Idea Playground: When Brainstorming is Not Enough

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ABSTRACT
Creativity and innovation are much sought-after qualities of individuals and organizations, but existing creativity practises are not cohesively integrated with digital workflows or digital artefacts. We introduce a set of design considerations for digital systems to support creative processes, specifically supporting the three ongoing, iterative activities of creative processes: gathering inspiration, generating ideas, and refining ideas. We present Idea Playground, a system built upon these considerations that supports diverse input sources, synchronous and asynchronous use, and freeform information structuring.

Categories and Subject Descriptors
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Design, Human Factors

Keywords
Design process, brainstorming, interactive environment, interactive surface, pen input, multi-user input.

1. INTRODUCTION
Innovation and creativity are predictors for success of both individuals and organizations. Yet how to build digital environments and tools to support creativity is less clear. In part, this is due to the range of working processes, tools, methods and artefacts that people use to support creativity. Because brainstorming is one of the better-known and understood creativity practices, researchers have tended to focus on building tools to support brainstorming activities. Yet brainstorming is only a small part of a longer-term creative process. In general, creative processes involve three iterative, ongoing activities [3]:

- *Gathering, hunting and collecting* of artefacts or ideas that stimulate and inspire;
- *Generating* ideas involving a whole range of creative techniques including brainstorming, and,
- *Refining* ideas by organizing, culling and selecting ideas, generally leading to a reduction in the idea space.

While this process leads a healthy existence in the physical world, digital tools and artefacts increasingly pervade our everyday activities. The problem is that existing creativity practices in the physical world do not necessarily engage or mesh well with digital artefacts or new styles of work given digital tools.

Our interest in this work is in developing tools that support and integrate digital workflows and artefacts into creative processes. Drawing upon literature about design processes [3,17] as well as empirical [1,23] and theoretical [5,6] literature on brainstorming, we develop a set of design considerations for tools for creativity environments. To achieve this goal, we take into consideration different creative processes, working arrangements, and artefacts that arise due to the increasing pervasiveness of digital tools/artefacts. Based on these ideas, we offer a set of design considerations and develop Idea Playground (Figure 1).

Figure 1. Idea Playground: an environment for creative problem solving.

Idea Playground is designed to support long-term creative thinking processes, allowing people to combine use of both digital and physical artefacts with a wide range of interaction tools. Idea Playground aims to provide people with latitude and flexibility in their creative problem solving.

Our main contribution is to articulate a set of design considerations for designers of environments for creative problem solving. As a second contribution we develop a digital environment that embodies several design choices given these considerations.

2. BACKGROUND
To provide context for this work, we first discuss our current understanding of creative problem solving and idea generation. As several systems have been designed to support this creative process, we outline and describe these systems.

2.1. Creativity in the Design Process
Buxton [3] suggests that design processes include a tension between idea generation and idea choices. These processes involve creativity at several stages. Design creativity might be best thought of as involving three separate activities [3,17,19]: *gathering* of inspiration, *generation* of ideas, and *refinement* of these ideas (Figure 2). *Gathering* happens at large in an amorphic, amebic manner, including collecting artefacts, objects, as well as ideas. Designer studio walls are often wallpapered with these artefacts as a means of inspiration—both to influence and to stimulate conversation and process, both personal and group-based [3].

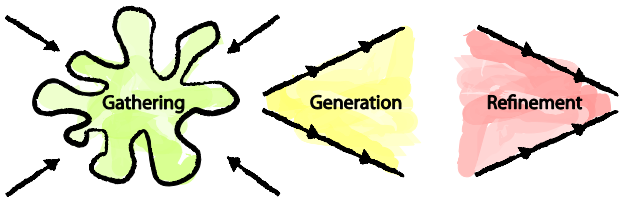

Figure 2. The three primary activities of design creativity.

Today, this activity takes place both digitally, such as on the web, and physically in the world we live in. *Generation* of ideas is where brainstorming plays an important role. The goal of this activity is to be deliberately expansive. As with the definition of traditional brainstorming [18], people are to be uncritical and deliberately unconventional. *Refinement* involves working these ideas, organizing, structuring and selecting; common practices include critique. In practice, these activities occur together iteratively.

2.2. Systems for Creativity

Considerable recent work has explored digital support for creativity, focusing on brainstorming or discussion support. Due to space constraints, we only sample from the literature, framing our review around gathering, generation, and refinement activities.

Gathering. Bao et al. demonstrate that providing facilities to "seed" the brainstorming process in advance of an actual meeting can improve results [1]. This accords with designers' practices, where rooms are wall-papered with physical artefacts to stimulate thought. In principle, these walls serve as ambient repositories for information; importantly, the *act* of collecting information also serves this "seeding" process. Accordingly, many systems support integration of external content [10,11], or imply that it would be a useful feature to include. Largely, however, these systems are designed for "brainstorming sessions" rather than deeply integrating external content for "seeding" ongoing activity.

Generation. Most systems focus on this activity, typically by providing rapid multi-user input in a shared workspace. PostBrainstorm, for example, focuses on the design of a fluid, pen-based interaction [10]. Similarly, Designer's Outpost facilitates the manipulation of tangible objects for affinity diagramming [14]. In contrast, Presmo Brainstorm [15] and Firestorm [4] emphasize speed of text-entry, providing participants with individual keyboards.

Most systems are informed by different types of *processes* for idea generation. While some emphasize co-located activity [4,7,10,13,14], others suggest a distributed process [15]. In part, this is due to the belief that structuring the process of these sessions can aid productivity [4,15]. The varying system designs reflect the differing opinions on how brainstorming should be structured. Whereas most co-located systems provide only a shared workspace, Team Storm [11] integrates the notion of a private space, where ideas can be prepared independently of, and in parallel with, the shared workspace. Facilitating this parallel process is also a design goal for several other systems [4,7,12].

Finally, the nature of how ideas are expressed differs. Many are restricted to text or words [4,15] while others also allow for, or emphasize sketches [11].

Refinement. Finally, several systems [10,12,14,21] provide powerful structuring capabilities based on affinity diagramming. For example, Designer's Outpost [14] and Hilliges et al. [13] facilitate grouping and linking of related ideas and concepts.

Through examining these activities it is apparent that designing digital environments to support creativity is a complex task. This is in part because teams have a wide range of needs and processes in which they engage. The range of capabilities provided by existing systems, and the processes they engender are testament to this wide diversity. Creativity may be best supported by embracing this diversity.

3. DESIGN CONSIDERATIONS

Incorporating a full design process including gathering, generation, and refinement, we propose a set of design considerations for digital tools to support creativity. These design considerations are focused upon providing guidelines for the design and implementation of computer supported creativity environments.

3.1. General Considerations

These general considerations apply to all three design stages of activity.

Tools. While people are increasingly using digital tools, they still frequently revert to non-digital setups when conducting design activities. As described by many studies exploring the role of traditional tools in problem solving [20,22] non-digital setups still afford more flexible work processes. When designing digital tools, several factors need to be considered. Where possible, the advantages of physical tools should be transferred into the digital counterpart. For instance, a range of input modalities, such as pen, touch, and full-body interaction should be considered. Effective use of input and display technologies can help to lower the barrier to entry for digital creative support tools.

Physical Setup. Similar to tools, physical setups that parallel advantages from what people are in the habit of using are beneficial. When considering an environment designated for collaborative interaction, the size of the room, having enough space to walk around freely, and to stand together as a group is important to provide ease and comfort.

Overarching Interaction. As noted by Guimbretière et al. [10], one of the most essential goals is to create an application that provides fast and fluid interaction. Creative activity can be adversely affected by interruptions, delays, and overly complex interactions. With software there is often a design tension between providing interaction power (the breadth and depth of the range of activities supported) and approachability (how little has to be learned to effectively use the software). For supporting creativity, it is likely that tending toward the approachability side of this tension would be useful.

Fuzzy Structuring. Another aspect of fast and fluid interaction with low entry barrier is to avoid the imposition of fixed and/or complex structures. Such structures force the user to formalize and structure ideas or concepts early on, even when this is hardly possible. This places the burden to know the structure and apply it to sometimes still vague ideas; this can discourage casual usage and even hinder the creative process. Allowing free form interaction and supporting the evolution of structure can avoid such issues.

3.2. Inspiration Gathering

To support gathering, hunting and collecting of inspiring artefacts and ideas [8], it is essential that content can be created in the world at large as well as locally as part of the system. Hunting is

primarily the action of observing and noticing. The means of gathering and collecting can vary from digital and paper sketching, to paper notebooks and journals, to digital devices and tablets, to smart phones and cameras.

Ubiquitous Ways of Input. When designing a digital system to support inspiration gathering, supporting the wide variety of devices and media types is beneficial too. For example, cameras and smart phones can be used to take snapshots to capture an idea that can then become content. Developers should consider supporting unique features of external devices to enable idea contribution in various situations not constraining the content type and offering both asynchronous and synchronous activity.

Observable Storage. In design environments, there are often "wallpapered walls" that serve as repository for collected artefacts and are also supposed to provide the right mood when dealing with and issue [16]. Within a digital solution an ambient repository that offers display, storage and archiving capabilities helps to gain overview over collected items. When not in "active use," the display can act as ambient display displaying the collected media.

Synchronous and Asynchronous Operations. While gathering might be thought of as preliminary process, in practice it plays an ongoing role in the design process. Hunting and gathering can happen within a collaborative session as well as in a distributed (place and time-wise) way. Therefore it is necessary to offer both asynchronous and synchronous activity.

3.3. Idea Generation

Some well-known techniques regarding idea generation are summarized under the term *brainstorming*. There are at least three major variations of brainstorming (verbal, nominal, and electronic), each with its strengths and weaknesses.

Support Various Brainstorming Techniques. Rather than restricting people to one particular style, we suggest providing flexible facilities that support more than one of these variations, thereby allowing people to choose the style that suits their needs. Furthermore, the environment should provide sufficient flexibility that people can modify/change their process in situ as they see it. The option of a shared workspace provides a focal point for activity, and is familiar, has low-cost of entry, and can promote group well-being [6]. Supporting independent, spatially and/or temporally separated workspaces can be accomplished through integration with mobile and personal devices. These workspaces allow people to overcome evaluation apprehension by anonymous contribution. Moreover, production blocking, a commonly cited problem in verbal brainstorming, can be overcome by providing simultaneous input support. By supporting simultaneous input, teams can employ processes with or without an explicit moderator. In the latter case, this would facilitate working in parallel.

3.4. Idea Refinement

Tools to support idea refinement are equally important to the creative process. As discussed earlier, while idea gathering and generating is about expansive thinking, idea refinement focuses on structuring, organizing and selecting these ideas. This activity is often performed in a group, discussing the options while the ideas are still visible for everybody. Mechanisms for refinement involve interaction techniques that enable quickly rearranging content, and offer ways to visualize dependencies. For example:

- *clustering*—the ability to move items freely to form spatially adjacent or aligned items;
- *grouping*—a little more formal, compared to clustering grouping usually includes some visual containment and some more decisive action to add or remove items;
- *consolidation*—in the course of a design process it is also necessary to focus on ideas that require deeper investigation, this includes to hide non-relevant information;
- *linking*—showing of relationships is often indicated by lines, links, and arrows;
- *colouring*—organization themes, similarities, etc. can be indicated by colour;
- *adjustment of size*—shrinking or expanding items helps add emphasis and clear areas.

3.5. Summary

It is important when designing digital tools to support creativity that the design considers all three activities of the creative process. Through careful attention to these issues, creativity applications can provide support for a large variety of creativity-based tasks.

4. REALIZATION OF IDEA PLAYGROUND

Building from these ideas, we developed Idea Playground, an environment for creative problem solving that attempts to harmonize a number of these design choices. Our particular focus was to enable all three creative activities without imposing a strict process. As Idea Playground represents an instantiation with specific design choices, we articulate these choices within our design considerations.

4.1. General Choices

Idea Playground offers a large, pen-based digital whiteboard powered by multiple high-resolution projectors similar to [12]. Brainstorming sessions in a traditional environment usually make use of a whiteboard. These large surfaces make ideas visible to all of the participants taking part in the brainstorming session.

In the same spirit of paralleling physical advantages of whiteboards, Idea Playground uses pen-based interaction. This provides a familiar means of interaction and supports several people working in parallel, avoiding physical or virtual keyboards as a means for text input [10,13]. Pen-based interaction offers people a common way to create and contribute new content by simply writing or drawing. This follows from the consideration of maintaining simple, flexible, fast, and parallel interaction.

4.2. Supporting Inspiration Gathering

One of the strengths of Idea Playground is the diversity of means through which information can be gathered into the system (Figure 4). We initially divide means of gathering information into two categories: digital and analog. Many digital devices are accommodated by allowing people to copy their contents into Idea Playground. For analog information sources, such as paper, flip charts or traditional whiteboards, we use tracking technologies such as digital pens or camera-based technologies to digitise this content for Idea Playground.

To support various digital devices and content types, we make use of Evernote[1] as a transport mechanism. This intermediary allows the transfer of digital artefacts between a variety of computing platforms. In our implementation, text messages, images, web-snippets and other similar forms of media can be submitted to the

[1] http://www.evernote.com

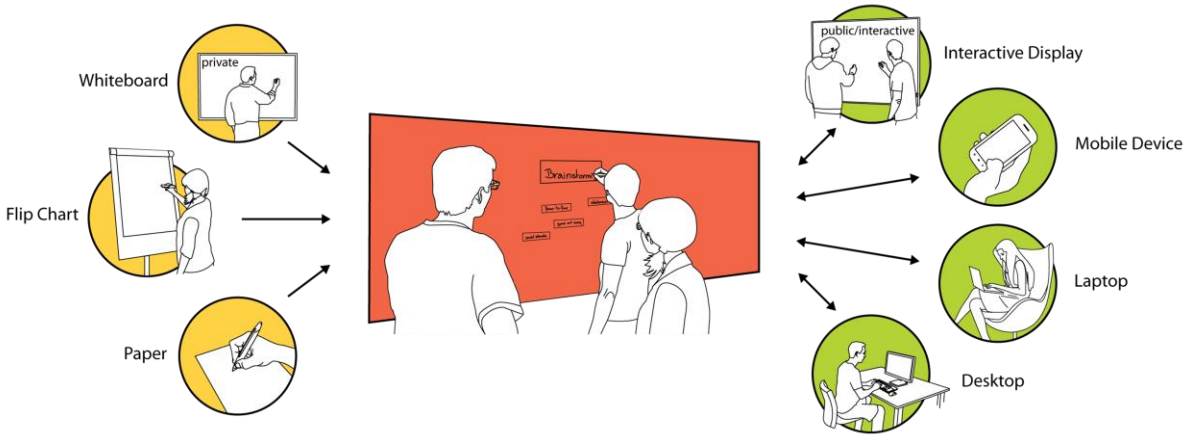

Figure 4. In Idea Playground, face-to-face sessions are performed on an interactive whiteboard, and various analog (yellow) and digital (green) devices can be used to gather information.

shared display. These media are immediately displayed even when the system is not in active use (i.e., functioning as an ambient display). Media also have different display modes. For example, web-snippets can be visualized as thumbnails on the whiteboard or magnified to regain full readability. Alternatively, they can be collapsed into a single-lined title bar to save screen space (Figure 5).

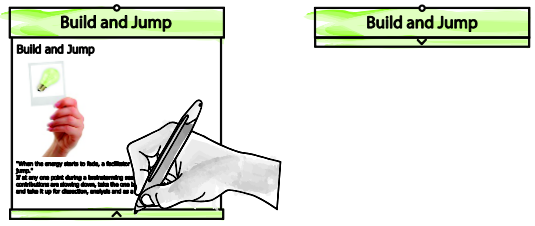

Figure 5. Standardized Evernote web-snippets are visualized by previewing a thumbnail (left). In order to gain more space the item can be collapsed (right).

We equip people with tracking technologies (i.e. Anoto[2] pens) so that even when they use analog tools (such as paper, flip-charts, and traditional whiteboards), their work can be incorporated into the digital environment. Thus, ideas written with analog tools can still contribute to the common pool of ideas. In this system, we make use of specially designed pieces of Anoto paper with dedicated areas to write down ideas and corresponding regions on the paper that act like buttons, exporting the paper contents to Idea Playground (Figure 6). This provides people with both independent space to work, and a mechanism to transfer information to the shared display. We have both regular letter-sized and flip-chart-sized paper.

Thus, both digital and analog devices can provide input from independent workspaces to the shared display. In this manner, we enable the types of advantages from both nominal and electronic brainstorming. By default, when sent, this information is put on the display immediately.

[2] http://www.anoto.com

4.3. Supporting Idea Generation

With the use of digital pens, one can simply draw or write to create local content directly on the interactive whiteboard. Most brainstorming techniques are characterized by the idea of producing chunks or short phrases of information [2, 13]. These phrases usually stand for a single idea or thought and consist of a few strokes that form words or sketches. These sketches/phrases are immediately transformed into a movable, resizable, digital note.

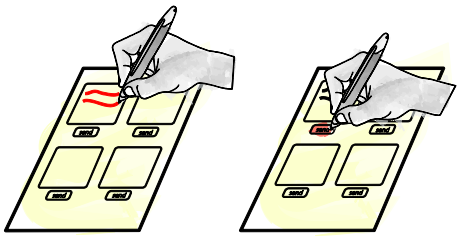

Figure 6. Dedicate areas and corresponding buttons provide a simple interface to submit ideas.

Similar to PostBrainstorm [10] we speed up workflow by providing high-level interaction that reduces the need to directly operate on single strokes through the use of stroke clustering. This decreases effort by avoiding the need to grapple with low-level activities, such as selecting several strokes to move an entire word. When a stroke is completed by lifting the pen, an item containing the entire stroke is created. Items are drawn as sticky notes that are slightly larger than the contained strokes. These sticky notes resize dynamically when new content is added. Finally, since people tend to write much larger on whiteboards than necessary for legibility [9], Idea Playground also reduces the size of item when it is not actively being edited. Editing can be re-started by tapping any item. Importantly, item creation supports multiple users at once. This prevents production-blocking that might otherwise occur with multi-stage gestures.

Independent, private workspaces are supported through either personal digital devices, or by using previously mentioned Anoto paper (Figure 6). This allows private work and bypasses evaluation apprehension. Ideas can be easily transmitted to the shared workspace, facilitating smooth transitions between independent and collaborative activity.

4.4. Supporting Idea Refinement

Idea Playground supports a variety of means to manipulate, reorganize, structure, alter, and remove information to support idea refinement.

In many sketching applications, editing is difficult. To fix an error, the digital pen's mode needs to be changed from writing to erasing; the mis-stroke has to be deleted, and then the pen's mode has to be changed back. To support fast and fluid interaction, we include a scratch gesture to remove strokes and items. Based on our design considerations we support the listed structure mechanisms.

Clustering: items can be moved into and out of proximity with one another by dragging items to the desired location.

Grouping: items can be explicitly grouped with one another by drawing a lasso around ungrouped items. The group is shown as a convex hull surrounding the group's items (Figure 7). Items can be moved and arranged within the group: the hull smoothly expands as necessary to contain all items. Dragging group areas where items are not present moves the entire group. Additionally, items can be added to the group by dragging them in, and removed by rapidly dragging them out.

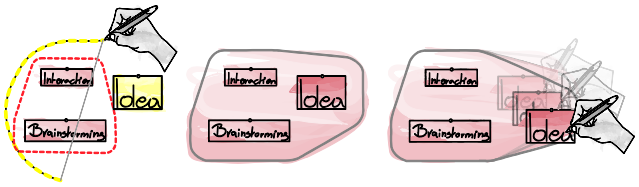

Figure 7. Items are grouped with a lasso selection. Items can be rearranged with the group.

Consolidation: besides the possibility of erasing content there are also more subtle ways of hiding content. Groups can be collapsed into a single stack that behaves like a single, consolidated item by tapping the group's background. Since the last item added to the group will be placed on top of the pile, piles can be labelled. Tapping a stacked pile restores it to its normal group state.

Linking: connections can be created between items by dragging a line from a small pin displayed at the top of each item to another item. This draws an arrow between the two items that is maintained even when objects are moved (Figure 8). Bidirectional arrows can be created by making a second connection between items in the opposite direction.

Figure 8. A connection between two items is established by connecting the pin of one item with the other item.

Colour: group colour can be changed by holding a contact on the group's border and then choosing a new colour from a popup colour picker.

Adjustment of Size: items can be presented in three different sizes. Items are largest when being edited, half original size when editing is finished, and lastly, can be shrunk when not in use to very small thumbnails at the bottom of the screen from where they can be tapped to be reclaimed.

Instancing: Idea Playground application also provides mechanisms for copying, saving, and restoring the whiteboard's state. This mechanism is helpful in various situations. The copy can be used as a snapshot, to store a particular state within the session that group might want to return to later. This can promote exploration that might otherwise be too costly to be worthwhile as previous state(s) can be easily restored. Display states can also be used to create new "pages" that provide additional space while maintaining easy access to the previous state. Each state is represented by a small square in the lower right of the whiteboard surface. This allows for creation of new instances, browsing through existing ones, and deletion without the complications of handling file names and dialogs.

5. CONCLUSION AND FUTUR WORK

We have explored a variety of design considerations that can assist in the creation of systems for creative problem solving. We stress the importance of supporting the associated activities of information gathering and idea refinement rather than idea generation alone. This can be promoted by including a variety of information sources, supporting synchronous and asynchronous usage, and maintaining awareness of the structures imposed by the system.

We have applied these considerations to create Idea Playground, a pen-based application that supports a low barrier to entry, a variety of digital and analog derived information content, synchronous and asynchronous use, and organization and structure of content in various ways.

In future work we are planning to do additional observations on how people make use of the system within their own creative process by running a field study with participants from different backgrounds.

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