Pen + Touch Diagramming to Stimulate Design Ideation

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ABSTRACT

Ideation, the process of generating new ideas, is central to design where the goal is to find novel solutions around a set of requirements. Designers engage in diagramming, creating external representations of ideas. Diagramming connects the body and creative cognitive processes, as the hands transform physical media to explore ideas. HCI researchers need to leverage body-based interaction to support creativity. My Ph.D. research develops a new body-based diagramming environment to stimulate design ideation.

Author Keywords

diagramming, design, ideation, body-based interaction

ACM Classification Keywords

H.5.1 Information interfaces and presentation: HCI.

INTRODUCTION

Generating new ideas is critical for design. Design processes are supported by embodied representations, including gestures, tangibles, and diagrams, which have been found to help people think [9, 8]. A *diagram* is a design thinking tool that stimulates imagination [1]. The process of diagramming mediates exploration of relationships between concepts, using ambiguity to foster multiple interpretations. Designers explore ideas by transforming physical diagrams (e.g. cutting, folding, sketching over) using their hands (with tools). The proliferation of sensory modalities, such as multi-touch, pen, and computer vision, enables cost-effective development of new forms of body-based interaction that can support expressive diagramming. We hypothesize that making diagramming more based in the body will promote exploration of diverse transformations, stimulating ideation.

We develop a new diagramming environment to investigate how body-based interactions impact creative cognitive processes. We derive new bimanual pen + touch interactions for diagramming on personal surfaces. We evaluate our new environment in landscape architecture education.

BACKGROUND

We ground design of our environment in embodied cognition. Cognitive models, including those associated with creativity, are based in the body [2]. Tversky et al. demonstrate that gestures help people not just to communicate meaning, but further, to remember and to understand complex ideas [10]. Of particular value are iconic gestures, whose shapes map directly to what they mean, metaphoric gestures, that use spatial representation to convey relationships, and embodied gestures, which encode knowledge motorically, as images and diagrams encode pictorially. These species of gestures provide us with cognitive guidance for how to develop body-based interfaces that will help designers diagram and form new ideas.

We seek to embody gestural interaction with diagrams through bimanual pen + touch techniques. Guiard developed one of the first models of bimanual interaction, the kinematic chain [5]. In a kinematic chain, the non-preferred hand (NPH) acts to define a reference frame for the actions of the preferred hand (PH). When drawing on paper, this is equivalent to the NPH positioning and rotating the paper in conjunction with the PH making marks with a pen. We design pen + touch interaction techniques using the kinematic chain model.

DIAGRAMMING ENVIRONMENT

We are developing a new diagramming environment to investigate how bimanual pen + touch interactions can support design processes. Through iterative design, we are evaluating impact on design ideation in architecture education.

Information Composition + Sketching

Our diagramming environment integrates information composition with sketching in an infinite zoomable space. Information composition, a medium for representing a personal information collection as a connected whole, supports reflection when performing information-based ideation tasks [11]. Designers engage in information-based ideation tasks, using information as support for generating new ideas [7], such as investigating how properties of different materials will impact a design. In our diagramming environment, designers gather images and text while sketching out ideas and exploring relationships amidst the collected information (see Figure 1).

Sketches act as interactive imagery [3]. Strokes are drawn, re-drawn, drawn over, and erased, transforming ideas. Design ideation environments should support abstraction, ambiguity, and imprecision in sketching [4]. Through integrating information composition with sketching, we support ambiguity and varied interpretations in diagramming.

Figure 1: Example information composition + sketching diagram created by a hypothetical student for a fashion design assignment. Student searched for information on materials, such as textiles, and collecting resources. She developed idea of warm vibrant silk contrasting with cold dark metal (right). Circle shapes inspired design of metal rings with silk strands. Ideas were explored by sketching over these images.

Body-based Diagramming: Pen + Touch Interaction

We seek to provide pen + touch interactions that are intuitive, expressive, and more directly connect designers to diagrams. The goal is not simply to make diagramming easier, but to aid designers in forming abstractions and investigating ambiguous representations through body-based experiences. While diagrams vividly convey spatial relationships and ideas, much of the thinking and mental models of the author are encoded in body-based creative processes of transformation. We define diagram transformation as any operation that changes a diagram to encode meaning, e.g.: adding and removing elements, affine transforms, color-space transforms, cropping, and distortion. Just as a designer uses her hands to transform physical diagrams (e.g. rotating, folding, or bending material), body-based interaction techniques are needed for transforming our new diagramming medium.

As recommended by Hinckley et al. [6], the pen, when used by itself, makes marks. The exception is when kinematic chains are created. When pen input is combined with touches, that act as modifiers, commands are invoked. We develop new bimanual pen + touch interaction techniques for diagram transformation, including cropping, layering, rotating with 3D perspective, and brush styling. Designers fluidly switch between sketching ideas and transforming diagram elements. Designers investigate varied ideas through transformations, while using a NPH undo gesture to iteratively revert changes.

Evaluation: Landscape Architecture Education

As a context for evaluating effects of body-based diagramming on design ideation, we are engaging in field studies in architecture education. Student teams in two design studios have used a preliminary version of our diagramming environment on course assignments. We collected the diagrams they created, video recorded their body-based interactions while working in the environment, and interviewed several participants. We are in the process of analyzing this data, both in terms of quantitative ideation metrics [7] and qualitative coding of video and interview data.

CONCLUSION

HCI researchers have the opportunity to transform design processes with the development of new body-based interactions. Digital environments enable creation and exploration of large information spaces that can be dynamically transformed. Interactions with these environments need to be expressive to support diverse transformations. Simultaneous pen and multi-touch input will support such expressive transformations. Developing pen + touch interaction techniques that use kinematic chains will help designers think about how elements are transformed and the relationships between elements and transformations.

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