Getting Inspired! Understanding How and Why Examples are Used in Creative Design Practice

Scarlett R. Herring[1], Chia-Chen Chang[2], Jesse Krantzler[2], Brian P. Bailey[2]

Department of Industrial and Enterprise Systems Engineering[1]   Department of Computer Science[2]

University of Illinois

Urbana, IL 61801 USA

{herring1, chang34, jkrantz2, bpbailey}@illinois.edu

ABSTRACT

The use of examples serves a critical role in creative design practice, but details of this process remain an enigma. This is problematic for both the understanding of design activity as well for the development of more effective design tools. In this paper, we report results of a study that understands and compares how designers (N=11) utilize, manage, and share examples to support the creative design process. The domains studied were Web, graphic, and product design. Our study shows that examples are a cornerstone of creative practice and are utilized for many reasons throughout the design process. Since examples are pivotal to the success of a project, more effective tools that support retrieval, storage, and dissemination of examples are needed. This paper contributes understanding of the benefits and roles of examples in the design process and implications for the design of more effective tools that support example usage.

Author Keywords

Case-based design, Examples, Web design, Graphic design, Product design

ACM Classification Keywords

H.3.3 [Information Storage and Retrieval]: Information Search and Retrieval --- Search process, Selection process; H.5.2 [User Interfaces]: Information and Presentation --- User-centered design

INTRODUCTION

Examples serve a large and critical role during the creative design process and finding and sharing examples is common in many design disciplines. For instance, Figure 1 shows a project workspace in which a product design team has immersed themselves with myriad examples (shown on the walls) collected during the design process. We use the term *example* to mean any material, product, prototype, or digital artifact (sketch, photo, Web page) that contributes

Figure 1: A design project workspace filled with examples.

directly or indirectly to a design. Though using examples is pervasive, this process has not been widely studied. This is important for both understanding the nature of design activity as well as for building more effective design tools.

Researchers have conducted lab studies to assess how the use of examples both similar to a design problem [6] and familiar to the designer [16] affects the design process and outcomes. However, these studies have not investigated which examples designers themselves would choose and why, or the different roles that examples serve in practice.

Research on case-based design also recognizes the value of examples (in the form of 'cases') [17]. This research thread has created efficient mechanisms for representing, storing, and comparing cases (e.g. [13, 15]), but has not studied which cases designers select or why. Sharmin et al. studied how designers manage and reuse their own design artifacts across projects [18]. That work did not focus on selection of examples from external sources (e.g. magazines or Web) or their usage in different phases of the creative process.

In this paper, we report results of a field study that aims to understand and compare the practices of example usage in three design domains: Web, product, and graphic design. Our field study consisted of semi-structured interviews with eleven professional and highly-skilled designers. The study here builds upon our previous study where we found that browsing the Web, magazines, and books was an important part of designers' ideation practices [10]. Our current work now studies this enigmatic behavior in much greater detail.

Specifically, this research contributes new understanding of how designers search for, retrieve, and share examples and the different roles that examples serve in the design process. Based on these results, we also derive new implications for how to develop more effective computer-based design tools that support the use of examples in the design process.

RELATED WORK

Studies of Example Usage

Several studies have investigated why designers use examples, the range of examples explored, and the effects of familiarity with examples on creativity. Bonnardel studied the role of examples in a non-routine design activity in a laboratory setting [6]. She found that designers utilize examples in the design process as a source of inspiration and innovation. Additionally, designers often use similar products as design examples and compare and analyze the different features. From this assessment, designers transfer desired features from the original product to the new design.

Purcell and Gero [16] studied the effects of image familiarity on creative output for a product design task in a laboratory setting. They found that familiar pictorial images increase the variety of ideas generated, but also produce design fixation (the tendency to reproduce certain elements from examples they have seen). On the other hand, pictures which are unfamiliar to designers have less of an effect on variety and fixation. Thus, a combination of both random and semi-random example searching is useful in generating novel ideas when one becomes fixed on a specific idea [12].

More recent investigations have applied these principles to the creation of API's for Web-based services [9]. They use the notion of 'hacking, mashing and gluing' where mashing refers to choosing pieces from existing technology and re-appropriating the functionality. The analysis of design features of existing products constitutes an important and necessary stage in the designers' activities because it allows for a deeper understanding of the design elements [6].

These studies have provided insights into the types and range of examples utilized in the design process and the effects of familiarity on creative design output. However, these studies did not investigate how examples are retrieved, stored, and shared in practice or the differences in the types of examples used in different design domains. Our work contributes further understanding of these practices through a field study of example usage in three design domains.

Studies of Creative Design Practice

Researchers have studied creative design practice from many different perspectives. One thread of research has sought to derive cognitive models of the creative process. For example, Warr and O'Neill synthesized many existing creativity models into a single, unified model [21]. Their *Generic Creative Process* model stresses the similarities of previous models and attempts to reach a uniform consensus.

Their model consists of the three non-distinct phases of Problem Preparation, Idea Generation, and Idea Evaluation. We use this model to structure some of our study results.

Another research thread has studied the techniques used to generate new ideas during creative problem solving. For example, Smith [19] has identified 172 techniques for generating ideas. Building on this work, Herring et al. [10] studied idea generation techniques used in design practice and found that 19 techniques were used most often. Of those identified, active and passive search were highly utilized by designers. Active search is organized around a specific information need. This ranges from searching for relevant images on the Web to searching through physical books, magazines, and newspapers. Passive search involves designers browsing materials in search of inspiration [2].

A third thread has investigated the use of representations in the design process. For example, Newman and Landay explored the evolution of idea representations throughout the Web design process [14]. Similarly, Bailey, Konstan and Carlis studied how temporal effects and interaction are captured in representations in the multimedia domain [5].

Relative to this corpus of design studies, our current study differs in that we are investigating the benefits and roles of example usage in three different design domains and how to build computer-based tools that better support this practice.

Systems that support Example Finding

The Web is widely used for information finding and prior work has shown that designers perceive the Web as a rich source of examples [10]. Though not the specific focus, there has been research that could improve the Web for example finding. For instance, in the area of image search, Yee et al. developed a category-based method that enables users to navigate along the conceptual dimensions of an image set [11]. Fogarty et al. developed a new interface that allows users to perform image search through visual composition of search rules [8]. Cuil, a new search website, renders images to illustrate the main concepts behind search results and arranges the results in a 2D space [1].

These and other improvements to search interfaces have the potential to aid designers in example finding. However, because less is known about how designers use the Web it is not clear whether, or how well, these techniques would help or be adapted for this search context. Our work contributes to filling this gap.

Case-based systems have been grounded in the perspective that designers solve new problems by relating them to prior experiences (i.e. examples) [17]. Research on these systems has focused on developing computational representations of cases and algorithms for efficient retrieval. These systems have been studied mostly in the engineering design domains.

Our work differs by studying how designers essentially build their own 'cases' by searching for, retrieving, and

storing examples from external sources such as the Web. Consistent with findings reported by Pearce et al [15], this area of research would benefit from deeper understanding of how designers find and select examples in practice and how tools can better support example finding behavior.

METHODOLOGY

Participants were recruited via electronic postings on the IDSA-Chicago website and Coroflot, the portfolio website for the Core77 design blog. Eleven designers responded and were interviewed for this study. Four participants were freelance designers while the others worked for one of several design firms in a metropolitan area. The firms are well known in the design community and have a recognized reputation for design innovation. All participants were typically contracted by external clients to design websites, physical products, visual logos, or product packaging. The experience of the participants ranged from 1 to 17 years with an average of about 9 years. They also had diverse educational backgrounds including a BFA in photography and a MFA in Human-Centered Communication design.

A semi-structured interview was conducted in a designer's own workspace. This allowed designers to have access to their design materials and allowed us to observe their work environment. The interview script consisted of 16 questions covering the benefits and limitations of examples; example retrieval, storage and dissemination techniques; and the designers' attitudes toward contributing personal examples.

Some of the specific questions included: what methods do you use to search for examples and what are the strengths and weaknesses of these methods; for what purposes do you share stored examples with others; and for what reasons do you consciously choose not to look at examples, if at all. Designers were also asked to describe a recent or ongoing project in which examples were used and to share anecdotes from this project as much as possible during the interview.

Participants were asked to describe their professional background for classification into product, graphic or Web design. Most of the designers had professional backgrounds in multiple design domains and were therefore classified into multiple categories. The classifications were 7 product, 4 graphic, and 3 web designers. By interviewing a diverse set of designers, we were able to identify similarities and differences of example usage among the different domains.

RESULTS

We present the benefits and use of examples in the design process structured according to the generic creative process model [21]. We then break the results into retrieval, storage and dissemination techniques. Finally we discuss designers' motivation for contributing their own personal examples to the design community.

Benefits of Examples

Examples have many benefits in design, particularly in the preparation and idea-generation phases. Examples were mostly cited as being an aid in not only providing a scope of what is already available on the market, but also for providing inspiration for new design ideas. The types of examples and utility of these examples are highly similar. Benefits of examples in design include: they provide a visual framework, allow for reinterpretation of ideas, and are used as a validation tool in the final design stages.

Preparation Phase- Visual framework

During the problem preparation phase, designers view relevant information associated with the problem in order to develop an understanding of what is required and to provide a basis for generating valid solutions. One of the benefits provided by examples during this phase is their ability to improve communication between the clients and the design team. Clients are often ambiguous and imprecise about exactly what they want. The initial meetings with the client are imperative as they set the stage for the entire project by developing common terms. During these meetings, clients often provide a report of the competition, projects they like, and directions they are interested in pursuing.

The use of visual examples is crucial for effective client-designer communication because examples allow designers to internalize client needs. As one designer stated, "Design examples are like frameworks. That's how we should view them. It's a visual that gets the whole team around an idea or a direction." Similarly, another designer said, "We use examples all the time. It's always the first part of the design process, what we refer to as survey and analysis." Once designers and clients have built shared understanding of terminology and directions, they begin generating ideas.

Idea Generation Phrase- Reinterpretation of examples

In the Idea Generation phase, designers must develop novel ideas. Examples have many benefits during this phase such as understanding the current market, reinterpreting designs, and determining the originality of a design. Designers often survey the market for similar products to assess what exists (see Figure 2). For example, one designer explained, "We use examples for most of our projects. Generally we ground our projects with an audit at the beginning where we look at current designs out there to get an idea of what the competition looks like." This allows designers to ensure their product is unique and to explain why it is unique.

Scoping what is already available on the market can also be beneficial if the design direction has been pursued before: "Sometimes it's interesting because you find someone has thought of your idea before but they have not developed it. It can be interesting to learn why it wasn't developed or why it didn't work." This information allows designers to move forward in the design process or helps guide them in a new direction. It is essential to not only determine if the design idea has already been developed, but also to identify mistakes made in or limitations of previous designs.

The designers reported that examples are also important because they allow for reinterpretation of ideas: "I've always believed in art that everything has been done. Essentially what we are doing is re-appropriating. Why struggle with recreating the wheel when you can just use what you've learned from the process of making the wheel to make it better." The importance of examples is not limited to merely seeing what has already been created, but also establishing new connections. One designer compared the design process to cooking, "You may not like a recipe, but you like some of the ingredients in the recipe. So you take what you like, maybe add in some new ingredients and create a new recipe." The same idea applies to design. One Web designer discussed how examples played a role in a website they created; "I see things, it's usually pieces and parts. For example, I saw how Apple shows shadows of their products on their web pages. I took that idea and reflected images on my site to improve the design." Examples allow designers to identify these connections.

Figure 2: Competitive audit and inspirational pieces from the early phases of the design process.

Evaluation Phase
In the *Idea Evaluation* phase, the designer evaluates the novel ideas produced and judges their appropriateness and creativeness. "Without examples you are just running blindly. It gives you a starting point but it also gives you rationale for what you've done and why it's a valid solution." Another designer commented, "Essentially that's what I think I am, a problem solver." For those who view design as problem solving, it is important to reflect on previous examples as one method to ensure they have created an original and valid design solution. Designers also use examples as a reference in the late stages of design to see where they started and how their design evolved.

Potential Limitations of Examples
Some designers may be concerned that viewing examples contaminates their minds and restricts their creative outputs. In some ways, seeing examples could reduce the range of possible design solutions because it guides the mind in certain directions. This notion of design fixation has been found in empirical studies [16], [7]. Although this may be an issue, there are disproportionately more designers who feel the benefits of examples outweigh the costs. One designer mentioned they are very influenced by what they see, do, and hear, and wonder if they should divorce themselves from examples. However, they said they "thirst for knowledge" and think it would be hard to shut off and not pay attention to examples. "I think that (looking at examples) sort of walks the line between being an artist and being a designer. Designers are able to pull connections between things and see connections and in art you don't have to do that. You can kind of follow your own path. We need to know what is going on."

One way the design firms keep examples from hindering their designers is to bring in designers not associated with the current project to the brainstorming sessions. It's good to bring those people in because they don't have the same reference points, haven't looked at the examples, and therefore bring new perspectives to the project. This keeps the design team from being "so entrenched in the process that they can't get outside the box." Other firms handle this differently. When looking for examples they specifically do not look in the same field they are working in. For example if they are doing a packaging design for an office supplier, they won't look at the products too similar or the "best in the market" because it could hinder their creative output.

Example Retrieval Strategies
There are two ways designers find relevant examples; through active search, when the designer is looking for a particular object or has a specific information need; or through passive search, when the designer is looking for inspiration. Designers use magazines, books, the Web and physical product libraries to find relevant design examples.

Examples in the same design domain were cited as being most useful, but designers reported utilizing many other types of examples. For instance, designers often research the target audience to see what types of culturally relevant artifacts they might be interested in (music, media, and other things users might have around) and try to identify relevant examples. They also look at examples of what's available in the market (research existing designs; get an idea of how they work). This means if they are working on a packaging project they aren't necessarily looking only at other examples of packaging, but also areas such as fashion design and current style trends. The following sub-sections will further explore how examples are collected and utilized for different projects in product, graphic and web design.

Product design
The most useful types of examples in product design are examples showing form and function. In the preparation phase, product designers collect many samples of current

products or take digital photos of products on the market. Because it is nearly impossible to collect all samples of competitive products, designers also draw inspiration from other visual sources such as blogs and stock photo sites.

One project described during the interviews was the design of furniture using environmentally friendly materials. The designer referenced different physical material examples to understand how they could be shaped and found examples of both furniture and products through image searches and Web browsing. They also drew inspiration from a poster series by Lester Beall, an artist famous for his print media. For example, the designer said, "I looked to him to say I'm not going to copy what he did, but I'm going to use his sort of style to then mimic that so people make the connection." The designer used the concept behind Beall's designs - simple geometric shapes and a simple color palette – as well as similar products on the market to draw inspiration.

As can be inferred from this case, product designers utilize visual sources to develop the form, function, and color palette utilized in the final product. Given they are 3D designers, physical examples are always the best, but it's "almost impossible to get your hands on all of them." Due to this restraint other sources such as magazines, books, and digital images can be used to draw inspiration and aid in the connection of ideas for future designs.

Graphic design

Graphic designers utilize a wide range of examples due to the variable nature of their work. The designers interviewed in this category worked on projects ranging from consumer packaging to annual reports. Both physical as well as other non-tangible sources were utilized by these designers. This domain differs from product design because the designers are not only interested in visual sources. For example, when designing a visual logo, designers need not only images, but background information and rationale for those images because the logo represents the entire company.

One designer described a recent project where they were creating a logo to represent a Christian organization. They wanted the logo to represent the ideals of growth and began

browsing gardening sites and researching the history of different types of natural trees. They then examined how different tree limbs branched down and intertwined with each other and how the roots were grounded. They used this as an analogy to represent the idea of giving back to the church and the connection of the church community. This draws on an important difference between graphic design and the other domains; they must understand what the symbols represent b represent the identity of the company.

Another facet of graphic design is consumer packaging. Graphic designers that work on packaging projects tend to use physical examples as well as other visual inspirations. Some graphic design firms specializing in packaging maintain a physical library of packaging examples, see Figure 3. This library contains many different types of packaging examples from a variety of sources (deodorant, cleaning supplies, alcohol, etc.). At the start of the design process, designers utilize physical examples as well as inspiration from other visual sources (magazine clippings, books, and Web images). Packaging design is similar to product design in that designers utilize more physical examples because the end product is tangible.

Another type of work tackled by graphic designers is print media. One designer discussed their use of examples in the design of an annual report, "I always look into how I can change the annual report: I always have parameters that are the same every year such as they want a lot of picture, but then they give me an un-godly amount of text. So I look at how I can make lots of text and lots of pictures look good. I like the treatment of this example (see Figure 3) because there is a lot of text there, but they break it up in a way that doesn't seem too gaudy." This shows that designers use examples not only for visual inspiration, but also for the design of new layouts.

Web design

Web design often involves aspects of graphic design such as when branding a company and developing a logo as part of a site. Therefore, when the designers are involved in the graphic design aspects of a website, examples are utilized and retrieved in the methods already discussed. However, when they focus primarily on website design (structure, layout, interaction, etc.), the examples collected are quite

Figure 3: Physical product library

Figure 4: Example used in the design of a report.

different. One designer mentioned when they started designing websites they tried not to look at any other website designs because it is easy to "fall into the rut of making your design look like something else." However, since there are so many usability guidelines, they state there are far fewer organic Web designs possible.

One difference between Web design and other design domains is there is a standard set of ingredients. As one designer explained "Almost all websites are the same. They have a header that tells you who they are, a navigation bar either at the top or down the side, a story to get your attention, a lot of 'news stuff' and then fillers and links to other pages." The designers in our study stated they weren't "recreating" web design, instead they look at other websites, choose the pieces they like and use them to inspire new designs. For example, one designer stated, "I flip through sites that sell (website) templates. I never buy them, but I look at the content. When I look at websites I think, 'I like this, I don't like all of it, but I like some of it'. So I pick what I want (layout, colors, fonts) and use it to inspire my design. The design process for me is about figuring out what's going into the soup (navigational bars, links, news information) and then making soup."

In addition to the layout of the website they also often look at trends in the domain for which they are designing. For example, one designer described the re-design process of a collegiate sports website. They reported visiting other university sports sites, flipping through related magazines (ESPN the magazine), and browsing through trendy digital images on Deviant Art. The web designers stated they rarely initiated an active search for inspiration or to aid with design, but more often found inspiration through passively browsing different visual sources.

Comparison of retrieval strategies
Designers utilize many sources for retrieving examples, including the Web, magazines, books, and products from local stores or via a physical product library. Designers have different perspectives about the most beneficial retrieval technique. One designer with seventeen years of experience stated they rarely use the Web to search for examples: "It's a generational thing. I'm online all the time, but I don't like to be distracted. Going to websites really distracts me. But sitting down and grabbing a book, that doesn't. It's more visual. It's more physical." In contrast, another designer said they love the Web because "it's free and constant knowledge". He added, "I'm usually looking for obscure ideas. The internet is good for that." Although the views of the best retrieval strategy may vary among the design community, several benefits and limitations became apparent throughout the course of the interviews.

When performing an active search on the Web, designers often struggle to articulate the keywords. One designer said, "It's weird the way Google searches stuff. Sometimes it will be so easy, you'll type in 'football logo' and you'll have things at least you can decipher. Sometimes football logo isn't the best example because when you say football in the US it's different than football to the rest of the world."

Another designer cited they were often too literal when searching the web, "If I'm working on sunglasses, I look at too much sunglasses and not enough 'sun' or related words. It's very useful for me when I start looking at real abstract terms." One strategy designer's use to aid in the selection of keywords is to write down a stream of consciousness for the design topic. For instance, if they are designing a line of baby products they may think of the word 'purity' which may lead them to 'water' which may lead them to look up different water bottle packaging since they are often centered around the 'purity of their water'.

The Web also does not provide designers with an idea of what is coming next. As one person said, "You can do an initial skim of a magazine and get a sense of what is happening next. If you click on an example on the internet, you're taken on a completely different tangent. Books and magazines are more organized." On the contrary, other designers dislike books and magazines because the information is filtered by editors and the public view of what is "acceptable for publication."

Many designers argue the 'randomness' of the Web allows for more connections and more inspiration than traditional retrieval strategies; "I like it (the Web) because I start meandering. When you get to page 20 (of a Web search), some weird stuff comes up and it's awesome because it's only kind of related to the project or term you searched for." Most designers feel magazines and books are too restrictive, whereas the Web allows users to easily switch between active and passive search.

Many designers referenced problems ranging from the linear nature of web searches to the lack of a hierarchical structure allowing them to focus more attention on relevant designs. They also have problems with losing information. For example, users might perform a web search, but didn't book mark it or save it and then can't find it again. One designer commented on this phenomenon, "I find when you get engrossed in what you are doing you forget to have the bookmarks and the tracking so you can actually find your way back to the point in which you got distracted by 'the bright shiny objects' and forgot about what you were actually supposed to be doing and follow that up."

A benefit of the Web is the abundance of constantly updated information. They mentioned that they have to search many magazines to get the spectrum of information available to them from the Web. Designers also like that they can search by content such as news or images easier than in books or magazines. They also frequent web blogs, particularly when they are related to design. They visit these sites on a daily basis to gain inspiration and get up-to-

date information on current trends in design. Since there are numerous design blogs, designers often utilize RSS readers, or a web feed to publish frequently updated works.

Example Storage Strategies
There are many types of examples stored by designers including; magazine clippings, copies from books, digital images, physical products and websites. Since designers store almost as many examples as they retrieve, underlying organization is needed in order to quickly retrieve and share them. One designer discussed this problem, "I don't have a problem with the volume of information or finding examples, but there is a problem with how you access it, store it and record it; how you get to the kind of things that would be useful at the time that you need them. There certainly is a difficulty in how to manage information especially now that there is so much around. Dealing with the volume of information has become quite a large task." Each designer / firm has their own way of categorizing information. There is also a difference in the organization and storage of tangible vs. intangible (electronic) examples.
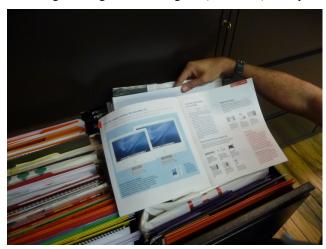

Figure 5: Storage of printed electronic examples

Tangible Examples
There were two types of tangible examples, actual products and other paper sources (magazine clippings, print-outs, photocopies). Many designers flag relevant examples in books and magazines and put the book/magazines in a pile or on a bookshelf. There are many problems with this strategy; designers forget that they flagged examples, forget why they flagged them or forget to review them. One designer commented on these problems, "I might go back a couple weeks after I flag an example and say 'why did I flag it or what about it did I find particularly worth flagging?' and when I figure that out, then it's something I can build off of when I start the next piece of a design."

The value of these examples resides within the designer's memory of what they stored and why they stored it. One way to combat this problem is to classify tangible objects into categories: "Collecting images and magazines is something a lot of designers do. It's always a problem trying to remember what you've got or to find things or classify [examples] without it taking an extraordinary amount of time classifying them." One designer posts a reminder on a wall when they collect an example to help them remember what examples they have stored.

Some designers are more extreme and categorize every tangible example they have. One designer prints all electronic sources and catalogs them into a physical library, see Figure 5. Every couple of months they organize their examples. They have many different file folders such as, "branding (examples or reports on branding), how to treat case studies, corporate ids, colors, diagrams and conference materials." This strategy is more useful than stacking examples because the designer can easily locate relevant design examples and share them with other designers. However, there is a major shortcoming in the time involved categorizing and filing the images.

Intangible Examples
Many digital examples are also collected during the process including: digital images, web blog text, and web pages. There are many structures for organizing these types of examples into searchable database. Some design firms take pictures of all of the physical samples and categorize them based off of their features in an online system. For example, if they have a shampoo bottle, they save it in the directory 'hair care' and then the sub-directory 'shampoo'. They then name the file with as many descriptors as possible, "We usually start off with the brand and go from there. It's basically a brain dump." The advantage of this method is it makes the library searchable by keywords and allows designers to view the library from any computer in the office. The designer added, "If we are careful about the file name, we can find the images with an easy search. For example, if I type in purple or shampoo to a search, I'll find any products matching that description in our database."

This is also the main drawback of this type of system – the file naming structure. In one particular firm, there are only two designers who add images to the database in order to keep consistency in the naming conventions of the file. One designer mentioned, "It's downfall is if I type out '3 quarter' versus '3Q' which is our abbreviation for a three quarter view, it's not going to come up if someone types in one or the other. So that's one of the reasons we've kept it to only two people naming the files to keep it consistent."

Another designer commented on the use of image libraries, "We don't generally have a library of images, because the general feeling is they aren't very searchable. You are better off just starting over on every project and just dragging together inspiration." In addition, the database cannot be constantly updated because it is limited by the availability of the people maintaining it: "if we get busy, the images pile up and become unmanageable."

This type of categorization is often utilized by individual designers. One designer explained, "We rely on the categorization and folders to find where the images are stored on the computer, the name of the image don't matter. We always keep the same file name as found on the internet." Designers do not want to take the time to rename a file, but merely place it in a folder relevant to the design. For instance, if it is an image of a coffee mug they may place it in the 'dish' category and the sub-category of 'mug'. Although this classification system is seemingly well organized and reduces the load on the designer, there are some drawbacks. "We use a lot of stock photos and save them in a project folder, but the image is only saved as a generic file name. When we are working on a new project we often say, 'you know what would be great, photo x', but you can't find it. It's not efficient; you have it (photo x) but you have to go back and manually search each folder."

Another problem with this method is designers rarely revisit these folders. As with these tangible files, designers often forget what examples they have stored. In fact, they mentioned only revisiting directories if they are adding a new image to it because it reminds them about the types of images they have stored. They then browse these folders using the 'preview' function, but they still have to search through a large quantity of images.

Other types of examples are saved as links to Web pages, but designers mentioned several problems with re-visiting them. The first problem is distrust in the links, "the Web is always changing so I feel like even if I bookmark it, the link could expire." To bypass this problem, designers pull images or related information off the Web and save it on their computer. Another method for saving websites is to archive the page. This allows designers to revisit pages if the web address has changed or disappeared. However, the most common strategy is the use of bookmarking websites.

Most designers mentioned they have an abundance of bookmarked sites. "The electronic bookmarks are much like what I do with the magazine bookmarks (flags)." In fact, some designers have the exact same difficulties they have with storing tangible examples; they can't remember what they have or why they bookmarked a particular site. The ease of bookmarking sites often creates many difficulties, "I do a lot more bookmarking than I refer back to. If there's something I like I'll put it in a bookmark." In order to organize these bookmarks, designers often use social bookmarking sites such as del.icio.us as it supports search and tagging which helps them track their bookmarks. Designers like these sites because they are accessible from multiple locations and allow storage and categorization.

However, there are some problems with these sites. One problem designers have with sites such as del.icio.us is there is no structure which separates the more important bookmarks; all sites are given the same weight. Designers stated they would like to have some mechanism that allows them to indicate the more salient bookmarks. Additionally, since there is a large quantity of sites stored, few are re-visited. As one designer stated, "It (del.icio.us) was annoying because I had to log into it. I like the idea I can access my bookmarks anywhere, but it was just annoying me. I also didn't like having to tag it. I just want to drag it, use it and run. I know the tags are nice for finding them later, but sometimes you only have a list of five things so it's not worth it to tag it. All of my tags are the same, 'design blog.'" The underlying problem with storing examples is the lack of tools enabling designers to be able to quickly categorize and organize examples at their own preference so they are easy to retrieve and review later.

Example Sharing
Designers reported that they frequently share examples with colleagues by sending e-mail messages with a link to the example and a brief description. One problem with this technique is that the messages may fill up or 'spam' a colleague's inbox. Another problem is that current systems do not weight the importance of the messages. One way to combat this problem is to create some type of file sharing repository, but this too has its limitations such as people do not want to contribute or do not visit the repository.

One designer described a physical wall that people pinned examples to. The problem was that no one ever looked at it. The designer noted, "I don't want to contribute (examples) if no one looks at them." Designers prefer email over other sources because they know people are more likely to review and use the example. They like the feedback they get from other designers when they find something particularly useful or inspiring, "maybe if there was a news feed like on Facebook where it gives you statistics of how many people have viewed your example, how many people liked it, maybe I would prefer another method."

Contributing Personal Examples
We asked about designers' contribution of examples to web blogs and other design outlets as well as their motivation for doing so. There are several restrictions on the types of examples designers can contribute to these sites, largely due to the confidentiality of their designs. It often takes companies several years to develop a product after its initial design. This means designers are held to confidentiality agreements about the products until they are launched and are not allowed to share any examples related to the work. Designers stated they would like to share their work with others if it was not a matter of intellectual property (IP).

There are also personal reasons for not wanting to share examples. For instance, designers may be concerned that someone will copy their work without permission while others are self-conscious due to the fear of criticism [4]. There is also a general consensus that sharing examples will affect their 'bottom line.' One designer commented, "there is interesting discussion around the design community

about 'open-source' because in some ways designers earn their money for the service of thinking of ideas and developing ideas. People find it hard to get their head around the idea that you would 'give things away' or share them without limitation." One designer who contributes examples discussed their rationale, "In the beginning I wanted to put stuff out there. I liked that I didn't know who would see it. It's also a way to broadcast a bit. I contribute examples for the same reason I add pictures to Flickr; I like to share it with other people around the world."

Although there are mixed feelings about contributing examples to the public, many designers feel they would be more willing to do so if the process was more simplistic. "I know I should do it (contribute examples), and I need to do it. I get more interested in doing it the simpler the tools are to use." Designers also mentioned they would contribute more examples if they were aware of people interested or working on similar projects. If they knew their examples were useful to others, they would be more open to sharing design examples as long as they weren't violating IP rules.

IMPLICATIONS AND DISCUSSION
From this study, we have developed several implications for how computer-based design tools can better support the use of examples during the design process.

Augment search to prevent fixation
Search engines typically assume that users can articulate their information need and have an end target in mind. When designers are actively searching for examples, they can articulate their need, but often do not have a target in mind (i.e. there is no "that's it"). Not only did designers cite the information at the end of the search results to be most inspiring, but studies have shown that viewing only similar examples increases fixation [16]. Therefore, the linear or cluster-based display of search results based on similarity (e.g. [22]) may not always be optimal for example search.

One way to overcome this obstacle is to not always order search results based solely on similarity to the query. For instance, more results could be displayed on the same page allowing designers to see more examples without having to navigate to pages deemed 'less similar.' A second method is to mix dissimilar with similar results to create a more diverse set. To find examples that are less similar but still useful or inspirational, systems could include results that are less related to the query terms (lower in ranking) or show results that are related to the query at different levels of abstraction. For example, if the designer searches for sunglasses, terms relating to 'sun' or 'beach' could also be included in the query (and results). These tactics would give designers more immediate access to less similar but still useful or inspirational results and help alleviate fixation.

Improve capture and visualization of search results
Designers may forget to save interesting examples they find and struggle to re-find those examples later in the process.

This is consistent with a recent study showing that forty percent of search queries are attempts to re-find information [20]. The use of social bookmarking sites can help, but the overhead of using such sites and the dynamic nature of the Web limit their value for designers.

One implication is to improve support for capturing search histories. Though research has begun to address this issue [[3]], when finding examples, designers need solutions that allow them to extract and follow new connections between related concepts and at different levels of abstraction. One solution is to employ techniques for visually structuring the search history. For example, the history could be organized in the form of a graph on an infinite 2D canvas, leveraging and extending visual structures often seen in mind mapping. This would allow designers to build explicit connections during the search process, reflect on the state of the search, and pursue new tangents without losing previous context.

Integrate physical and digital sources of examples
Our study shows that designers use electronic and physical sources of examples but have different storage strategies for each modality. Some designers try to merge the two modalities by either taking pictures of physical examples or printing electronic sources. The implication is designers need better synergy between physical and digital sources of inspirational materials. For example, a designer could take digital photos or scan pages of physical magazines or paper sketches and insert and position them in the visual structure previously mentioned. This would not only allow designers to have a unified and holistic example space but also allow them to better retrace their overall search process.

Help designers recall why they stored examples
Our study showed that designers have difficulty remembering why they store examples because they have to store the entire example even when they only found a particular piece interesting. For instance, if a designer likes the layout of a web page, they are typically only able to store (via a bookmark) the page itself and must remember what they liked about it.

The implication is that designers would benefit from mechanisms that would allow them to quickly and easily record why they found particular examples interesting. For instance, a web designer could directly choose attributes of an interesting website such as its layout, font type, or color scheme to aid in the recall of why they stored a link to that page. This basically allows a designer to "tag" the examples with little or no additional effort. Also, if the underlying HTML code is available, design tools could import the components related to the attributes. For example, a tool such as FrontPage could import the layouts of saved Web sites and show them as available templates or could show existing design ideas with the fonts or color palettes previously flagged. This works best for domains where the raw data file associated with an example can be parsed (e.g.

the HTML code of a web site). However, similar techniques could be utilized in other domains if designers were able and willing to contribute their raw engineering models.

Encourage contributions of personal examples
Designers commonly search for and use examples but rarely share their own personal designs, even though they could serve as inspiration to other designers. This imbalance is often due to the fear of real or perceived criticism or lack of motivation [4]. The implication is that tools should include mechanisms that help decrease costs of example sharing and/or better link the benefits to the costs.

One way to decrease example sharing costs is to more tightly integrate content creation tools with online personal design blogs. When desired, a designer could blog designs directly from the creation tool without the overhead of a context switch. To reduce fear of criticism, blogged designs could be made available anonymously (e.g. not showing the source location or a designer's alias with retrieved designs). To better the link the benefits to the efforts of contribution, systems could record and show how often others have accessed the designer's designs, creating a social incentive.

CONCLUSION
The use of examples is a common but enigmatic practice in design. This paper has made several new contributions to understanding this practice in three design domains. First, our results shed light on the benefits and different roles examples serve in different phases of the design process. Second we described how designers search for, store, and share examples from physical and electronic sources. We also discussed some why designers often do not contribute personal examples to the design community. Finally, based on the results, we offered new implications for how tools can better support example usage in design.

We have several directions for future work. One direction is to realize our implications within new or existing tools and study the effects on creative output. Second, we want to conduct controlled studies to further quantify how often designers use different types of examples and how their use influences design activity. Third, we want to study the use of examples in the engineering design domains and compare the results to the creative domains studied here.

REFERENCES
1. Cuil - Our Philosophy, http://www.cuil.com/info.
2. Alexander, F. and Henry, L. A Goal-Oriented Web Browser. *Proc. CHI*, 2006, 751-760.
3. Amershi, S. and Morris, M. Cosearch: A System for Co-Located Collaborative Web Search. *Proc. CHI*, 2008, 1647-1656.
4. Ardichvili, A., Page, V. and Wentling, T. Motivation and Barriers to Participation in Virtual Knowledge-Sharing Communities of Practice. *Journal of Knowledge Management*, *7* (1): 64-77.
5. Bailey, B.P., Konstan, J.A. and Carlis, J.V. Supporting Multimedia Designers: Towards More Effective Design Tools. *Proceedings of Multimedia Modeling*, 2001, 267-286.
6. Bonnardel, N. Creativity in Design Activities: The Role of Analogies in a Constrained Cognitive Environment. *Proc. Creativity & Cognition*, 1999, 158-165.
7. Bonnardel, N. Towards Understanding and Supporting Creativity in Design: Analogies in a Constrained Cognitive Environment. *Knowledge-Based Systems*, *13* (7-8): 505-513.
8. Fogarty, J., Tan, D., Kapoor, A. and Winder, S. Cueflik: Interactive Concept Learning in Image Search. *Proc. CHI*, 2008, 29-38.
9. Hartmann, B., Doorley, S., and Klemmer, S. Hacking, Mashing, Gluing: A Study of Opportunistic Design and Development. *Pervasive Computing*, *7* (3): 46-54.
10. Herring, S.R., Jones, B.R. and Bailey, B.P. Idea Generation Techniques among Creative Professionals. *Proc. HICSS*, 2009.
11. Ka-Ping Yee, K.S., Kevin Li, Marti Hearst Faceted Metadata for Image Search and Browsing. *Proc. CHI*, 2003, 401-408.
12. Lubart, T. How Can Computers Be Partners in the Creative Process. *IJHCS*, 2005, 365-369.
13. Maher, M.L. and Gomez de Silva Garza, A. Case-Based Reasoning in Design. *IEEE Expert*, *12* (2): 34-41.
14. Newman, M.W. and Landay, J.A. Sitemaps, Storyboards, and Specifications: A Sketch of Web Site Design Practice. *Proc. Designing Interactive Systems*, 2000, 263-274.
15. Pearce, M., Goel, A.K., Kolodner, J.L., Zimring, C., Sentosa, L. and Billington, R. Case-Based Design Support: A Case Study in Architectural Design. *IEEE Expert: Intelligent Systems and Their Applications*, *7* (5): 14-20.
16. Purcell, A.T. and Gero, J.S. The Effects of Examples on the Results of a Design Activity. *Knowledge-Based Systems Journal 5* (1): 82–91.
17. Schank, R.C. and Leake, D.B. Creativity and Learning in a Case-Based Explainer. *Artificial Intelligence*, *40* (1-3): 353-385.
18. Sharmin, M., Coats, C., Bailey, B.P. and Hamilton, K. Understanding Knowledge Management Practices for Early Design Activity and Its Implications for Reuse. *Proc. CHI*, 2009.
19. Smith, G.J. Idea-Generation Technique: A Formulary of Active Ingredients. *J. Creative Behavior* (32): 107-133.
20. Teevan, J., Adar, E., Jones, R. and Potts, M. Information Re-Retrieval: Repeat Queries in Yahoo's Logs. *Proc. SIGIR*, 2007, 151-158.
21. Warr, E., O'Neill and Understanding Design as a Social Creative Process. *Proc. Creativity & Cognition*, 2005, 118-127.
22. Zeng, H., He, Q., Chen, Z., Ma, W. and Ma, J. Learning to Cluster Web Search Results. *Proc. SIGIR'04*, 2004, 210-217.