free flowing

tense positions
tightly wound

following the movement

extensions of movement

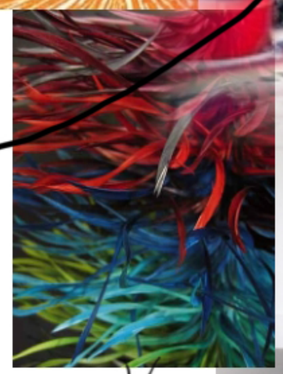
textile materials

adding a bit of **metal** to silk makes the gossamer but **strong-as-steel** natural fiber even stronger

Combine metal rings with silk

Contrast of warm light fabrics with cold and hard metal.

cold colors appear to be more distant, while warmer colors appear to be closer



vibrant silky colors

lightweight fabrics are often harder to cut and pin

free flowing

tense positions
tightly wound

following the movement

extensions of movement

adding a bit of **metal** to silk makes the gossamer but **strong-as-steel** natural fiber even stronger

Combine metal rings with silk

caption	colour 17.
location	http://farm4.staticflickr.com/3407/3299757519_aaf7c0636d_z.jpg?zz=1
source	
title	colour 17.
views	11 views
flickr tags (10/15)	
tag name	rosie colour shoot
tag name	photography
tag name	scarf
tag name	movement
tag name	studio
tag name	people
tag name	bold
tag name	acidic
tag name	clothing
tag name	fashion
author photos	
author photostream	/gee-gina/

metal.

cold colors appear to be more distant, while warmer colors appear to be closer

vibrant silky

nt fabrics are often
ut and pin

Creative Visual Thinking through Information Composition + Diagramming

Andrew M. Webb
Interface Ecology Lab
Dept. of Computer Science and Engineering
Texas A&M University
andrew@ecologylab.net

Andruid Kerne
Interface Ecology Lab
Dept. of Computer Science and Engineering
Texas A&M University
andruid@ecologylab.net

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Abstract
Promoting creativity is important to the advancement of knowledge, innovation, and experience. Creative cognitive processes are deeply rooted in perception. Visual perception includes cognitive processes that operate beyond simply recognizing differences in visual patterns. To harness the power of visual perception and support creative visual thinking while working with information, we introduce the integration of information composition and diagramming. We present an example of the integration in the form of a visual artifact, and explain how creative visual thinking is supported through a scenario.

Author Keywords
creativity, visual thinking, information composition, diagramming

Introduction
Creativity is central to intellectual endeavors, such as scientific research, art, design, and engineering. It drives innovation, transforms knowledge, and provokes new experiences. Visual thinking, from the initial perception of visual stimuli to the cognitive processes associated with concept formation and abstraction, plays a fundamental role in fostering creative ideas.

In creative cognitive processes, emergent ideas can arise

Figure 1: The original Fountain by Marcel Duchamp, 1917, photographed by Alfred Stieglitz.

from conceptual combination and synthesis, that is mental blending of two unrelated concepts to form a new unique concept [5]. Arnheim explains the foundational role of visual perception in the formation of concepts, where the mind operates with more than just visual stimuli from the eye, bringing together visual imagery from memory and organizing a lifetime of experiences into visual concepts [1]. Visual perception thus operates on higher order cognitive processes than just recognition of patterns. Visual perception can compare and discriminate, supporting recognition of conceptual combinations. Dondis describes a similar phenomena with the polarities of visual composition, contrast and harmony, which sharpen or level visual clues affecting perceptual comparison and aiding visual communication [3].

The Internet abundantly provides conceptual resources. We define *information-based ideation* as the process where new ideas emerge while working with information [10]. A person engages in an *information-based ideation task* to answer an opened ended question with the goal of discovering new ideas through collected information. Examples of information-based ideation tasks are developing a research topic, designing a dream home, or planning a family vacation.

Prior practices for collecting information typically require explicit definition of the collection's structure, such as saving a large number of bookmarks into folders or tagging a collection of images. In "Formality Considered Harmful," Shipman and Marshall retrospectively examine how converting thinking processes into formal models, such as node-link structures, and schematized types, imposes extra cognitive steps into sensemaking, diminishing usability [12]. Shipman and Marshall propose using more implicit representations for authoring, such as spatial hypertext where relationships between hypertext documents are defined by spatial position rather than node-links.

Information Composition + Diagramming
We employ another form of implicit structure authoring called information composition, in which relationships are represented by visual features beyond spatial position, such as size, color, translucence, and font face (see Artifact 1a). *Information composition* integrates an information collection connecting parts to form a whole [9]. Each element in the collection is represented by one or more image or text hypermedia *surrogates* clipped from the element, providing metadata details on-demand (see Artifact 1b) as well as access back to the element. A surrogate functions as a found object. Much like Marcel Duchamp's *Fountain* [4] (see Figure 1) and other "readymades," a surrogate gets a purpose from the element it represents, while also deriving a new purpose in the context of the information composition. For example, the image of a cotton spinning frame in the center of the submitted artifiact represents both an illustration from a document about the textile industry, and the ideas of form, shape, and color contrasted with the adjacent orange slices. New ideas emerge through conceptual combinations formed by the juxtaposition of surrogates or groups of surrogates.

An information composition represents a holistic view of a collection, helping the author to reflect on the combination and synthesis of ideas while authoring. Reflection is critical to ideation and problem solving. We reflect on a difficult problem or design in order to discover a way to re-frame it, leading to a solution. When reflection occurs in the process of doing as with information composition, Schön calls this

reflection-in-action [11]. Heidegger conceptualizes *Ready-to-Hand*, describing the internalized use of *equipment* as an extension of the body [6]. Reflection-in-action becomes a seamless tool, fluidly engaged as an extension of the self, like Heidegger's Ready-to-Hand. Reflection-in-action hinges on surprise from intuitive operations. Serendipitous juxtapositions can arise while authoring an information composition, serving as reflective insight for problem solving or sparking emergent ideas.

Berger reasons that the invention of the camera transformed the way people saw [2]. For impressionism, the visual became fleeting or in continuous flux. For cubism, the visual became not one view, but all views of a subject at once. In a similar fashion, we hypothesize that information composition can transform the way people view information, moving away from the familiar rigidity and explicitness of lists, linear documents, and hypertext towards a more surreal and implicit representation of information, championing creative visual thinking.

Diagramming represents visual thinking in analytic and expressive forms, articulating conceptual relationships and developing new ideas. Since the 1940s, architects have approached diagrams more conceptually, focusing on form-finding. They draw visual components from existing images, transforming them into design languages. Integrating diagramming with information composition creates a new environment in which to collect and arrange requirements and source materials, and traverse the key phase-transition of creative research and design processes, in which intentions and solutions emerge.

We present a scenario explaining the submitted visual artifact as evidence for creative visual thinking with information composition and diagramming. We conclude with a discussion of implications.

Artifact: Architecture Student's Fashion Design Composition + Diagram

The artifact is a composition created by a hypothetical architecture student for a course assignment. It demonstrates the integration of information composition with diagramming. Two versions are provided. Artifact 1a is the final composition. Artifact 1b highlights the underlying semantic structure of an information composition by visualizing metadata for a surrogate in-context. We now present a scenario to explain the creation of the artifact and highlight processes of creative visual thinking.

Scenario

Rosalind is a 4th year architecture student in studio working on a fashion design assignment. She will design a light, transformable structure that attaches to the body. The objectives are to understand how the body and its movements define space, incorporating materials and tectonics. Rosalind must engage in creative visual thinking by collecting information about how fashion structures can connect to the body and exaggerate its movement, drawing over collected images of body gestures to evolve her ideas, and diagramming a new design.

Rosalind opens a blank white composition space and a Google search page in her web browser. She realizes information needs on conceptual, visual, and tectonic levels. She begins by searching for tectonics of making fashion using textile, structure, texture, contrast, transparency, cut, folding, and pleating as search terms.

Rosalind notices an interesting textile design with three orange slices in her search results. She collects the image

by dragging it from her browser and dropping it into the center of the composition. Returning to her search results, she notices an image of a spinning frame used in cotton mills. The image contains three circles geometrically similar to the orange slices in the other image. Her visual perception not only recognizes similarity of shape, but also compares the cold, mechanical aspects of the spinning frame with the warm, organic aspects of the orange slices. She drags the spinning frame from her browser into the composition, and places it next to the oranges. She begins reflecting about contrast between the warmth of the oranges and the coldness of metal spinning frame. Rosalind picks up the stylus. She begins writing ideas next to the two images. She circles them for emphasis.

She continues collecting material and annotating. She opens another Google search page and queries fashion, body, form, style, and expression to represent her conceptual information needs.

In the search results, Rosalind sees an image of brightly colored silk fabric. Reflecting on her composition, a new idea emerges: combining metal and silk. She drags the silk fabric image into her composition. She collects more images and text about silk and metal. She composes, connecting cold dull metal with warm vibrant silk centered on the original two images. During this process, she brushes over an image of a woman dancing with a silk scarf, revealing in-context metadata details-on-demand (see Artifact 1b). Rosalind examines the tags associated with the Flickr image. She notices "movement," an important concept for the next part of her assignment. She clicks the tag, opening its Flickr page in her web browser for later use. Rosalind continues composing.

Circles remain central to Rosalind's ideas. Suddenly, through reflection-in-action, she thinks of rings. The idea of using metal rings with long colorful silk fabric emerges. With a solid fashion theme concept in hand, she proceeds.

Rosalind selects all elements in her composition and drags them to the right to make room for the next part of her assignment. She switches to her web browser, where she finds the Flickr tag page full of images representing movement.

Rosalind again collects by dragging elements from the web browser to her composition. She composes, with scaling and overlapping. To diagram precisely, she picks up the stylus for inking. She sets ink color to white, since most images she collected have dark backgrounds. She begins diagramming her ideas over collected images.

Through diagramming, Rosalind discovers visual design components. She diagrams shapes based on individual images and texts, and combinations. These shapes, although drawn two-dimensionally, can be read in both two and three dimensions in later design phases.

Rosalind iterates through collecting, composing and diagramming. She annotates themes with handwritten text. After formulating ideas, Rosalind sketches a set of rings with three silk ribbons running through them, between the images of movement and the materials composition. This connects the sides, emphasizing the warm vs. cold and light vs. heavy themes, and refines using painting tools.

Conclusion

Designing tools to support creative visual thinking is an essential area of HCI research. Such research will benefit from an interdisciplinary approach connecting aspects of cognitive psychology, sociology, art, design, and engineering. Supporting the powerful processes of visual

perception is necessary. Information composition integrated with diagramming and other approaches promoting information-based ideation can be further advanced with the introduction of computational algorithms to aid in searching, collecting, organizing, and visualizing information [8, 13].

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