

Group 1 : HCI Winter School Literature Review

Creativity Support Tools

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ABSTRACT

A number of artistic fields have already finished their transition to using computer tools. This is even truer in music composition or photography, for example, where post processing is a necessary step in production. In this article, we take a look at the literature of these creativity support tools. We take three different scenarios: Ideation, Design processing, and Artistic tools. They all share the creativity theme while facing completely different issues. Artistic tools show a disparity between computer interface and artist work space. Design processing struggles due to lack of communication means issue between designers, engineers and expert users. Ideas emerging from the ideation process are difficult to convey to non-designer stakeholders. We review the papers in this literature to highlight the solutions to these problems.

1 INTRODUCTION

Creativity is one of, if not the single most important trait in a job of a designer or an artist. It is questionable whether creativity is an inborn privilege or a skill attainable through effort and learning. Runco et al. [20] identifies certain genes responsible for increased creative fluency. Fasko (2007) [8], however argues, that creativity can be increased through education, and can decrease if an individual does not receive mind stimulating education. We believe both of these ideas to be true. Some individuals might have a certain predisposition to creativity, but tools to support it are a necessity. This literature review presents an overview of such tools, divided into three categories: design processing, artistic practice and ideation assistance.

Design processing support tools focus on facilitating ideas expression and communication between designers and stakeholders. Designers, engineers and experts are three very distinct parties, that due to varied background might encounter communication difficulties during the process. The next section about ideation assistance partially overlaps with the previous one, due to the fact that many design methods have more than one purpose, e.g. video prototyping is a form of communicating ideas but also leads to the emergence of new thoughts. Lastly, artistic practice support addresses the problem of divergence of computer interfaces and artists' work spaces. One looks nothing like the other. Artists are unable to personalise the interfaces and struggle with lack of tool transfer-ability.

2 RELATED WORK

The reviewed work was separated accordingly to the three categories presented earlier. We start with Design Processing and discuss solutions related to creation of storyboards, sketches, paper and video prototypes and general assistance throughout the design process. Then we review information visualisation tools and reflection aids in ideation assistance and finish by reviewing some tools related to artistic practice.

2.1 Design Processing

As of now, developers and designers use completely different tools and don't necessarily share skills in their respective fields. This leads to a number of breakdowns during the design process, that can be solved with face to face collaboration or long back and forth of sending messages and documents. This created the need of collaborative tools between engineers and designers. Forsyth and Martin [9] took a try at this exercise. Their design takes the form of a storyboard that you can annotate progressively. You attach tags to objects such as Action, Event, Context, Time. The system can also prompt users for tags when information is missing. From the storyboard, the system generates a state machine that can then be translated into code. The design is a great step forward, but presents a number of limitations. This creates a reliance on storyboard from a design perspective, which is not ideal. Storyboards also contain ambiguity, usually a starting point for ideation in design, but a barrier in coding implementation.

A further exploration of collaborative tools was done by Leiva et al. [17] in the form of ENACT. The paper presenting studies in depth the breakdowns that designer-developer collaboration face, such as the ambiguity caused by designed artifacts, and extracts four principles that collaborative tools should follow.

- Support multiple viewpoints: The prototype should be seen from a designer as well as a developer point of view. This means it should support both code and visual representation.
- Maintain a single source of truth: Modifying an object in either paradigm should modify both. This solves inconsistencies from lack of communication.
- Reveal the invisible: some objects only exist in code, and some only in prototypes. The software should be able to generate a mirror image in the other point of view.
- Support design by enactment: have designers and developers play the role of users in input and interaction. This solves

Very nice job.
Two of you write extremely well, aren't bad!
written and under stand
Two thought fully
This would help others these papers.

16.5/20

Nice!

unnecessary

Reference!

Avoid "you" It's too informal

Careful! This is an unsupported claim - you need a reference.

A bit strong ...

No space before a colon in English

edge cases and allows further exploring of novel interaction techniques.

ENACT ^{looks} has a similar look ^{to} to the electronic storyboard design. The main addition is the support of an external device, which is related to the fourth principle. Users can test the prototype directly from the device. This keeps interactions ^{as human focus} in a prime position, and allows for novel and complex techniques to be understood easily by developers.

Ironically, creation of design artifacts ^{is} also lacking ⁱⁿ tools. ^{There is} a big reliance on paper prototyping for low fidelity mockups. Paper prototypes are very powerful, but are not fit for continuous interaction that necessitate feedback such as resizing. Leiva and Beaudouin-Lafon's [16] Montage is a proposed solution to this. The authors idea is to split the prototyping into three: a user context where ^{the} interactions happen, an interface meant for paper prototype support, and a canvas where ^{you} can draw. By overlaying those views into a single place through streaming, designers can insert dynamic feedback and complex representations. This extra processing can either be done live by a wizard, or as post processing.

~~Moving on to another topic,~~ Kim et al. [12] provides ^{valuable} insight on the future of Human-Fabrication interaction. The current creative process on FabMachines is very **linear**, making creators follow a very **linear** process of first designing until almost perfection and then start the production of their design. However if the production were to fail, the creator needs to restart again and make adjustments. This way of working prevents spontaneous and serendipitous in-the-wild design ideas from emerging during design and fabrication workflows. Kim et al. [12] seek to re-frame the relation between fabrication machines and designers. FabMachines are envisioned as colleagues providing precise digital fabrication and yet allowing for material manipulation on the fly to leverage the beauty and serendipity of handcraft. This work provides a series of design fictions illustrating and speculating the future of Human-Fabrication interaction.

^{There have also been studies on human collaboration.} Brown et al.'s study of collaborative events and shared artefacts [4] focuses on point of view of agile teams. ^(It is a common design paradigm meant to produce a prototype as soon as possible and iterate on it.) This method has conflicts with design teams [17], due to the time required to submit a decent design. Those conflicts are resolved through collaborative events, a process called alignment work. Brown et al. identify ³ types of collaborative events and 12 types of artifact, all ^{being a part of the cultural sphere of collaboration between designers and developers.}

A similar study ^{was also done to} investigate the design process of novice designers. Bousseau et al. [3] focus their research on discovering how ^{do} novices sketch in order to draw design implications for CAD tools targeting novice users. Their research is motivated by the fact that most CAD tools are created for professional design practice, which is a serious drawback for novice designers, due to the fact that sketching, prototyping and collaboration has a strong positive impact on the quality of the final design. The study proved that laymen lack the ability to draw their sketches accurately and

that physical materials play a key role in their design process and prototype fabrication. Furthermore, ^{they} it was discovered that collaboration based on feedback and critique is more valuable than ^{that} one based on presentation. A CAD tool targeted at novice users would have to incorporate these findings in order to be useful.

The subject of sketching in more advanced context is discussed by Felice et al. [6]. This work focuses on designers' common problem of aligning and distributing graphical objects. They conducted an initial study that allowed them to identify the shortcomings of widely used graphical editors, ^{including} lack of: persistence, control and generality. Identifying these weaknesses allowed the authors to create StickyLines, a tool that treats guidelines as first class objects, reunifying them in a form of a line, that can be manipulated. StickyLines allow precise control over objects distribution and alignment by using 'tweaks' that belong to objects and can be copied between them and reused. An experiment comparing commands and ^{the} latter performed 40% faster and required 49% ^{lower} less actions. However, the participants of this experiment identified some features that were missing from StickyLines, ^{like} mirroring tool or merging and dividing guidelines.

2.2 Ideation Assistance

Starting with Mood Boards, Lucero (2012) [18] explores the application of mood boards in the design process. ^{They consist} mostly of images, but might also include textures, color swatches or objects. These boards are deliberately highly ambiguous, in order to initiate a debate between stakeholders and designers. Based on ³ retrospective interviews, Lucero [18] argues that this technique plays an important role in ⁵ early stages of a design process: framing, aligning, paradoxing, abstracting and directing. As powerful ^a tool as they are, mood boards do not lack limitations. Their creation is time consuming and expensive. Additionally, the mix of openness and research can be rather confusing for some stakeholders, thus they can be used the most effectively among designers themselves, who are accustomed with the technique.

Koch et al. [14] address this last problem by designing SemanticCollage, a tool ^{for} supporting designers in the creation of mood boards by enriching the images with semantic labels. This augmentation allows the users not only to ^{easier} explain the concept to non-designers stakeholders, but also to transform their vague ideas into precise search queries. SemanticCollage uses computer vision algorithms to extract the labels related to each image and gathers them into 'tags clouds'. This way, designers can become aware of the main ideas behind their design, even if they are not quite able to define them just by looking at the images. Furthermore, this tool provides a solution for the disruption of the creative flow by switching between the graphical tools to create the mood boards (e.g Adobe Illustrator) and tools to search for images (e.g. Pinterest). SemanticCollage integrates both the image searching and the mood board creation.

To justify their work Koch et al. [13] ^{highlights} that "professional designers create mood boards to explore, visualize, and communicate hard-to-express ideas". They also state that "very few systems

Avoid "There is" - it always works better
Designers often rely on paper prototypes for low-fi mockups, but lack simple tools for certain types of interaction, such as ...

removes

This is your def. of agile teams, but it is worded awkwardly

Not really lacking - more suggestions for additional tools

Moodboards contain

double negative

explain

support the entire creative process, with support for different facets of inspirational practice and mostly focus on finding new material or simply encourages collaborative work". In response to that issue was born ImageSense, which is an intelligent, collaborative ideation tool that combines individual and shared work spaces, as well as collaboration with multiple forms of intelligent agents.

Reference
should describe image source

Webb et al. [23] pushes the concept of mood boards further and builds on the idea of visualisation being an important factor in a creative ideation process, but adds a semantic dimension to it. The system allows for creation of rich bookmarks combining visual clippings and semantic metadata. Webb et al. [23] emphasise the importance of reflection and interpretation in creative processes. InfoComposer being a form of a mood board allows for ambiguous interpretation, but also for reflection on previously reviewed articles, patents and ideas thanks to the addition of the semantic layer. It lacks however the flexibility of a mood board, due to limited type of objects that can be added to a rich bookmark.

"being" is almost never necessary

Sharmin et al. [21] decided to deepen the on-action process in creative design, by first reporting results from in-depth interviews with practicing designers. What they discovered was that activities related to reflection-on-action are intentional, repetitive and frequent, and there is a strong need for better reflection support tools. Emphasis was put on the importance of adopting reflective practices and the positive impact it can have on design outcomes. To address this need, they created a tool, called ReflectionSpace, that uses file meta-data and naming conventions to map design materials to the appropriate design phase and context of use and places corresponding representations in a time-and-activity centric visualization that can be navigated at different levels of detail. Designers reported that this tool helped them comparing the design processes of different projects and recalling useful anecdotes, and the mapping of design materials to the different design phases was considered effective.

Much too passive. Use active voice

Proceeding further into the topic, Lucero (2015) et al. [19] focused on a project that explored how to provide support for professionals in their work with novel technology by systematically involving end users throughout the design process. This process of co-designing brought to life the funky-design spaces vision of a holistic design studio housing interconnected tools that support the creation of mood boards. Two prototypes were made and evaluated with designers. The evaluations that derived suggest this type of environment could improve creativity and encourage collaboration.

Citation passive

Further insight on design spaces was provided by Dove et al. [7] who argued that reflecting on the design space of a project provides three important benefits. First it increases the awareness of the constraints introduced by particular design choices. Second, it qualifies the understanding of the way design activities can influence the design space. Third, the consequent prompt to challenge these constraints and reconsider disregarded choices. They have introduced SnapShot, the web-based tool they are developing to support the design space reflection approach, and presented two example cases in which projects were revisited to argue about the importance of documenting and reflecting on the design space. To

that

This section has too many unnecessary and passive phrases. Read white's "The Elements of Style". It is short and will help - especially the section on style.

provide theoretical support for their work, they also articulated an interpretation of "design space" as an instance of a conceptual space.

Say more

2.3 Artist practice *needs an intro sentence*

Tsandilas et al. [22] developed Musink, a tool to support the creative design process of composing original music. Due to the divergent aspects and characteristics that play a role in this process, composers don't limit themselves by expressing their ideas on paper, but also working with the computer, developing functions for new sounds that cannot be captured with traditional music notation. In this study, they came to view Musink as an interactive paper interface to Open Music and co-invented new functionalities with the composers. They demonstrated the primary role that paper continues to play in the creative process, but also how the final result could be influenced by the particular input/output characteristics of the synergy between computer and paper.

Another expressive software is Knotation by Felice et al. [5], which is a software meant to enhance the note taking from users in the field of dance. The main challenge compared to Musink lies in the fact that individuals all have their personal notation for movements, style, and so on. The goal of notation is not to create a generic notation for all these users, but instead to give more power to note taking. Knotation can attach knots to any stroke and or object drawn by the user, and this knot contains information relevant to dancing movement: energy, speed, and quality. It also has two other distinctive objects which are timelines and floorplans. The design puts two principles in the foreground which are expressivity and appropriability. Those objects don't have a predetermined used, and it's up to the user to take advantage of them. The main idea to extract is how the design doesn't diverge from the initial working method of dance users which is taking notes on actual paper and filming, but expands on it instead.

← actually this is true for both. Notes are universal, but annotations are personal

Moving on to another technology we have Mobi3DSketch [15] which offers 3D concept designs in a real-world context using a single AR-enabled mobile device. 3D sketching has mainly been explored in Virtual Reality. Compared to VR, Augmented Reality allows users to author 3D sketches that are more directly linked to real-world objects or environments. Sadly, the only phone applications that exist are mostly for doodling and making simple designs. With a proper challenge analysis for mobile AR, 3D sketching Mobi3DSketch provides the design of novel interaction. The first working prototype unifies relative drawing, various forms of snapping, and planar/curved surface proxies into a powerful workflow. However motion tracking is not yet robust enough which makes the technology somewhat unstable.

Review

Sentence order problem too informal

We can easily imagine the previous technology to be joined with Color Portraits. In that research Jalal et al. [11] commented that color pickers have remained largely unchanged for 25 years. In fact untrained users still have trouble selecting particular colors [1] and professional artists do not want to simply follow prescribed color systems and theories [2]. Thus the research strives to improve how authors of digital media manipulate color to achieve desired effects. This resulted in a set of four color probes to manipulate color

awkward

what?

Avoid contractions: do not vs don't

relationships within a shared context, compose and decompose diverse colors and textures, generate and capture chains of color guided by the user and finally reveal underlying processes by subtly changing hue and color intensity.

Moving from an artistic context to an office environment, Han et al. [10] ^{show} pointed that writing technical documents often requires to follow constraints and a consistent use of domain-specific terms. Most of the professional ^{users} figures they interviewed ^{by} admitted they rely on memory to maintain consistent vocabulary and manage dependencies in their writings. In order to find a solution to this problem, the authors introduced the concept of Textlets, interactive objects that concretize selections of text into persistent items.

The ^{consequent study they did, proved} the value of searchlets, a complex type of textlets. By turning search matches into persistent objects that users can manipulate directly, users were able to use functions that they would otherwise have avoided in a traditional word processors. Moreover, searchlets were so versatile that the users used them in unexpected ways, ^{like} to avoid forbidden words. ^{such as}

With the same motivation of helping professionals, Xia et al. [24] state that electronic whiteboards remain surprisingly difficult to use in the context of creativity support and design. A key problem is that once a designer places strokes and reference images on a canvas, doing anything useful with a subset of that content involves numerous steps. The will to unify them into one and provide a continuity of action by erasing the barriers a designer can face between SELECTION and ACTION brought WritLarge to life. The design of WritLarge sought to open new vistas for freeform content on electronic whiteboards. The system achieves this in a unique way, using carefully crafted input techniques that afford unified scope, action, and zoom, with pen-plus-touch—and both hands—in natural and complementary roles. ^{fix order of sentences}

3 CONCLUSION

The technologies presented in the last part of our Related work section are only the tip of the iceberg. This field of study is filled with promising researches that will, without a doubt, prove to be of use and enhance any creative process, be it music, dancing, writing a paper or anything else. It is also ^{delighting to} see tools as Color Pickers[11], that we are well accustomed to, evolving and still bringing new possibilities. This is a creative process of it's own, to build upon already existing methods, systems and practices and imbed them with modern technology as demonstrated with *Mobi3DSketch* [15]. The variety of the proposed solutions constitutes an incredibly diverse toolbox for any creator to pick from and thus maximizing his creative process.

It is not only some specific technologies that are improved and put together. On a larger scope the whole creative process is evolving with constant meta-data analysis of design processes allowing to produce smooth workflows. In the middle part of our Related work section, we explored the design process, analyzing different systems that supported it. Starting from mood boards as a tool to communicate, visualize and express ideas, we moved from a pure visual content to a more hybrid one. We passed from images to semantic metadata in order to better convey concepts, and create

richer workflows. Then further steps of the creative design process were investigated and developed into useful tools, concluding with an analysis that led to challenge the constraints in the design activities. Finally, most of the tools and processes mention and take into account the collaborative process. Collaboration is going to be the main direction for research, especially at a distance considering the situation that arose with the 2020 Covid-19 pandemic, where people were forced to smart-work from home. The enhancement of design processes will ultimately affect software development as a whole, and is a key research question to answer in the future.

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[↑] This is a bit informal, but gives a nice summary and conclusion.

users

Their study shows

Not just searchlets!

Not clear explain which is the system

Reward Don't start a paragraph with "it"

conference name is missing

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