance between exploration or diversity and trust or convention. Where the visual arts often heralds the figure of a lone or singular artist [34], contemporary visual arts often involves collaboration and integration of technological, political, or social challenges within the artwork [6]; group creative problem-solving processes are thus used in this context. In this work, I draw from the practices of both community artists and beyond to understand their collaborative practices and technological needs in order to inform the design of a digital support tool.

Interdisciplinarity in the creative arts is practised by artists from a variety of backgrounds. Definitions of interdisciplinary arts emphasize the integration of art forms, artistic practice, and synthesis of ideas in their creation [5]. These kinds of artworks can be viewed as *intermedia*, a term coined by Higgins [30] where the medium of the work draws from two or more known and defined media (e.g., combining collage, music, and theatre). Some directions of intermedia emphasize the use of technology in artistic practices, leading to art forms such as performance art, video and

film, and multimedia work [24]. Collaborative problem-solving processes also emerge in the creation of intermedia works. For example, multisensory projects combining visual arts and performance arts involve visual artists and musicians working together to enable audience members to "hear the image" in projecting sketches that act as a visual representation of live music [2] or "see the music" in overlaying projections over a performance in sync with music [37]. Given intermedia's affinity for both collaboration and technology, I also aim to understand and support multi- and interdisciplinary artistic practises through our work.

2.3 CREATIVITY SUPPORT TOOLS FOR PROBLEM-SOLVING

Creativity Support Tools (CSTs) are systems or tools created to support human creativity and the creation of open-ended digital or physical artifacts [18]. In the context of digital CSTs, the design of these tools should support a non-linear, four-phase approach of *Collecting, Relating, Creating,* and *Donating* [63]. In HCI research, CSTs include the creation or use of existing software and platforms for music [39, 46], creative writing [20], visual and digital arts [43, 69], performance arts [36], creative coding [4], and much more. As a means of empirically evaluating a tool's adequacy in supporting creative processes, a variety of measures and strategies have been used [54], including questionnaires such as the *Creativity Support Index* (CSI) [16, 18]. Recent work has explored how creatives across various domains use CSTs for idea-capturing within their creative process [58], recommending future tools to support quick idea capture, easy visualization, overviews, and tool integration. My work expands on prior CSTs made for divergent processes such as idea-capturing and collecting by the creation of a novel CST directly integrating features for convergence (e.g., idea evaluation or relating).

For collaborative work, there exist a variety of tools adapted and created to aid in group creative problem-solving. Hymes and Olson [33]'s early work explores the usage of an unstructured, collaborative WYSIWYG editor to facilitate idea generation in groups. Shih et al. [62] created *GroupMind*, a real-time collaborative visual mind-mapping system with no explicit constraints on the users' processes. Both of these early works point towards the free-form nature of creativity, and the importance of CSTs to be flexible in structure. In the design space, *ImageSense* [40] is a collaborative intelligent mood board made to aid in designers' ideation processes, and *Co-3Deator* [53] is a "team-first" ideation tool for 3D modeling teams, consisting of an individual workspace and a collaborative exploration tool for 3D art and design. These tools are made with a particular artistic or design discipline in mind, signalling the importance of adding features informed by current workflows by practitioners. My work takes inspiration from both flexible and specialized CSTs for use in the arts and design spheres. Drawing explicitly from artists' collaborative practices in

interviews (found in Chapter 3), I create a flexible collaborative document platform for decision-making while incorporating specialized features discussed by or interpreted from artists (e.g., brainstorming technique presets).

Current research in CSTs has begun to integrate Generative AI (GenAI) features as a creative tool or collaborator. LLMs have been implemented in tasks such as prewriting [15, 67], songwriting [38], group ideation [61, 71], visual diagramming [68], and beyond. While these studies demonstrate GenAI's abilities to aid in idea generation or act as a virtual facilitator in group settings, other work has shown AI support to have a negative relationship with creative task performance [7]. Furthermore, there exist mixed or negative perceptions from both artists [3, 10] and non-artists [48] with respect to art created by GenAI or GenAI as a collaborator. As such, while I recognize the existence of this line of research, and briefly explore GenAI usage of artists in their creative processes, I intentionally do not explore the inclusion of GenAI features or tools in the developed platform.

3 FORMATIVE INTERVIEW STUDY

To better understand the creative problem-solving processes and technological needs of artists working in collaborative environments, I conducted a semi-structured interview study with artists of all disciplines who have worked in formal or informal arts organizations, with a particular interest in community artists. The study received approval from the University of Waterloo's Office of Research Ethics, as well as the regional secondary school board's research ethics board. Interviews took place in February and March 2024 (P1-P8), and March through July 2025 (P9-P20).

3.1 METHODOLOGY

3.1.1 *Participants*

20 artists were interviewed in total (10 male, 8 female, 2 non-binary; average age of 33). Recruitment started by identifying music ensemble groups, artist and curatorial collectives, and local and community theatre groups via the internet, on-campus social media channels, and the regional secondary school board; often contacting the art or communications director with a recruitment email. Further recruitment was done via posters on a local university campus, cafes hosting artist events (e.g., zine nights, open mic nights), art stores and organization sites, and snowball sampling. Artists were manually screened to ensure they had prior experience working collaboratively in an artistic setting, with prioritization of those in curatorial or directorial roles. Table 3.1 summarizes the artistic background of the participants.

3.1.2 *Procedure*

One-on-one semi-structured interviews were held online through the use of Zoom or in-person at the artist's organization or studio, the University of Waterloo campus, or at a local library. Each interview lasted approximately one hour. During the interview, each artist was asked to complete a demographic survey, describe their process of being a part of performances, programs, or exhibitions and any constraints faced when creating them. In addition, participants were asked about their creative process, use of technology, and how others are integrated (e.g., collaborating artists from within and beyond their primary discipline, audience members, other professionals) within the creation process. Sample questions can be found in Table 3.2.

PID	Primary Discipline	Years of Experience
P1	Music	7+ years
P2	Music	1-2 years
P3	Music	1-2 years
P4	Music	7+ years
P5	Music	<1 year
P6	Music	7+ years
P7	Music	1-2 years
P8	Music	3-4 years
P9	Theatre and Performance, Storytelling	7+ years
P10	Theatre and Performance	7+ years
P11	Curatorial Practice, Writing	3-4 years
P12	Theatre and Performance	7+ years
P13	Graphic Design	1-2 years
P14	Visual Arts	<1 year
P15	Theatre and Performance	7+ years
P16	Visual Arts	5-6 years
P17	Poetry, Media Arts	1-2 years
P18	Music	7+ years
P19	Documentary, Theatre and Performance	7+ years
P20	Visual Arts	1-2 years

Table 3.1: Artistic demographic information for participants, including primary discipline, and years of experience in a directing or curatorial role within the discipline.

3.1.3 *Analysis*

For interview data, I applied Reflexive Thematic Analysis (reflexive TA) [11] as my approach. Where I draw directly from the perspectives of practitioners in a variety of creative disciplines, reflexive TA is well-suited as a methodology to both identify and interpret findings across participant backgrounds without prescribing a particular disciplinary viewpoint.

Automatically generated interview transcripts were manually cleaned to ensure correctness and to familiarize myself with the data. After, an initial set of codes were generated in an open and iterative manner by myself using QualCoder[1]. After initial coding, the merging of similar codes and initial theme development were completed through a mapping exercise, and Dr. Edith Law and I later met to refine the codes, themes, and theme names. Any disagreements in refinement were managed through group discussion. This process resulted in 105 codes spread across 3 themes

1 https://github.com/ccbogel/QualCoder

Background
What is your current position/role? How long have you been in this role for?
Have you ever led or been a part of an inter- or multi-disciplinary artistic experience?
Experience
Think about a recent program, performance, or exhibition that you developed. Can you walk through how you develop the material/repertoire for the program?
What is the smallest and largest group that you've developed a program, performance, or exhibition for?
Decision-making and Problem-solving
How are decisions traditionally made in programs, performances, or exhibitions that you've overseen or been a part of? If you led the program, performance, or exhibition, were you able to incorporate feedback from artists?
Have you faced any roadblocks or setbacks when making group decisions? How have you usually managed contradicting ideas or disagreements?
Technology
Think back to that recent program, performance, or exhibition that you developed. Do you use any software in your artistic process? What kinds of software do you use often? What platform/device do you use it on?
Did you use any existing software to facilitate decision-making? How does the use of software impact your decision-making?

Table 3.2: Sample questions from the semi-structured interview guide.

(examples visible in Table 3.3), which are reported upon in the following section.

3.2 RESULTS

The Reflexive TA of the 20 participants gave light to 3 themes. The first, *Collaborative Problem-solving in Practice*, explores how group creative problem-solving is both enabled and sustained among groups of creative artists and relevant stakeholders across disciplines. The second, *A Director's Role in Convergent and Divergent Creativity*, understands how creative directors or curators contribute to convergence or divergence in creative thinking and ideas. The third, *Problem-solving Technologies for Collaborative Art*, discusses how technology is used in group creative and artistic problem-solving processes, and various barriers or enablers to adopting novel technological tools.

3.2.1 *Collaborative Problem-solving in Practice*

In practice, collaborative problem-solving among creative artists relies on a mixture of open communication and particular strategies. For many groups, collaboration consists of constant communication [P1, P7, P15, P17, P18, P19], put succinctly as "talking to death" [P12]. Idea generation

Theme	Code
Collaborative Problem-solving in Practice	artist personality changes collaboration
	collaboration has a lot of moving parts
	collaboration is playing off of teams' strengths
	collaboration starts with listening
A Director's Role in Convergent and Divergent Creativity	directors act as the coordinator between all roles
	directors enable collaboration by not speaking first
	directors have the final veto
	director's vision puts all components of an experience together
Problem-solving Technologies for Collaborative Art	people use technologies they're comfortable with
	technology is used for organizing
	technology is used for visualizing
	technology should be a "one-stop-shop"

Table 3.3: Example codes for each theme from the Reflexive TA of semi-structured interviews.

in groups may be divergent, starting by saying "yes" to everything [P1, P6, P9] and having ideas rise up organically or informally [P12, P13, P17, P18, P20]: "I can't really explain it. I just go with what feels right?" [P12]. Converging on common ground or building a consensus among group members is often done in collaborative environments [P1, P8, P12, P15, P16, P17, P18, P19], with strategies such as creating a common vocabulary when working across disciplines [P12] used to facilitate this. Successful problem-solving in these groups use a variety of divergent and convergent creative techniques or methods. Exercises such as appreciative inquiry [P9], letter-sending [P4, P12], speculative fiction [P11], SWOT analyses [P14, P16], or whiteboarding [P13, P16] are used in support of brainstorming and group cohesion.

In order to facilitate effective collaboration in groups of creative artists and stakeholders, the creation of a safe space acts a prerequisite for trust, transparency, and comfort. Having a culture of trust and transparency largely aids with communication among group members [P3, P4], understanding mental and physical discomfort [P1, P8, P10, P15, P19], and giving greater agency to artists' creative practice [P11, P15]. When working with larger groups, transparency in the decision-making process (i.e., directors or executives releasing a "document as to why [they] do things" [P3]) aids in communicating disagreements. In the theatre and performance space, actors and textile artists must discuss comfort and consent with respect to costumes and props [P15], particularly ones that are revealing [P10]. To facilitate the creation of a safe space and outline shared values and discomforts, a collective room [P1] or community agreement [P19] living document can be created during early meetings. By listening to one another, artists are engaging in an "embodied practice", seeing, watching,

and talking in order to learn "collaboratively with other people towards a goal" [P15].

Beyond communication and collaboration techniques, individual or group factors and disciplinary norms shape the dynamics of collaboration among creative artists. In the creative arts, individual disciplines have their own norms with respect to collaboration. Artists interviewed generally discussed visual arts [P9, P11, P16] and classical music [P4, P5, P7, P8] as constraining collaboration, while theatre and the performing arts afford it [P9, P10, P15, P19]. The artist's or stakeholder's personality changes what collaboration looks like [P4, P5, P7, P8, P9, P10, P11, P12, P16, P19, P20]. In some cases, individuals may not want to contribute [P4, P8], where even in instances where "democratic decision making [is valued,] people tend to get very frustrated if there's too much freedom and not enough...cohesive guidance" [P10]. People's capacity for commitment impacts how collaborative a group is, where individuals may not have adequate time to be a contributing member [P4]. If group members enjoy their work [P3, P8], the particular style of work [P18], or who they work with [P11, P13, P15], collaboration is made easier. As a result, groups will either play to individuals' strengths [P3, P4, P8, P13, P14, P15, P16], or take a "community [or] relationships first" approach [P4] to their collaboration. The size of the group also plays a role in group dynamic, where smaller groups aid in making logistical (e.g., scheduling [P3, P12]) and problem-solving (e.g., sharing of opinions [P7, P8, P10]) processes easier. On the other hand, the larger the group, the harder it is to include everyone's ideas and opinions [P3, P7, P13] or communicate at-scale [P12].

Interdisciplinary collaboration is often facilitated through the programming itself, where imagery or visual elements may be displayed alongside musical performances [P8], musical performances related to particular artworks may occur in gallery spaces [P11, P16], or artwork may be made as part of a performance [P11]. Interdisciplinarity was also mentioned to go beyond different media, where artists may work with local community members or Indigenous knowledge carriers to broaden the groups' perspectives and inform their artistic practises [P9, P19].

3.2.2 *A Director's Role in Convergent and Divergent Creativity*

Overall, even in most collaborative environments, creative directors or curators are the main driver of convergent thinking with respect to creative-problem solving. Directors and curators generally act as a group coordinator, for example, making decisions on installations or spatial layouts [P11, P17] or facilitating disagreements [P2, P3, P4, P16]. Many directors or curators will have some form of "veto" power [P1, P2, P3, P5, P15] to facilitate this, aiding a group in moving forward when a team is unable to come to a final conclusion through discussion. A major aspect of directing or curating is the concept of crafting a central "vision" [P10, P15], being able

to integrate both community and artist needs or values into the creative experience (also mentioned indirectly by P1, P2, P3, P4, P5, P6). On the other hand, many artists are not interested in formally structured meetings [P10, P16] or managing the logistics of a project [P5, P16, P19], where "people will step up for things like conceptual ideas and things that are within their area of expertise...but then you ask someone like, what kind of marketing plan should we have [and they aren't interested as they] don't know anything about that" [P16].

Beyond convergence, directors also facilitate the creation of diverse ideas. Many directors put trust in their artists by recognizing "I don't know what I don't know" [P15], "getting out of the way" [P1] or asking "what do you want? [We'll] just kind of get it for you" [P11], thus giving control to the artists. This act of listening and voice-giving helps organizers gauge artist interest [P1], manage disagreements [P4, P8], and discover novel points of view [P5, P8, P10, P11, P12]. When everyone has a voice, disagreements can be resolved collaboratively:

> "I've done, like, solo concerts, where [a] pianist really wants to play a couple specific pieces and they love these pieces and I go...I think the balance wouldn't work as well with this particular audience...so we would try with kind of like all the different options and having a couple different programs...and we ended up with kind of, yeah, more of the pieces than I thought would be able to fit in the program...the way we were able to lay it out reassured me that like we had enough variety and enough kind of movement in the program. But then the pianist also came to the realization in that process that like all the pieces didn't necessarily complement each other super well, so yeah, it's like trying out different cases and coming to a conclusion together." [P8]

3.2.3 *Problem-solving Technologies for Collaborative Art*

In collaborative art settings, digital technology is used for a variety of tasks. In ideation and evaluation, this includes the sharing and organizing of files [P2, P3, P4, P6, P7, P8, P11, P12, P13, P15, P16, P17, P18, P19], planning meetings or connecting over distance [P2, P3, P4, P7, P9, P10, P11, P12, P13, P15, P16, P17, P18, P19], surveys [P4, P7, P20], creating visualizations or mood boards [P13, P14, P15, P16, P17, P19], and advertising [P10, P16]. Including technology in the creative decision-making process aids in automating tasks [P3, P4, P8, P10, P11], in particular, the use of spreadsheets to manage group voting results [P3] or programming from a large repertoire [P8]. Oftentimes, rather than using bespoke solutions made for creative tasks, collaborative document platforms (e.g., Google Docs [P10, P12, P13, P15, P16], Excel [P3, P8, P10, P16]), content aggregators (e.g., Pin-

trest [P14, P15], Google Drive [P11, P13, P17]) or video calling platforms (e.g., Discord [P2, P3, P7], Zoom [P4, P15, P18, P19]) are used in decision-making contexts. In particular, technology is used to create "catch-all" documents to outline the theme [P13] or understand group norms [P1]. Outside of problem-solving, artists often use discipline-specific technologies in their creative practices, such as Digital Audio Workspaces (e.g., GarageBand) for music [P1, P3, P4, P6, P18, P19], QLab for performing arts [P1, P10, P15], and digital raster or vector graphics editors (e.g., Photoshop) in a variety of contexts [P10, P12, P14]. Though its use in creative tasks may be contentious [7], some artists discussed how they used Generative AI for determining word definition in songs [P18], portfolio structure recommendations [P14], creating content calendars for social media [P16], and asking questions about the curatorial field when starting out [P13]. Future technologies for decision-making in the creative arts should combine popular features of existing platforms into one cohesive system [P10, P12, P14, P15, P16, P17], and as many artists use tablets for their work, it should be multi-platform [P16].

Generally, the largest driver or barrier for creative artists to use technology was familiarity with the tools. While there exist purpose-built platforms to facilitate decision-making or communication in the arts, many creatives will fall back to general platforms as there's less technical knowledge needed to set up [P4, P10] or use for daily tasks [P10, P11, P14, P16, P17]. Creatives with existing backgrounds in technology (i.e., they work as a product manager outside of their creative practice) will occasionally bring in tools (e.g., FigJam [P17]) in their artistic practice for decision-making, but face issues in onboarding non-technical users to the platforms [P4, P10, P16, P17]. Learning new technologies requires artist capacity [P9, P17], where "there isn't always time or desire to like learn more intricate tools" [P17].

3.3 DESIGN IMPLICATIONS

Drawing from the interview analysis and prior work in creative problem-solving processes, I now discuss design implications for the design and creation of collaborative CSTs for problem-solving in the creative arts.

3.3.1 *Supporting Convergent and Divergent Problem-solving*

Creative problem-solving processes of idea generation, evaluation, and beyond can often be understood as either divergent or convergent. In interviews with artists, these processes in practice involve both kinds of thinking: divergence through constant communication and informal or organic idea generation, and convergence through consensus building strategies and a central "vision" surfacing. Oftentimes, a director or curator would facilitate an iterative process, adapting both open communication

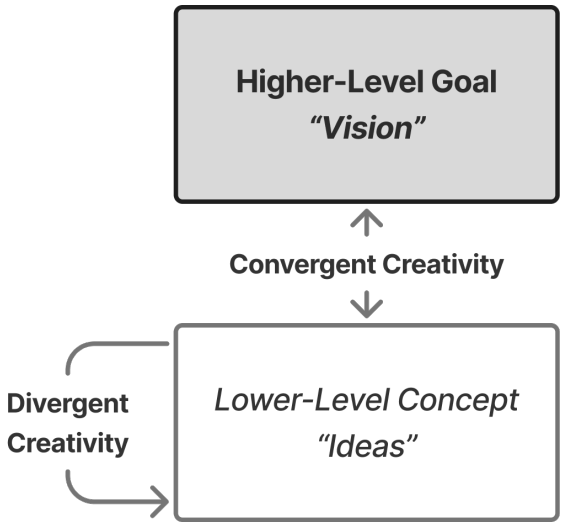


Figure 3.1: This works' understanding of group creative problem-solving as a *multi-levelled* process, adapting from Rodrigues, Cabral, and Campos [56] and Zhang, Sjoerds, and Hommel [70].

and fixed strategies to simultaneously generate novel ideas and refine the groups' vision. Through this iteration, convergent and divergent creativity are linked, where a convergent "vision" contributes to and is shaped by diverse "ideas" generated.

Building on previous models used to understand the interplay between divergent and convergent thinking [56, 70], I interpret group creative problem-solving as an iterative, *multi-levelled* process; divergent thinking is used to explore lower-level concepts, while convergent thinking is used to refine and ground them through higher-level group goals. This notion of a central "vision" being used as a point to converge on aligns with prior literature exploring creativity in artists, where artistic disciplines use a "vision" as a higher-level goal in comparison to a general problem or universal laws in the sciences [25]. As such, CSTs made for collaboration in the creative arts should not only be **(a) designed with both forms of thinking in mind**, but **(b) understand artists' creativity as supporting the divergent generation of "ideas" converging on a "vision"** (Figure 3.1). Platforms should thus include and integrate ways to generate and add upon existing ideas (e.g., collaborative documents or systems) and surface or make transparent a central vision for or from the ideas to support evaluation or implementation of artistic experiences.

3.3.2 *Adapting or Mirroring Existing Technologies*

Shneiderman [63] outlines a four-phase framework of creative tasks that should be supported by CSTs: collection, relation, creation, and dissemination. As outlined by study participants, in current practices by artists,

many use existing or unstructured platforms (e.g., Google Drive or Pintrest to collect or aggregate photos) not specifically made for creative or artistic tasks in order to facilitate these phases. Oftentimes, participants discussed temporal constraints in either learning or teaching novel platforms or technologies to collaborators while simultaneously engaging in their own artistic labour. For this reason, existing, free, and widely-used platforms are preferred to bespoke CSTs used to manage idea generation, evaluation, and decision-making. Prior work mirrors the effectiveness of unstructured or free-form tools for aiding in creative decision-making tasks [33, 62], and work in CSTs for creative professionals often adapt and build upon existing practices such as digital mood boards [40]. Where there exists room to improve on existing platforms to support artists' workflows (e.g., combining features into one cohesive system as discussed in interviews), CSTs for collaborative creative problem-solving in the arts should **mirror or complement existing tools used by artists across tasks**, introducing novel features or constraints in careful ways to increase use of access without complicating interactions.

4

DESIGNING *DELIBERARTS*

Informed by the interview study and design implications, an online platform, *deliberarts*, was developed to support collaboration for ideation and evaluation in the creative arts. The platform consists of a web application built using Next.js, Slate.js, Yjs, and Supabase, hosted securely on university servers.

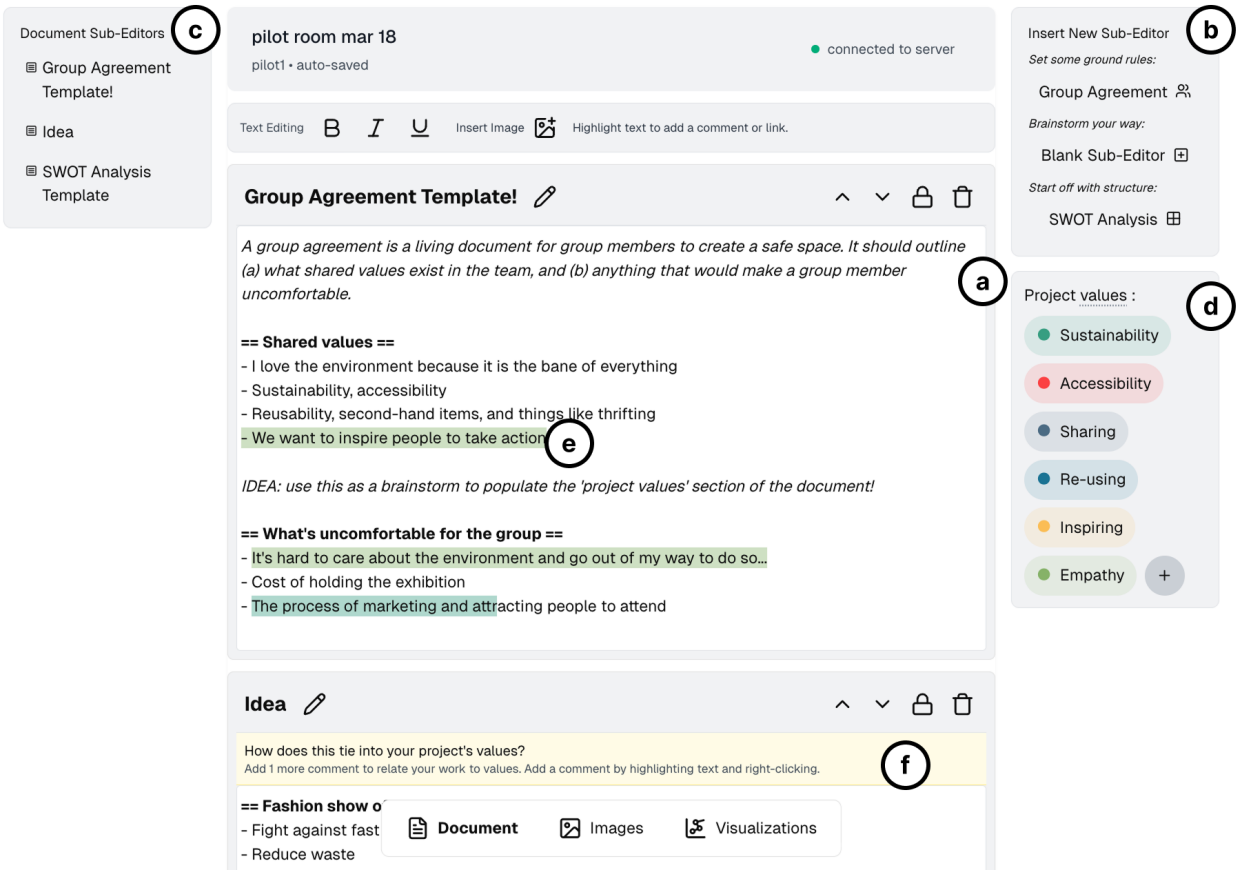


Figure 4.1: The "document" page of *deliberarts*. The document is split up into "Sub-editors" (a), containing text, images, and links. New sub-editors can be inserted (b) into the document, and easy navigation between sub-editors is facilitated through a table of contents (c). The project's values are always visible on a right-side panel (d), where the colour of comments (e) maps to the value colours. When a sub-editor reaches a certain number of words without any comments, a banner (f) appears to prompt users to reflect on how their content relates to the values.

4.1 FEATURES

deliberarts consists of three pages: a realtime collaborative document editor, an image aggregator and viewer, and a dynamic visualization page. All three pages are described below.

4.1.1 *Collaborative Editor*

The primary page of *deliberarts* is a realtime collaborative WYSIWYG document editor (Figure 4.1), similar in features to existing platforms. Compared to traditional editors dividing content into "pages", *deliberarts* divides content into named "Sub-editors". New sub-editors can be inserted via a panel to the right of the document, where artists may choose to insert a blank one or an existing template of "Group Agreement" or "SWOT Analysis" (derived from existing practices [M1, P6, P8, P11] in the interview study). Images are uploaded to the system itself and can be inserted and resized inline with text. The document is persistent and synced to a database in order to support both synchronous and asynchronous collaboration.

Novel to the system is the inclusion of a project values pane, a central manner for artists to contribute to a shared vision of an exhibition, performance, or other artistic experience. In this work, and on the platform, values are defined as "higher-level objectives that are important to the group". Comments made on the document are directly related to these values, thus artists must populate this pane in order to make comments on the document. In order to increase the saliency of this feature, when a sub-editor reaches a particular number of words without a sufficient amount of comments, the system will generate a sticky banner at its top prompting the user to add comments in order to relate their work to the project's values.

Design Rationale. Having an integrated project values and commenting system acts as the main support for realizing a multi-levelled creative problem-solving process (Figure 4.2). Artists can engage in divergent thinking through unstructured brainstorming techniques or structured templates (e.g., Group Agreement) using the document editor. To evaluate these generated ideas, artists are then able to add comments relating their ideas to a central, shared "vision", acting as a convergent process.

4.1.2 *Image Aggregator*

deliberarts includes an image aggregator (Figure 4.3) akin to other content aggregators used by artists. On the images tab, artists can both upload and view all the images added by collaborators to the system in a grid-like fashion. When images are added to sub-editors, a new subsection is added

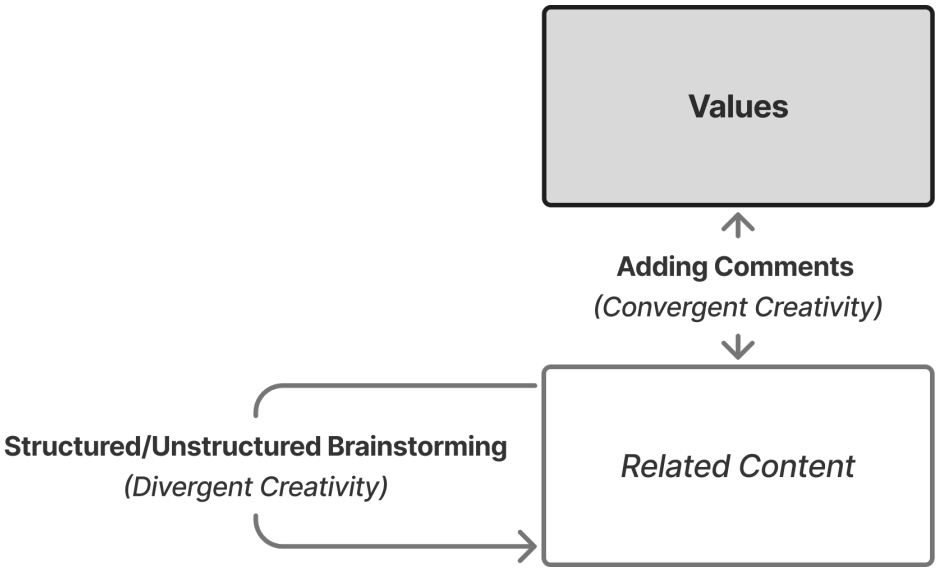


Figure 4.2: The multi-level creative problem-solving process as implemented in *deliberarts*.

to the images tab displaying all the images related to the editor, enabling the creation of custom "mood boards" for a project task.

Design Rationale. The inclusion of an image aggregator enables a visual form of divergent creativity. Artists are able to upload images on the same platform as the collaborative editor and directly insert them, creating a cohesive and unified system for both written and visual ideation.

4.1.3 *Visualizations*

Drawing from the document tab, the visualizations tab (Figure 4.3) enables artists to visualize the kinds of values accounted for in each sub-editor. Each sub-editor containing comments will have a matching interactive visualization displaying the proportion of comments per value and the proportion of positive to negative comments within a value (through fractional shading). Clicking on a circle will display a transparent modal over the visualization containing all comments related to the value within the modal, the comment and its author, and a snippet of the text the comment is related to. These visualizations are real-time, and will update as comments are being added to the document without the need to refresh.

Design Rationale. The visualizations page enables artists to understand and discuss how their groups' ideas from the collaborative editor are related to a shared vision. Drawing from work in collaborative visualization [29], while the colour-coded highlights of comments on the editor act as a mechanism for *embedded discussion*, the visualizations page's link of text-to-visualization acts as a mechanism for *independent discussion*. By enabling

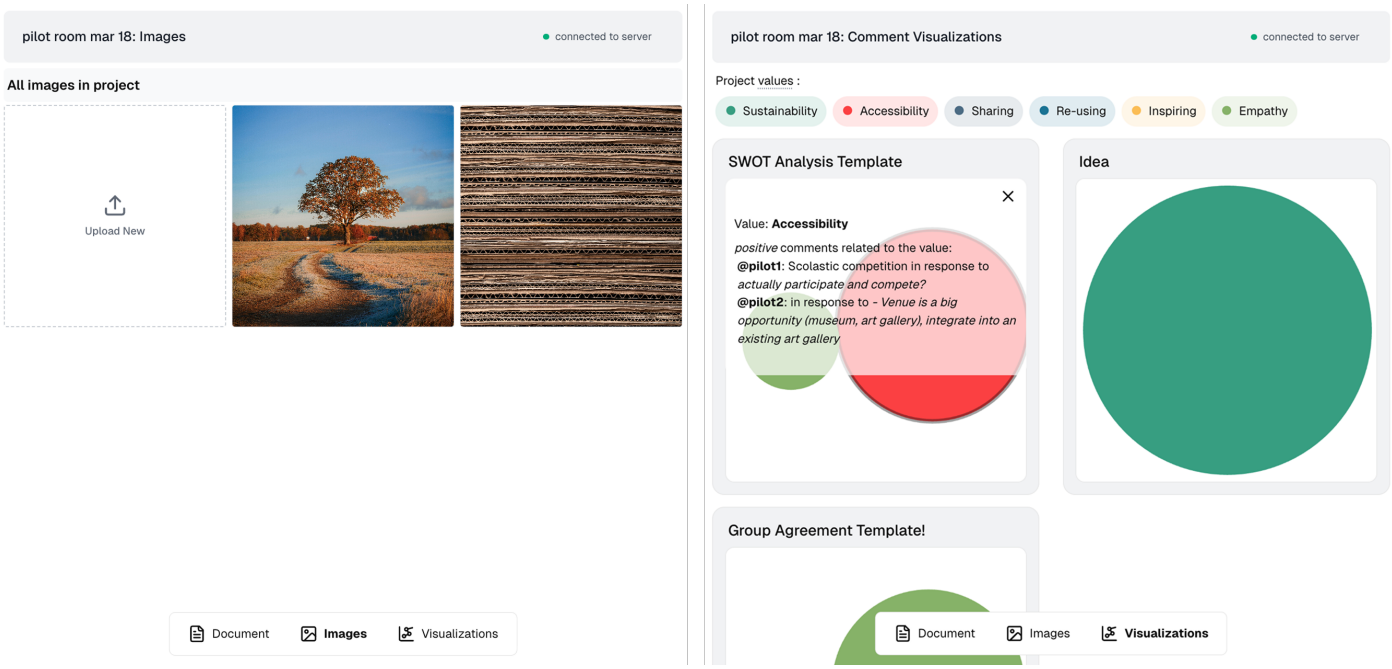


Figure 4.3: The "images" (left) and "visualizations" (right) pages of *deliberarts*.

multiple forms of discussion on the platform, artists are able to establish common ground and converge on a shared understanding of the "vision".

4.2 EXAMPLE USAGE

Two visual artists, A and B, are putting together an exhibition related to climate change and local resilience in their local community centre's foyer. They wish to work together to flesh out the exhibition's theme, plan any programming they intend to have while the exhibit is up, and create a list of any logistics required for the project. Using *deliberarts*, they start off by adding a "Group Agreement" sub-editor to the top of their project in order to understand what their shared values and discomforts are. They are able to asynchronously add in their individual values with respect to the project's theme, and note down anything they would be uncomfortable with throughout the processes.

Synchronously, A and B meet and generate their projects' values from this agreement. After populating the pane, they each start to work in different sub-editors, where A is adding ideas for the art to be created or displayed, and B is adding a "dump" of images for visual inspiration. After A adds ideas, B is able to add comments to connect the ideas to the project's values. A is able to go on the visualizations page and visually see that they are missing art related to a key value, and goes back to contribute more.

To discuss this exhibit with respect to their venue, A and B add a "SWOT analysis" block to add structure to their brainstorming. They are able to determine areas for opportunity drawing from their exhibit location and update other sub-editors accordingly. Resulting from this brainstorming process, they take this information back to the community centre and can ask questions related to their project.

5 EVALUATING *DELIBERARTS*

To evaluate *deliberarts*, I conducted prototype evaluation sessions with groups of artists, directors, or curators from a variety of creative disciplines. Each evaluation session lasted approximately 3 hours and consisted of 1-2 small groups of 2-3 creatives co-creating the plan for an artistic experience (e.g., an exhibition, a performance, a zine, or a program) using the developed prototype of the system. This study received approval from the University of Waterloo's Office of Research Ethics. The sessions took place in May 2026.

5.1 METHODOLOGY

5.1.1 *Participants*

13 artists from a variety of disciplines in 6 groups took part in the study over 4 evaluation sessions (5 male, 5 female, 2 non-binary, 1 self-identifying as queer; average age of 28). Recruitment started by directly contacting the same artists and groups as the interview study, along with further identification of new groups on the internet and social media channels. Further recruitment was done via posters and snowball sampling. Table 5.1 summarizes the artistic background of the participants. Both individual artists with experience in artistic groups and pre-existing groups of artists were recruited for the study. As the tool was created with any discipline in mind, individual artists were not assigned to groups based on their discipline. Artists were only required to report their primary discipline in a demographics form, yet many artists had prior disciplinary experiences beyond their primary (e.g., ROS, a visual artist, having previous experience in cabaret). Artists participating could give consent for themselves to be attributed for their creative brainstorming done in the session. Groups could also create a attributed name or use their existing group name for their work if desired.

5.1.2 *Procedure*

Each session was held in-person on campus. Each session consisted of three main parts: (1) a platform walkthrough, where the researchers outlined the key features and task for the group in the form of a presentation; (2) each group was given up to 1.5 hours to make decisions around a theme and plan an experience; and (3) each group presented their proposed experience to other groups and the facilitator at the session. The task for the

Group	PID/Attribution	Primary Discipline	Years of Experience	Career in the Arts
G1	Isabella Stefanescu	Visual Arts	7+ years	Professional
	Bastian	Music	3-4 years	Vocational
G2	P2.1	Music	3-4 years	Amateur or Hobbyist
	P2.2	Visual Arts	<1 year	Amateur or Hobbyist
G3	P3.1	Fiber Arts	<1 year	Amateur or Hobbyist
	P3.2	Dance	7+ years	Amateur or Hobbyist
G4	P4.1	Music	7+ years	Vocational
	P4.2	Visual Arts	7+ years	Professional
Dance4Climate	P5.1	Music	5-6 years	Amateur or Hobbyist
	P5.2	Dance	7+ years	Amateur or Hobbyist
	P5.3	Music	7+ years	Amateur or Hobbyist
Sweem Team	Gillian W	Visual Arts	3-4 years	Vocational
	Ros	Visual Arts	3-4 years	Amateur or Hobbyist

Table 5.1: Artistic demographic information for participants of the prototype evaluation, including primary discipline, years of experience in a directing or curatorial role within the discipline, and whether they describe their career in the arts as "Professional", "Vocational", or an "Amateur or Hobbyist".

group was to use the platform and co-ideate an exhibition, performance, or any form of artistic experience around the theme of *Sustainability and Climate*. Each group were given short examples of topics within the theme (climate change, recyclable materials, and living a "1.5 degree lifestyle"), but were encouraged to go beyond these ideas to elucidate their own group values and topics. This theme was chosen in reference of art's ability to elicit social change [14] and environmental or civic discussions being often used in deliberative processes [72] and technologies [60]. After the session, participants completed the CSI questionnaire [18], and engaged in a focus group discussion about their perceptions of the platform. Sample questions can be found in Table 5.2.

Post-study interview
How did you find that process? What were the easiest and hardest parts of the process?
How effective was using the platform for identifying values and group deliberation? How did this process differ from your previous creative experiences?
What features of the platform did you like the most? What features did you not enjoy using? Are there any additional features you would prefer to have in this platform?
How would you use the ideas generated here to further inform the rest of the curatorial/programming process? What else could the platform do to support your creative process after ideation?

Table 5.2: Sample post-study focus group questions for the prototype evaluation session.

5.1.3 *Analysis*

Participant interaction with the platform (e.g., adding text, commenting) during the prototype evaluation was automatically logged by the system and saved to a database table. The entire session was audio-recorded and platform usage was screen recorded. Additional observations during the session were manually noted by myself. Automatically generated follow-up focus group interview transcripts were manually cleaned to ensure correctness and to familiarize myself with the data.

Focus group interview transcripts were analyzed using mixed (deductive and open) coding, using the design implications outlined in Section 3.3 as a guide. After initial coding, myself and Dr. Edith Law met to refine the dataset and managed disagreements through group discussion. Platform screenshots and observation logs were used as additional qualitative data, understanding participant interaction with the platform and inter-group dynamics. Interaction logs were used to further understand group dynamics and generate descriptive statistics about platform usage. As this study does not compare between system variants, I use the CSI as an interpretive measure as to understand what aspects of creativity the tool excels at. The groups' creative output (i.e., the resulting plan for an artistic experience) was not directly evaluated for quality. Given the limited time for creation (1.5 hours), participants were informed that their idea did not have to be completed nor realistic (e.g., they were not constrained by a budget).

5.2 RESULTS

I report the results of the prototype evaluation in context of the design implications. First, I explore how the platform supported ideation and divergent creativity. Then, I discuss how convergent collaborative problem-solving was facilitated through the inclusion of values. Last, I report how effective *deliberarts* was as a CST guided by existing technologies, and look at extensions that could be made to the platform as discussed by participants.

5.2.1 *Ideation and Divergent Creativity in* deliberarts

Idea generation among participants in evaluation sessions occurred both on and off of the platform. Where on the platform, this was done through the shared document, off-platform collaboration often times involved talking out loud at length [G1, G2, G3, G4, DANCE4CLIMATE, SWEEM TEAM]

Collaborative ideation strategies over the course of the study session differed across groups. For G2, G4, and DANCE4CLIMATE, groups did a mixture of silent typing and live discussion about ideas generated,

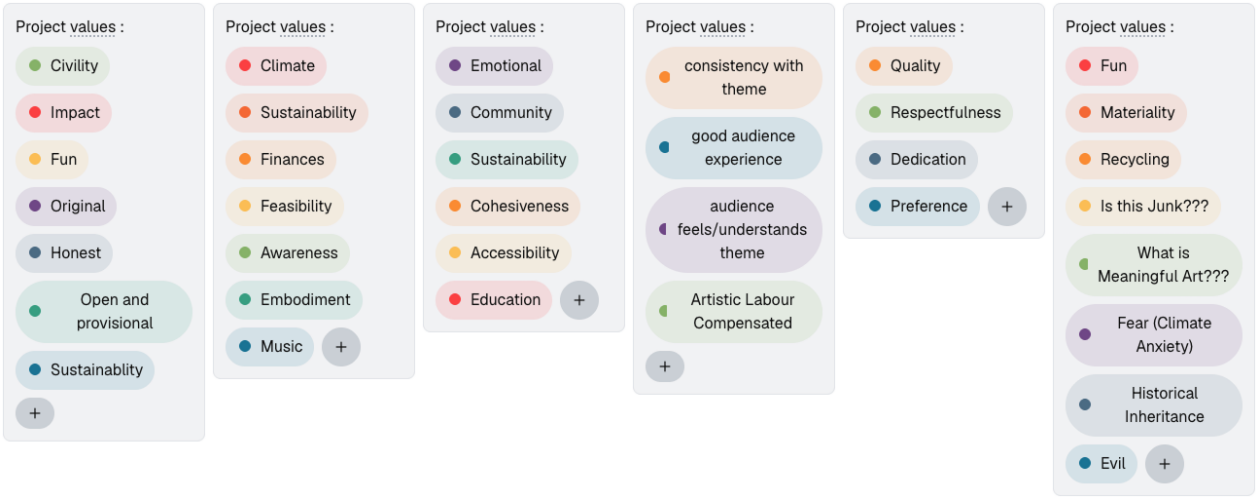


Figure 5.1: Screenshots of project values from groups of artists in the study.

where G3 tended to engage in more face-to-face discussions. Interestingly, in G1, BASTIAN did much of the typing, where ISABELLA STEFANESCU noted how she "got totally engrossed in what [they] were doing rather than using the tool...[BASTIAN] is a faster typer", rarely touching the platform partway through the session. Even though both artists used the platform throughout the session, SWEEM TEAM often had periods where GILLIAN W spoke out loud and ROS dictated ideas onto the platform. As these sessions were in-person and groups were co-located, these interaction strategies were viable. Apart from interacting with the platform or talking about ideas out loud, participants were observed to use their time in the session googling relevant concepts, drawing on paper (notably G3), taking a moment to think, or engaging in casual (non-related) conversation.

Ideation strategies in collaboration were discussed by participants to be different from ones used in individual work. Where in individual settings, ideas are "all in [one's] head" [P2.1], platform features such as sub-editors [P2.1, P3.1, P5.2] and highlighting or commenting on text [P2.2, P4.2, P5.2] work well in collaborative settings to give a common structure. This "makes sure [that the group is] on the same ideas" [P2.2], or "either enforce[s] people to take a stand on different points of discussion or sort of act[s] as the leader of the group and usher[s] them along in a direction...the platform sort of takes that burden away from you by giving you like a worksheet and your school child brain is like, yeah, let me fill this out" [P5.3]. In reflecting on this, BASTIAN mentioned where the platform's structure aided in a collaborative setting, "Individually I don't have...the way I'm organizing things is always changing. So it definitely would benefit from a structure, but I don't know what kind of structure.".

Group	*Experience*-Centred Values	*Logistic*-Centred Values	*Mixed* Values
G2	Climate, Sustainability	Finances, Feasibility, Music	Awareness, Embodiment
G3	Sustainability, Emotional, Community	Cohesiveness, Accessibility, Education	
G4		Consistency with theme, Good audience experience, Audience feels/understands theme, Artistic labour compensated	
Dance4Climate		Quality, Respectfulness, Dedication	
Sweem Team	Materiality, Fear (Climate Anxiety, Historical Inheritance	Is this Junk???, What is meaningful art???, Evil	Fun, Recycling

Table 5.3: Project values made by groups in the study mapped to the kind of content highlighted in the collaborative editor: *Experience*-Centred Values related aspects of the artistic experience to the overarching theme, *Logistic*-Centred Values related ideas to technical aspects of a production, and *Mixed* Values related to both. G1 was omitted as they had only commented twice, with one value.

5.2.2 *Values and Convergent Visioning in* deliberarts

The project values feature (including the pane, commenting, and the visualizations page) was deliberately included as a mechanism for convergent creativity. Thinking of higher-level values first "motivated a discussion and a workflow ... that was my favourite part about it" [BASTIAN]. Within the study, the project values generated by participants (Figure 5.1) were mostly used in a common manner across groups. Looking closer at the relation between the content highlighted and the values attributed to the highlight, groups' values tended to be centred around the theme of the artistic experience they were planning, the logistic or technical aspects of the plan, or a mixture of both (Table 5.3). *Experience*-centred values (e.g., *Fear (Climate Anxiety)* [SWEEM TEAM] (Figure 5.2)) related divergent ideas or descriptions of the artistic experience to the group's understanding of the overarching theme. *Logistic*-centred values (e.g., Feasibility [G2] (Figure 5.3)) acted as a function to related divergent ideas to more technical aspects of a production such as the physical space or a reminder of relevant stakeholders for the project. Both experience- and logistic-centred values created by participants acted as a way to evaluate their ideas and select which ones they preferred, guided by a higher-level shared "vision". The only notable exception to this pattern was DANCE4CLIMATE's value of *Preference*. In lieu of a built-in voting feature, P5.2 attempted to use the value highlights as a mechanism for each group member to "vote" on ideas they preferred and reach a consensus to move forward.

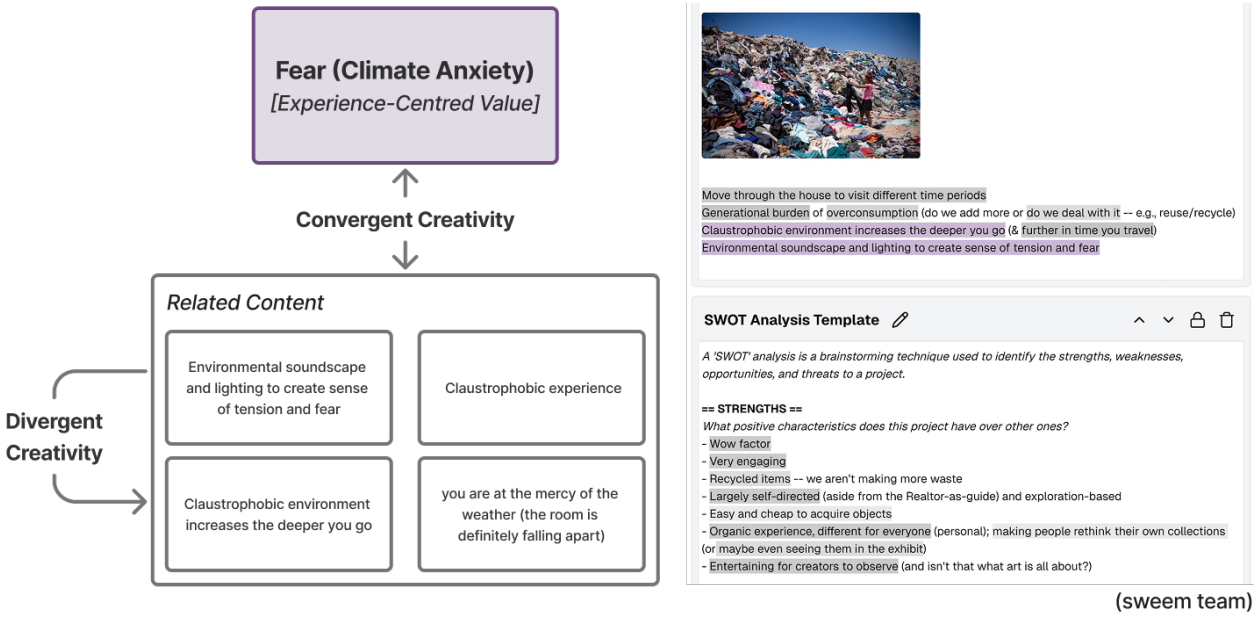


Figure 5.2: An example of an experience-centred value, *Fear (Climate Anxiety)*, and how SWEEM TEAM commented on or highlighted relevant content to the value in their document.

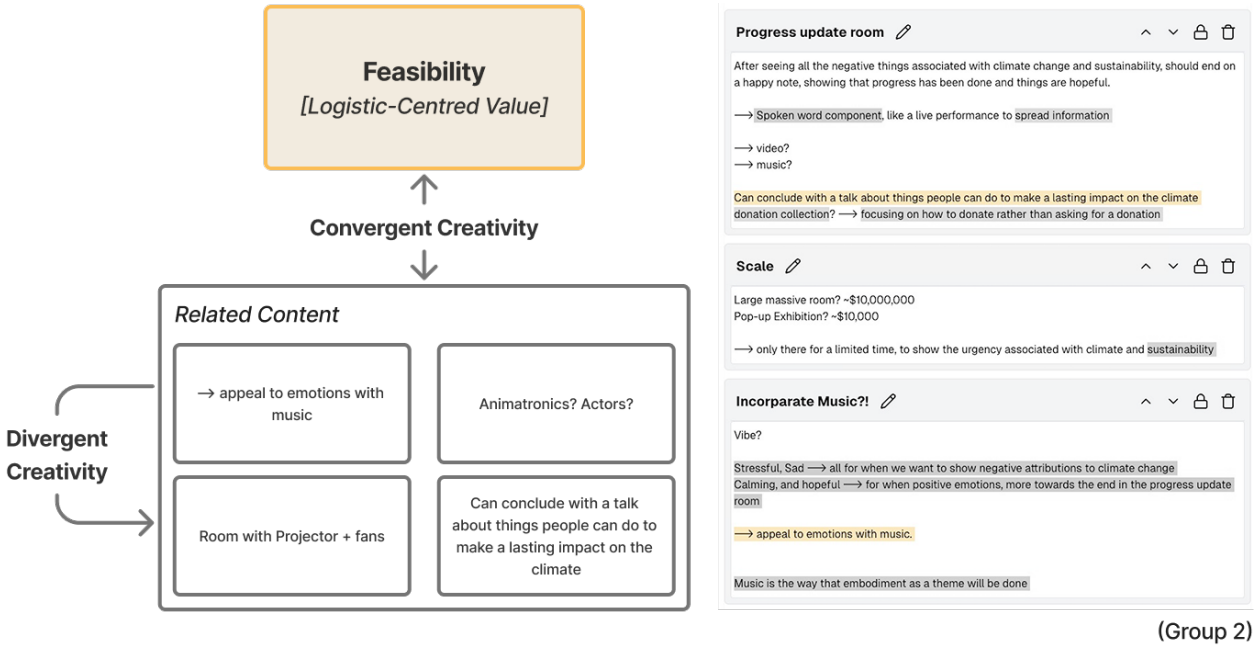


Figure 5.3: An example of an logistic-centred value, *Feasibility*, and how G2 commented on or highlighted relevant content to the value in their document.

In practice, groups used the value-based commenting feature in different ways. Participants in G2, G4, DANCE4CLIMATE, and SWEEM TEAM added comments often, and those in G1 and G3 rarely added them. Beyond the literal sense, participants also used comments to colour-code their document with their values ("paint[ing] the page" [P2.2]), where 69.57% of comments added had no text included [P2.1, P2.2, P3.1, P3.2, P4.2, P5.2, P5.3, GILLIAN W, ROS]. Being able to code for values in a collaborative document "helps you like, point to staying focused" [P4.2], enabling convergent thinking in groups.

Being generated by these comments, the visualization tool also acted as a driver for convergent thinking. After generating ideas, participants looked to the visualizations to answer "where is [a value] missing in this place? Where is [a value] smaller [than the others]?" [P2.1] or determine whether the group is "too heavy on one of the values versus not speaking enough or addressing some of the other values" [P5.2].

The commenting reminder banner had mixed effectiveness, with some participants being annoyed at its persistence [P2.1], splitting up text across sub-editors enough such that it rarely appeared [G3], or ignoring it completely [G1]. However, groups that did not comment often [G1, G3] or rarely saw the banner appear despite commenting frequently [DANCE4CLIMATE, SWEEM TEAM] were still aware of their values throughout the process. By starting their ideation with value creation and having them persist on the screen throughout the idea generation process was sufficient to remind groups, where having "project values [so] prominently displayed along the side [of] the shared interface that we're all using to think about the project, it naturally becomes something important that we keep talking about" [P5.1]. Alternatively, the feeling of completion or consistency [GILLIAN W] pushed some groups to continue commenting despite not seeing the banner, "and once I got most of them, it was like a completionist part of me came in, and I was like, no, no, every single bullet point I should tag as something, because I have all the colors. It should fit somewhere" [ROS]. The feature being described as *commenting* rather than colour-coding or highlighting constrained groups' usage, where for G3, "while we were going through it, we were talking and pointing out the values, but we weren't highlighting them. I think a barrier for me was I had the idea of it has to be a comment, and I had no comments" [P3.2]. Whether or not they used all of the features of the platform, the existence of the pane aided in mediating convergent creativity in groups.

Overall, the platform and its implementation of project values was discussed as being effective for convergence as *consensus-building*:

> "I think this could be one of like many interfaces that really like helps bridge people's ideas and like we both have an opportunity to like put things down and comment on each other's like approaches and...come from a place of like where we can like put values...I think this acts as like a good forum for

> consensus, generally speaking. It doesn't affect your creative process. It just merges yours with someone else." [P4.2]

5.2.3 deliberarts *as a CST for Group Problem-solving*

deliberarts as a platform was able to support many of the common tasks found in existing CSTs for collaboration in the creative arts. Participants who used the sub-editors appreciated the feature for organization [P2.2, P3.1, P3.2], discussing how "because they're different modules, it makes it very easy to edit in one without it affecting the rest of the document, which is a problem, I would say, in a lot of the usual softwares" [P3.2]. Participants appreciated how familiar and flexible the platform felt, making parallels to existing platforms such as Google Docs [P1, P4.2, P5.2, P5.3]. The inclusion of features from multiple platforms (e.g., a living document and image aggregator) was appreciated by participants ("But yeah, I think it's very easy to use, and it's fun. I like how it combines a lot of elements of various different collaboration tools" [P5.2]), however additional features such as spreadsheets [P4.2, P5.1] or budgeting [P3.2, P4.2] would aid the platform in covering more of the logistic-related tasks behind creative problem-solving. The platforms' flexibility in workflow choice was a benefit to some artists, where *deliberarts* was "fun as a sandbox, I think. Because I think there are other platforms where it could maybe dictate too much of what you're trying to do, where this in that sandbox kind of way is fine. You're giving us tools, but you're not giving us too much. And it's not too narrow of purpose of these things" [GILLIAN W].

The inclusion of AI features were only notably discussed by the professional artists in the participant sample, ISABELLA STEFANESCU and P4.2, with differing opinions. Where ISABELLA STEFANESCU would be interested in having AI automatically code your text to your values ("I was thinking in the values, if you had some kind of AI in the text that would actually code, would you have that connected to your values?"), P4.2 mentions:

> "I think when I signed up for this, I thought there was going to be more to do with AI. And whenever I hear AI, like technology, creativity, I just, I, as an artist, like your hackles go up and just immediately assume that this is going to be a misunderstanding of the creative process."

Given that this study is neither comparative nor includes a large number of participants, I use the CSI solely as an interpretive measure to understand the strengths of *deliberarts* with respect to individual rating scales. In the CSI results (Table 5.4), the platform's overall score was 70.18, with strengths in enabling *Collaboration* (average score of 48.77, standard deviation of 26.38) and *Exploration* (average score of 47.00, standard deviation of 21.77). The overall CSI score can be interpreted as a grade on a scale of 100, meaning the platform was rated a B- for the task at hand; a passing score

Scale	Avg. Factor Counts (SD)	Avg. Factor Score (SD)	Avg. Weighted Factor Score (SD)
Collaboration	3.46 (1.39)	14.46 (4.65)	48.77 (26.38)
Enjoyment	1.69 (1.32)	13.31 (3.64)	24.08 (20.22)
Exploration	3.31 (1.11)	13.69 (3.47)	47.00 (21.77)
Expressiveness	2.54 (1.56)	11.69 (4.01)	33.31 (27.23)
Immersion	1.69 (1.80)	11.23 (5.10)	22.69 (29.99)
Results Worth Effort	2.31 (1.75)	14.77 (3.35)	34.69 (27.06)
Overall CSI Score			70.18 (15.22)

Table 5.4: CSI results for *deliberarts* under the task given in the prototype evaluation.

with room for improvement. Where the post-study interview findings are positive with respect to enabling collaboration, visioning, and organizing ideas, there exist a handful of quality-of-life upgrades to the technology itself that may describe the low score. Beyond the comment banner annoying some participants [P2.1], the WYSIWYG editor not having additional feature such as native bulleted lists [P2.2] or other users' cursors [P2.1, P3.2] were mentioned to be frustrating. Images on the platform needed to be uploaded directly to the platform for the images tab to function correctly. Not having a simple drag-and-drop functionality interacting with the tab was frustrating to some participants [P2.1, P3.2, P4.1]. Beyond these points, the ability to put multiple images on one line [P3.2], captions on images [P3.1], editing comments [P5.2], a sketchpad or drawing features [P3.1, GILLIAN W, ROS], and support for audio or video clips [P5.3] would be appreciated by participants. After making the platform more feature-full, I expect the CSI scores (particularly *Enjoyment*) to increase.

6 DISCUSSION AND CONCLUSION

Exploring how technology is used in collaborative creative problem-solving processes represents a key area of interest for research in HCI. To build upon this work, I interviewed 20 creative artists from a variety of disciplines, developed a novel CST, and evaluated the tool with 6 groups of creative artists. Through semi-structured interviews and a prototype evaluation of a novel CST made with multi-level creativity in mind, I contribute to an understanding of technology-mediated creativity and the design of digital tools for creative artists across disciplines. I conclude with a discussion about the design implications and open space for future work, focusing on the development of CSTs for convergent and divergent creativity, and the creation of tools for collaboration among creative artists.

6.1 MEDIATING DIVERGENT AND CONVERGENT CREATIVITY THROUGH VALUE-DRIVEN TECHNOLOGY

Creative decision-making in groups involves tasks related to divergent (e.g., idea generation) and convergent (e.g., idea evaluation) thinking [51]. Even though both kinds of tasks are interrelated, much work on CSTs within an HCI context has surrounded divergent thinking tasks such as ideation [55]. By understanding creative problem-solving as a multi-levelled process and drawing from prior models [56, 70] and the formative interview findings, I implemented a value-based commenting system in *deliberarts* to directly support relating higher-level goals to lower-level concepts. Prior work in CSTs supporting group creative problem-solving has explored features for active reflection or summarization. Koch et al. [40]'s *ImageSense* used dynamically generated tags and semantic labelling to create summary clouds of mood board content for designers, and Wan et al. [68]'s work exploring the integration of LLMs in CSTs for writing tasks included features to summarize or associate text. Rather than relying on automation, *deliberarts*' value-based commenting/tagging system enables groups to collaboratively engage in both generation and reflection. By making the process manual, groups had to actively deliberate and focus [P4.2] on how their plan related to higher-level goals such as the theme, experience, or necessary logistical categories; thus, enabling both divergent and convergent creativity.

Using the term "values" for the feature was chosen intentionally, as I wanted to allow participants to use the system in a flexible manner. As a result, artists brought their own understanding of "values", which they then integrated into the groups' creative process. P5.1 from the prototype

evaluation, with background in music and theatre, directly mentioned how "the word values to me means the things that you and your team want to embody in terms of a community and not necessarily like the goals that you want to achieve". However, creativity research points towards these definitions being interrelated. By looking through the lens of a systems model of creativity [21], the individual and community goals interface with one another. With this in mind, future work exploring the creation of CSTs which support value-driven convergent creativity ought to understand convergence as relating lower-level ideas to both an individual's or particular group's and a community's or culture's shared values as shaping the central "vision".

Various barriers to collaborative problem-solving exist, including *social loafing* or "*free-riding*", where individuals may put less effort in a task as other group members are also contributing ideas [64]. In the formative study, various artists discussed cases where individuals on an artistic team may not want to contribute beyond the artistic production [P4, P8, P10, P13, P16, P19]. Where this could be an example of social loafing, other forms of group dynamics in creative problem-solving tasks may facilitate this. Lave and Wenger [42] describe the concepts of *Communities of Practice* (CoP), or the relationships between people, shared activities, and the world they exist in, and *Legitimate Peripheral Participation* (LPP), where newcomers to CoP participate in meaningful yet minor ways (akin to apprenticeship). Work surrounding LPPs in HCI has explored them with respect to large online creative communities such as fandoms [23] or visual coding [17]. In group creative problem-solving contexts, artists may be engaging in LPP rather than free-riding. As such, future work could explore how group divergent and convergent creativity in CSTs and LPP interface, enabling minor ways to contribute to both higher-level goals and lower-level concepts when initially joining a creative group.

6.2 DESIGNING TECHNOLOGY FOR CREATIVE ARTISTS ACROSS DISCIPLINES

CSTs made for collaborative problem-solving between artists should include features found in existing tools used in order to meet creative needs and reduce the barrier of entry to use the system. Many participants across disciplinary backgrounds appreciated *deliberarts*' interface design and similarity to collaborative document platforms used in their own practices. Drawing from their cross-domain study, Rosselli Del Turco et al. [58] provided a set of recommendations for designing CSTs with ideation in mind, including the facilitation of capturing quick ideas, support for overview or revisiting of ideas, and manners to link the current ecosystem of tools together. The findings mirror these needs for creatives in group ideation and evaluation tasks, where participants in the study discuss the use of existing tools (e.g., collaborative document platforms) for idea capture and

overview, and the desire for platforms that combine multiple tools into one connected system (e.g., extending *deliberarts* to include budgeting and spreadsheets). Going beyond the specific needs, I point out in this work the importance of designing CSTs with familiarity in mind; where creative and artistic labour is the main goal of practitioners, the capacity to learn new technologies or tools for logistic or planning tasks is limited. Future work in CSTs should explore further adaptation of existing interface designs or general-built platforms for artistic work and collaboration.

Creative problem-solving platforms should grant artists agency and choice in how and what they contribute to the development of an artistic experience. The open and flexible nature of *deliberarts* enabled artists to contribute in their own manner: G1 had BASTIAN do most of the typing, while ISABELLA STEFANESCU simply engaged in discussions, G3 used sub-editors liberally to split up their ideas and match their mental models of what the creative process looked like, and P4.2 started making their own custom *mad libs*-style template to aid P4.1 in idea-generation. Li, Hashim, and Jacobs [44] argue that automation or abstraction in CSTs may act as barriers to artists' self-reliance in their creative process; CST research should go beyond efficiency gains and focus on artist agency and maintaining manual control in their creative processes. By keeping a CST's main features (e.g., the document tab in *deliberarts*) open and flexible to a variety of creative workflows (e.g., liberal usage of sub-editors, novel template creation) while adding minimally intrusive features to augment or guide a workflow (e.g., the values pane and comments), efficiency and agency can be maintained in parallel.

In the formative study, interdisciplinary collaboration in the creative arts existed in the kinds of programming done by groups of artists. Mirroring this, interdisciplinary groups in the evaluation of *deliberarts* tended to combine their disciplinary backgrounds in their imagined programming. For example, G2 combined a visual gallery with music matching the theme of the space and G3 included aerial silk performance in a nature-themed gallery. Without requiring groups to draw from their own disciplinary backgrounds in the task, participants created plans for intermedia art-work. Further, where intermedia work may emphasize the inclusion of technology in the art itself [24], many groups included a technological component through video or projections [G2, DANCE4CLIMATE], dedicated applications [G1], or augmented reality [G3]. Future work in collaborative CSTs should further explore notions of intermedia and interdisciplinar-ity beyond ideation and idea evaluation to discover the needs of artists working across disciplines in different phases of the creative, curatorial, or directorial process.

6.3 TECHNOLOGIES FOR DELIBERATION: ADAPTING CREATIVE PROBLEM-SOLVING TO A CIVIC CONTEXT

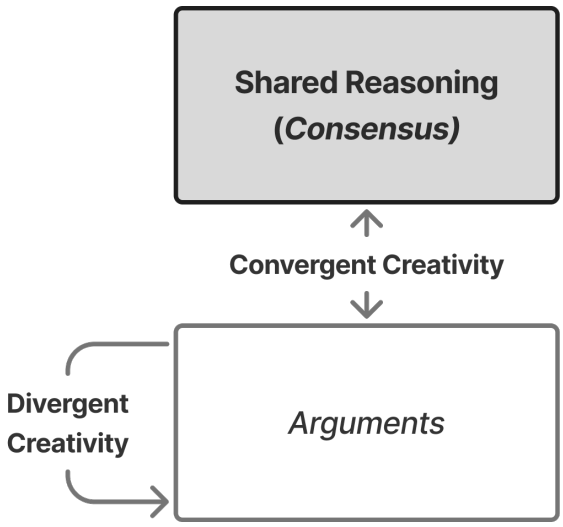


Figure 6.1: A potential adaptation of the *multi-levelled* model of creative problem-solving to a deliberative process.

Beyond artistic domains, mediating group problem-solving processes through technology is prevalent in contemporary practices. Beyond idea generation and evaluation, work on group decision-making technologies in HCI research largely exist within the context of civic engagement strategies such as town halls [35] and participatory planning [19, 32].

Directed towards public decisions, civic engagement involves the methods and ways stakeholders or citizens are involved in policy design and changes, ranging from being informed through the dissemination of information to direct collaboration [47]. To enable civic engagement in societies at a federal to municipal level, various methods for citizen participation have been developed, a notable one being *representative deliberative processes*, a process where a representative sample of people learn, deliberate, and recommend solutions to a public problem [47]. Citizens' Assemblies [72], an example of a deliberative process, begin through a sortition process, where members are selected by a stratified lottery to ensure a diverse and representative sample. After the members are chosen, they undergo a process consisting of value-sharing and rules-building, learning and building familiarity with the topic, building consensus through deliberation, and voting and sharing recommendations [22]. Mercier and Landemore [45] define a deliberative activity as one where reasoning is used explicitly in collecting, exchanging, and weighing of arguments with respect to a proposition. Rather than being persuasive, deliberation aims to build consensus from a variety of opinions through a feedback loop of reasoning. Recent work by Tessler et al. [65] and Papachristou, Yang, and Hsu [49] has

explored the mediation of deliberative processes through technology to extract, coordinate, and evaluate preferences or create and revise a "group statement" in a collective decision-making process.

Group deliberation and creative problem-solving in the context of *deliberarts* share many similarities. Deliberation could be understood in a similar *multi-levelled* fashion (Figure 6.1), where a shared line of reasoning related to a proposition acts as a method of converging on consensus from a diverse set of arguments. As such, I argue future work in technology-mediated deliberation and decision-making in contexts beyond artistic domains could adapt many of the same design implications from *deliberarts* and other research surrounding collaborative CSTs.

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