Sitemaps, Storyboards, and Specifications: A Sketch of Web Site Design Practice

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ABSTRACT
Through a study of web site design practice, we observed that designers employ multiple representations of web sites as they progress through the design process, and that these representations allow them to focus on different aspects of the design. Designers also employ multiple tools during the course of a project, including graphic design, web development, presentation, and word processing software, as well as pen and paper. Sketching on paper is especially important during the design exploration phase of a project, when designers wish to explore many design possibilities quickly without focusing on low-level details. Web site design tools intended to support the early phases of the design process should employ informal interaction techniques, should support multiple site representations, and should integrate well with other applications that designers use regularly.

Keywords
Ethnography, Work Analysis, Web Site Design, Information Architecture, Informal Interfaces.

INTRODUCTION
We undertook a study to identify current practices in the field of web design. The goal of this study was to illuminate issues that would guide the design of informal tools for supporting web site design. By "informal" we mean tools whose user interfaces are designed to support natural, ambiguous forms of human-computer interaction [7]. Examples of interaction modes that informal interfaces support include speaking, writing, gesturing, and sketching.

We are interested in the exploration of informal interfaces in general, and in our research group we have developed informal applications to support graphical user interface design [10] and group note taking [9]. We know that designers in general employ ambiguous means of expression and communication (such as sketching on paper) when they are exploring design ideas [11, 18]. Since web design is an emerging field, the tools to support it are not yet mature. We believe that there is a real opportunity for improving the state of the art.

In the remainder of this paper we present related work, describe the study that was conducted, present the picture of web design that was observed through the study, discuss the implications of our study towards future web design tools, and briefly describe DENIM, an informal web site design tool that we have developed based on the results of this study.

DIS '00, Brooklyn, New York.

RELATED WORK
Several work practice studies have appeared in the literature that are relevant to our study of web site designers. Sumner and Stolze's study of speech application designers [17] and Bellotti and Rogers' study of editorial staff at several publishing companies [1] showed that designers and editors use multiple intermediate representations of products during their creation, some similar to the representations found in this study.

A certain amount can be learned about web design practice by reading the growing body of literature that covers it [6, 13-15]. Unfortunately, much of this literature is prescriptive rather than descriptive, and may not accurately reflect what designers are actually doing in the field. To learn what designers do, there is no substitute for direct contact. We elected to conduct our investigation into web design practice through field visits and interviews with professional designers. Our approach was inspired by the methods proposed in, for example, [3, 8].

DESCRIPTION OF STUDY
We interviewed eleven designers involved in the web site design process. Ten of these designers were at five different companies and one was a freelance designer. We also collected and studied many artifacts of the design process, including sketches, prototypes, written documents, presentations, finished web sites, and several other types of artifacts, some of which will be discussed later. All interviews were conducted in the designers' offices, which facilitated the observation of artifacts and allowed us to observe their working environments.

Years of experience	# of participants
Less than 5 years	7
Between 5 and 10	3
More than 20	1

Table 1a: Designers' Professional Experience

Background	# of participants
Graphic design	8
Computer Science	2
Cognitive Science & Library Science	1

Table 1b: Designers' Backgrounds

Responsibility	# of participants
Graphic design	4
UI Design/Information Architecture	3
Hybrid	4

Table 1c: Designers' Current Responsibilities

Who Was Interviewed

Four of the five companies we observed were design firms that are typically contracted by outside clients to design web sites. The fifth company was a large Internet directory and search engine (i.e., a "portal").

The designers represented a range of professional design experience levels (see Table 1a). All of the designers with more than five years of experience had been involved in designing user interfaces for software applications before getting involved in web site design, and one of them had been involved in print design as well. Most of the designers had backgrounds in graphic design in terms of education and experience (see Table 1b).

In terms of the designers' current responsibilities, four were focused almost exclusively on graphic design, three were focused exclusively on user interface design/information architecture, and four had responsibilities that were general enough to incorporate aspects of both kinds of design (see Table 1c). The meanings of the terms "graphic design," "user interface design," and "information architecture" are discussed in the next section. None of the designers were involved in programming or development of the final, production versions of the sites they designed.

What Was Asked

Each participant was asked to choose a recently completed or nearly completed project, and to walk the interviewer through the entire project, explaining what happened at each phase. The designer was asked to show examples of documents that he or she produced during each phase and explain the meaning of the document with respect to the process as a whole. At the end of some of the interviews, the designer was asked to give us copies of the documents discussed during the interview. In this way, examples of design process artifacts were collected from four designers.

Examples of projects discussed include corporate identity and information sites, a state tourism site, a site for an aquarium, an online clothing catalog, a university site, an online software tutorial, and sub-sites of an Internet portal.

A Note on Observations

The next several sections of this paper present our observations of web design practice based on this study. Much of what was observed is not necessarily unique to web design but probably draws from a broader tradition of design including fields like architecture, industrial design, and graphic design. Our intent was not to find what was unique and new about web design but simply to learn about current practices in the field to guide the development of tools to support those practices. We have not attempted to invent new terminology or redefine existing terminology—wherever possible we have used terms as designers used them during the interviews.

SPECIALIZATION WITHIN WEB DESIGN

Designers were careful to use specific terms to refer to different areas of concern within the web design space. The term *information design* was used to refer to the problem of identifying groups of related content and structuring information into a coherent whole. A closely related area, *navigation design*, refers to the design of methods of finding one's way around the information structure. *Graphic design* (or *visual design*) refers to the visual communication of information using elements such as color, images, typography, and layout. Whereas information and navigation design focus on the entire web site and the relationship between large-scale elements (such as pages) within the site, graphic design focuses primarily on the presentation of individual elements.

Information architecture is an emerging specialty within web site design that refers primarily to the combination of information design and navigation design.

The term *user interface design*, when applied in the web domain, refers primarily to the design of navigation systems, with some overlap into information design and graphic design. In addition, an individual specializing in user interface design often has responsibilities extending to testing and verification of the site's usability.

Even though several designers mentioned that they employed user-centered design techniques such as heuristic evaluations, cognitive walkthroughs, and usability testing, the integration of these techniques into the design process was not discussed much during the interviews. For many designers these methods seemed to be employed on an "as needed" basis, rather than as a regular part of the process.

Figure 1 represents the relationships among the different areas of design. There are many areas of overlap between different types of design. For example, the design of an

individual page must take into consideration the information that is to be presented on the page, its relation to other information found elsewhere on the site, the support for navigation to other areas of the site, and the visual presentation of information on the page.

In three of the five companies studied, there were specialists who focused on particular areas of design. One of these companies focused exclusively on information architecture and user interface design and subcontracted graphic design. Two companies had specialists designated as "Information Architect/User Interface Designer" (in both cases a hybrid title was used) and specialists designated as "Graphic Designer." The two remaining companies did not distinguish among the different types of design, but rather the same individuals would practice different types of design at different points during the design process. The independent consultant primarily focused on graphic design.

In almost all cases, information and navigation design were done *before* graphic design. At the web portal, the graphic designers preferred to have the information structure worked out before the project reached their desks. In the firms where a single designer would focus on different types of design at different phases of the process, he or she would switch to graphic design only after working out the information structure and obtaining approval from the client. One firm tended to work on graphic design ideas before (or sometimes in place of) working on information and navigation design. This discrepancy seems to have arisen from the firm's

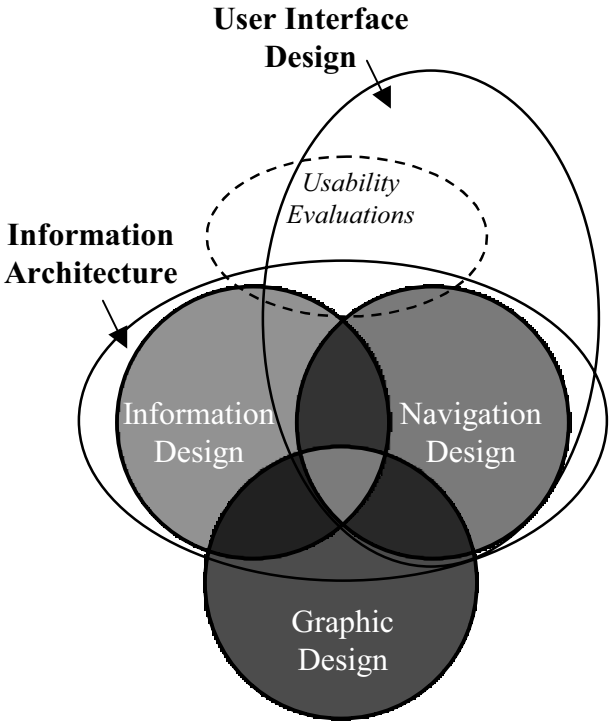

Figure 1: Different specialties within web site design.

background in print advertising and their emphasis on novel, entertainment-oriented sites.

THE STORY OF A DESIGN: A SOFTWARE TUTORIAL

Before presenting a general description of the design process, it will be helpful to ground the discussion with a look at a particular design project. The project described was a tutorial for a suite of software CAD tools. The tutorial was designed for deployment on intranets of companies using the client's CAD tools, remote access via the Internet, and distribution on CD-ROM.

This project was one of the shorter projects discussed in the interviews, although the overall process and the artifacts produced are representative of the projects described in other interviews. The durations of each phase of the design, however, should be taken with a grain of salt, as there was a great deal of variation among projects. The *relative* amounts of time dedicated to each phase is consistent with projects described by the other designers.

The design team for this project consisted primarily of a designer, a creative project lead, and an account manager. The designer carried out most of the design work, in close consultation with the creative lead and with other designers in the firm. Other team members were concerned with client contact, budget, and schedule.

During the first two weeks of the project, the designer immersed himself in the background information for the project. This consisted of reviewing the previous version of the tutorial (as this was a complete redesign of an existing product) and engaging in extensive discussions with the client to understand the content of the tutorial and get feedback about what was desired for the new version. During this time he also sketched some ideas on paper, including representations of the structure and navigation of the previous version, and new structures representing ideas about how to improve certain aspects. At the end of the two weeks, a written "Needs Analysis" document, detailing project goals, schedule, and general design directions, was delivered to the client.

A meeting with the client was scheduled for the week following the delivery of the Needs Analysis, at which initial ideas for the redesigned product were to be presented. The designer spent the week generating "Initial Design Variations," which focused on the high-level structure of the tutorial and the basic means of navigating the structure. He first made about twenty sketches on paper representing the overall structure (see Figure 2), individual pages (see Figure 3), and specific interaction sequences (see Figure 5). To create something "presentable" for the client, he then created two variations of the site structure and navigation using Adobe Illustrator, which he showed to the client as a large-format color printout. He also created a walkthrough of the structures. The walkthrough was created as a sequential

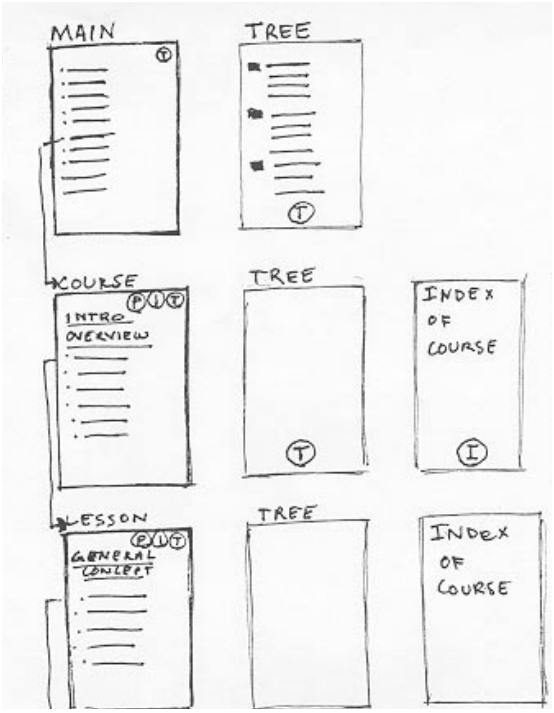

Figure 2: A portion of the sketch of the overall structure of the CAD software tutorial.

presentation in Macromedia Director consisting of images produced in Illustrator.

The images presented in the walkthrough were representations of individual pages in the tutorial. These representations were devoid of images and icons, used a simple color scheme consisting of three colors (blue, green, and black), and contained almost no typographic variation. The designer said he chose blue and green for these initial images simply "because blue is different from green." He intended to show that different regions of certain pages would be colored differently from each other in order to distinguish the content, but he did not intend to propose what the final colors would be. Similarly, the bland typography and lack of images were not intended to represent decisions about the final product, but were used intentionally to keep the focus on the "mental model" of the tutorial, i.e., the overall structure and the means of navigating that structure.

After the presentation of the initial design variations, the designer had a week to prepare the first round of "Visual Design Variations." Whereas the initial design variations were intentionally devoid of graphic details, the visual variations were intended to address these details. In particular, high-fidelity mock-ups of the home page and one second level page were created (figures not available but see Figure 7 for an example of a mock-up). These mock-ups contained images, icons, rich typography, and sophisticated color schemes, and these details of the visual presentation were meant to be taken literally.

To produce the visual variations, the designer made a few "very quick" sketches on paper, and then created mock-ups using the "Paint" window of Director. In addition, three other designers within the firm were asked to create mock-ups to give the client a wide range of options from which to choose. All of the mock-ups were based on the initial design variations. As was done the previous week, a Director presentation was made to the client, this time showing electronic mock-ups of five different design ideas. The client selected two designs for further development and a meeting was set for the following week.

The designer spent the next week refining and developing the selected designs using Director. The next presentation included not only the refined home pages and second level pages, but several other "content pages" as well. The goal of this presentation was for the client to select a single design for development into a prototype. It turned out that the client liked aspects of both designs, so the two were merged and the hybrid design was selected for further development.

At this point, the client announced that they wanted a prototype produced as soon as possible for an upcoming trade show in three weeks time. This shortened the amount of time that the designer could spend refining and developing the visual design ideas and forced an early transition into "production mode." He worked on the mock-ups for a little bit longer before beginning to code the prototype in HTML. He said that his normal practice is to flesh out the mock-ups as completely as possible before starting to code since he likes to "in Photoshop make this as complete as [he] can and then switch [his] mind from visual design into coding." Once he begins coding, he does not work on the mock-ups anymore.

For the two weeks while working on the prototype, he used Photoshop to work on images and icons and Bare Bones Software's BBEdit to write the HTML. He also used Netscape Navigator to preview the prototype.

According to the designer, the development of a prototype is usually followed by the writing of guidelines to accompany and specify the prototype. Such a document would be handed off to whomever would develop the design into a working product. At the time of the interview, however, the guidelines had not been written. The clients had not determined whether they wished to develop the prototype into a product, or whether the prototype was to be used to convince the client organization's management to pursue a more serious redesign. Without knowing the ultimate fate of the design, neither the client nor the design firm thought it worthwhile to devote time and effort to producing guidelines.

THE DESIGN PROCESS

As was seen in the preceding story, designers follow a process of iterative refinement that moves the design from

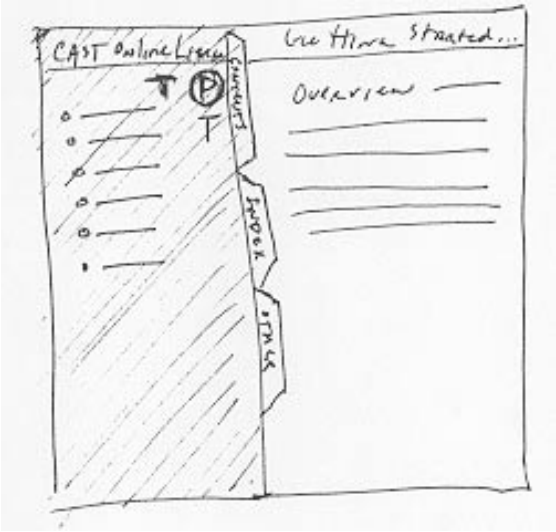

Figure 3: A sketch of one page within the CAD tutorial.

high-level and general to increasingly specific and detailed. Depending on the designer, and the organization in which the designer works, the process that is followed may be less or more explicit. In the types of design firms studied in this investigation, the process tends to be explicit, largely because it directly structures the interaction between the designers within the firm and clients and other stakeholders.

Each phase of the design process is usually punctuated by a presentation to the client at which the designers obtain approval from the client (often called *sign-off*) about the work that was performed during that phase. The explicit design process, which is often published on the firm's web site or made available to clients in other published forms, is also used to educate new and potential clients about how the firm operates and what they can expect. Only the web portal and the freelance designer did not have explicit, published processes, though the designers at the web portal claimed that they were in the process of developing one internally.

Presented here is a generalized design process, derived from the processes described by the designers interviewed and refined in subsequent conversations with them and with other designers. This process has four phases: *discovery*, *design exploration*, *design refinement*, and *production*. The number of phases is consistent with the three to five phases found in a short survey of published design processes from several other firms [4, 5, 16].

Discovery

The purpose of the discovery phase is to determine and clarify the scope of the project, the desires of the client, and the characteristics and/or needs of the intended users. If the project is a revision or redesign of an existing site or product, the designers will carefully review and evaluate the existing version. It is common to perform a *competitive analysis* during this phase, which involves reviewing and evaluating competitors' products for common features and opportunities for improvement and differentiation. Other techniques that might be applied at this phase include interviewing or corresponding with the client to clarify aspects of what is expected, and various techniques to discover the needs of the users such as interviewing, observing, testing, or surveying.

Design Exploration

During the design exploration phase, possible solutions to the problems identified in the discovery phase are generated and explored. Information design, navigation design, and rough graphic design are often performed during this phase. Multiple rough design ideas and variations are generated. Initial designs generated at this point often do not reflect ideas about color, imagery, and typography. They often *do* reflect ideas about site structure and navigation, though this is not universal. Normally the goal of this phase is to quickly produce several designs and present them to the client who is expected to select one for further development.

Design Refinement

After a design idea has been selected from the variations presented in the design exploration phase, the designers develop the selected idea further. During this phase the design is iteratively refined and detailed. Such aspects as the precise typeface of labels and body text, the exact sizes and appearances of images, and color schemes and palettes are determined. For most sites it is not necessary to design every single page of the site, since the site will have been broken down into classes of pages (for example: home page, second-level pages, pages for specific types of content), each of which can be represented by an example or *template*. A fully detailed example of each type of page is usually considered sufficient to represent the design.

Production

When the design has reached a satisfactory level of detail, or when the deadlines and budget dictate that design should end and implementation begin, designers prepare the design for hand-off to the implementers. *Production* refers to the creation of an artifact or set of artifacts that will be delivered to the client (or to the software development team) to embody and represent the design. Such artifacts may include interactive prototypes, written descriptions, guidelines, and specifications.

PRODUCTS OF THE DESIGN PROCESS

Throughout the design process, the web site being designed is represented as a set of intermediate artifacts, such as site maps, mock-ups, and prototypes, that help facilitate communication among the various individuals involved in the design project. Artifacts may support communication among team members, between designers and clients or other stakeholders outside the design team, between designers and implementers, or simply between

the designer and herself. Often an individual artifact will support multiple dimensions of communication.

Site Maps

A *site map* is a diagram showing the structure of a site (see Figure 4). It is used primarily to reflect an understanding of the information structure of the site as it is being built and to a limited extent the navigation structure. In many cases, site maps are only used internally by the design team to organize work and obtain consensus on the goals of the project. In some cases, though, site maps are cleaned up and shared with clients. Sometimes, site maps are published on the release version of the web site, though these are often substantially different from the site maps used internally.

Site maps often evolve throughout the entire life of the project, being updated constantly to reflect new understandings of the site structure. Early in the design process, site maps will reflect the site's structure broadly and, as time progresses, they will be revised to become increasingly detailed. In some cases, where site maps are used more extensively, they will evolve until they reflect every single page in the site. They can then be used to support project management, content management, and the generation of specifications. Site maps are the primary artifact of information design, and in organizations that have information design specialists, the site map will be generated and updated by that specialist. All five organizations used site maps regularly.

Site maps usually consist of labeled blocks and lines as in Figure 4, with some additional features to indicate certain kinds of groupings. The blocks represent individual pages and contain brief descriptions of the contents of the page, often only a short label. The lines and arrows represent navigational paths between pages. Often just the "primary" navigational paths are reflected in the site map. For example, even though it is common that users are able to reach the home page of a site from any page on the site, this fact is not reflected on a site map such as the one in Figure 4—it is just assumed.

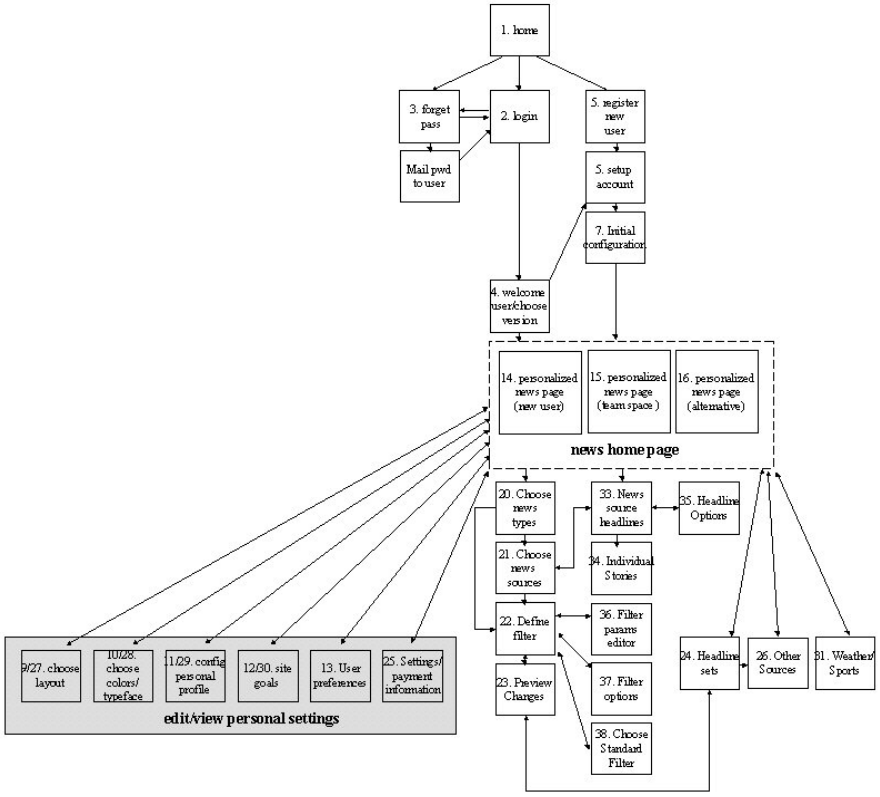

Figure 4: Site maps are high-level visualizations of site structure in which web pages or entire subsections of the site are represented by textual labels. This site map is for a hypothetical news web site.

Storyboards

A storyboard is a representation of a particular interaction sequence. It is accompanied, either explicitly or implicitly by a narrative about the task the user would be trying to accomplish via the particular sequence depicted. Storyboards reflect limited detail about the contents of each page in the sequence and only the navigation links required to accomplish the task are represented. For example, the storyboard shown in Figure 5 shows an interaction sequence that a user might execute in order to access information within a tutorial system. It shows what would happen if a user started at the main page, clicked "Begin Tutorial," then clicked "Courses," and then

clicked "Modeling." One other possible sequence is shown: when the user clicks "Cast Contents" she will be presented with a table of contents. It is clear that there are links on several of the pages depicted that would lead to other pages, but those interactions are not shown.

Like site maps, storyboards are primarily used within design teams to communicate ideas about site structure and navigation, and are not used to communicate with people outside the team, e.g., clients. Storyboards were not as widespread as site maps and less likely to be used as a central, standard part of the design process. The idea of presenting a narrative to a client was quite common, only it is often not done using storyboards. Rather, designers prefer the *walkthrough,* which, like a storyboard, is accompanied by a story about what the user is doing and perhaps why. Whereas a storyboard is a document showing multiple pages at once and the transitions between them, a walkthrough is a mediated, sequential presentation of screens narrated by the designer with an explanation of what the user is doing on each screen. A storyboard might well be used to design a walkthrough.

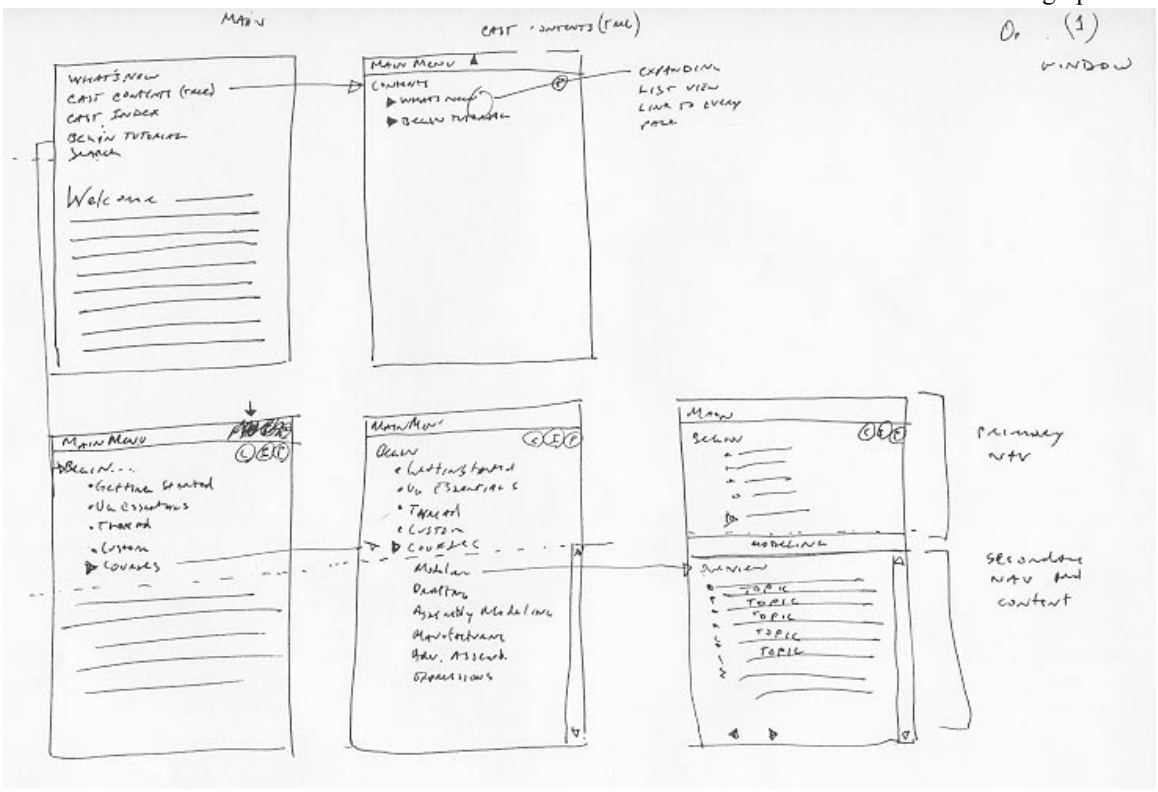

Figure 5: Storyboards represent sequences of interactions that a user would carry out in order to accomplish a task. This storyboard shows how a user would interact with a tutorial system to find information on a specific topic.

Schematics

Schematics are representations of the content that should appear on a particular page. They are usually devoid of images, though they may indicate with a label where an image should be placed. While schematics are not meant to show how color, typography, and graphics will be used on the page, they may themselves use simple color (often they are monochrome or grayscale), typography, and graphics to indicate other things about the page. For example, simple typographic variations may be used to show that a particular label is supposed to be larger and bolder than other labels on the page. Colors and lines may be used to separate regions of a page from each other and indicate that those regions should be made visually distinct from one another when the graphic design for page is done. Schematics often mix actual page contents with annotations indicating the type of content that should appear in a particular region (see Figure 6).

Even though schematics focus on an individual page, they fall into the domain of information and navigation design rather than graphic design. All of the information design specialists created schematics as part of their work, whereas none of the graphic design specialists did. This is because schematics represent the information organization on a given page and the elements that support navigation that must be included on the page (e.g., links to other pages, navigation bars, feedback about the page's location within the site). In each case where specialization among designers was observed, schematics were used as a means of communication between the information architect and the graphic designer: the information architect would specify the page contents using a schematic and the graphic designer would determine how to present the

contents in a clear and visually appealing manner. Designers in the organizations without specialization regularly produced schematics before working out the graphic design. Schematics were quite common, and examples of them were observed at all five organizations.

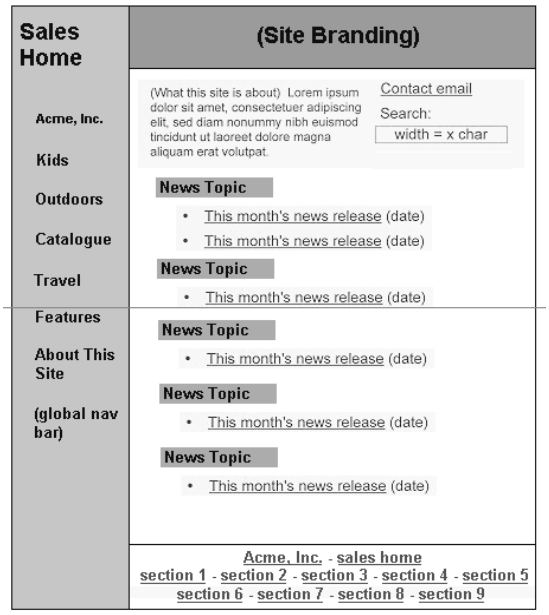

Figure 6: Schematics show the types of information and the information groupings on an individual page.

Electronically produced page schematics are sometimes shown to clients during the early phases of design because they do not look like finished web pages. They can be made to look aesthetically pleasing and professional without appearing "finished," so they are appropriate for client presentations during early design. Presenting a representation that is too polished encourages clients to focus on irrelevant details such as fonts, colors, and images, when it is often desirable at this point to get feedback on the structure and organization of information [18]. However, presenting too rough a representation can seem unprofessional and unimpressive. For design firms working with new clients, it is often important that they make a positive impression early in the design process to reinforce that the client made a good decision in hiring the firm. Early presentations must strike a delicate balance between keeping the focus on basic, structural issues and making a good impression. Schematics were regarded by several of the designers interviewed as a good way to balance these demands.

Mock-ups

A mock-up is a high-fidelity representation of a web page that shows exactly what the page is supposed to look like. They are usually produced using a graphics application like Photoshop and are not interactive. Unlike schematics, the graphic design of a mock-up is meant to be taken literally. The mock-up shown in Figure 7 is a literal representation of a site's home page.

All of the organizations used mock-ups as a regular part of their process, with the responsibility for creating them generally falling to the graphic design specialists. In some cases, mock-ups are the final deliverable of a design project, perhaps accompanied by written guidelines or specifications.

Prototypes

While the term *prototype* could refer to anything that serves to represent the system as a whole, and therefore is occasionally used to refer to a site map, a set of schematics, or a set of mock-ups, it is most often used to refer to an *interactive prototype*. Interactive prototypes are usually done in HTML or Macromedia Director, and allow the designer to demonstrate how the user will interact with the finished site. Prototypes are usually produced late in the design process (i.e., during the production phase). Every designer we interviewed had at least some involvement in creating prototypes.

Specifications and Guidelines

Specifications are detailed documents that attempt to describe exhaustively and precisely the intent of the design. They usually accompany a prototype and refer to it explicitly. The intended audience for a specification is the developers who will implement the site. The specification instructs the developers on how to extrapolate from the prototype to the finished site.

Guidelines are similar to specifications, though the term "guideline" implies something less rigid and detailed than a "specification." Whereas a specification can be thought of as a set of exact instructions about how to build the site, guidelines are more like suggestions. Guidelines do not have to be as comprehensive, and they can leave more details to the discretion of the developers.

Although some designers use the two terms interchangeably, for at least one firm studied the distinction between a specification and a guideline was considered extremely important. The principal of this firm said that there is a factor of ten difference in terms of production effort and cost between a specification and a guideline. Specifications or guidelines were a common deliverable at each of the four design firms. They were not, however, used at the Internet portal.

Several designers expressed a preference for *interactive specifications*, which integrate the specifications with the prototype. The precise form of the interactive specifications vary from firm to firm and from project to project, but generally they provide a way of accessing the specification information about a particular element of the site from the *element itself*, as it appears in the prototype.

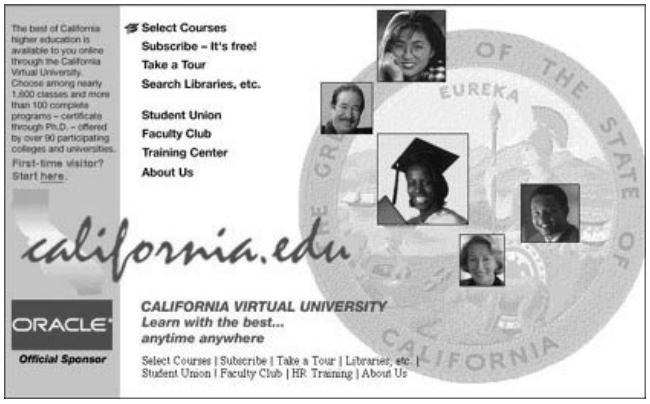

Figure 7: A mock-up. Since mock-ups are high-fidelity representations of web pages, they are sometimes indistinguishable from the real thing.

Presentations

Presentations to the client were regarded by the designers as a significant part of the design process, especially in the design firms. Since interactions with the client may be limited and somewhat formal, presentations are often the only means available for designers to convey design ideas to the client. Designers at all four design firms described the process of creating client presentations as "a design process in itself." The freelance designer expressed a similar sentiment. One firm had worked with an outside contractor for three weeks nearly full time to produce a presentation describing the results of the discovery phase to the client. Another firm had a "theater" for hosting client presentations: an elegant meeting room made to look like an old movie theater. The goal was to impress clients and increase the likelihood that they will react favorably to the presentations.

Presentations often require strategic planning to evoke the desired response from the client. One designer described some of the complexity of creating a presentation early in the design process. The design team truly wants the client's feedback, and at the same time wants the client's approval. It is particularly important at this early phase that the client is not misled into thinking that the site is nearly finished, so it is desirable to make the images presented appear somewhat rough. Similarly, it is not useful to get feedback about irrelevant details that are not appropriate to the early state of the design, such as the fonts used or the background color. On the other hand, the client may be unfamiliar with the designer's work, and may have high expectations, so it is desirable to make a good impression with a polished design that shows off the designer's strengths. These considerations are often in conflict and need to be carefully balanced when creating a presentation.

At all four design firms, presentations tended to punctuate phases of the process, especially in the early going. Later in the process, a higher comfort level could be achieved that would allow feedback and approval to be sought in less formal ways. For example, during later stages of the process some designers would post work to an extranet and allow the client to review it directly. Early on, however, presentations are frequent and tend to drive much of the designers' day-to-day work. At the Internet portal, presentations were important, but not as central to the design process as they were at the design firms.

In terms of content, presentations may consist of any of the artifacts described in this section. Electronic mock-ups are the most common elements included, but site maps and page schematics are sometimes included as well. As mentioned in the discussion of storyboards above, one common way of structuring presentations is the walkthrough. In a walkthrough the presenter leads the audience through a sequence of steps, showing the pages that the user would see at each step.

Written Documents

In addition to specifications and guidelines, many other written documents appear throughout the process. A great deal of information regarding things like work progress, requests for additional work, and requests for feedback, is transmitted through email. Additionally, several formal documents are often produced during the process, including reports on the results of the discovery phase, initial concept ideas (referred to at one company as the "creative brief"), market surveys, reports on usability studies, work schedules and contracts. It is hard to generalize about the types of things that appear in written documents, but suffice it to say that quite a bit of written material is generated.

TOOLS OF WEB DESIGN PRACTICE

The story of the designer working on the CAD tutorial illustrated the fact that designers use a wide variety of tools during the course of a project. He sketched with a pen on paper and also used an array of computer applications to accomplish his work. His pattern of use was typical of other designers.

Sketching on Paper

In keeping with our interest in informal modes of expression and communication, we paid special attention to ways that designers currently use sketching. Almost all of the designers did at least some sketching on paper, generally during the design exploration phase, and was employed for information/navigation design as well as graphic design. Examples of sketches done in support of information and navigation design can be seen in Figures 2, 3, and 5.

Some designers indicated surprise that we wanted to see their sketches and were even mildly reluctant to show them. The presentation of the sketches was accompanied by a series of apologies for their "poor quality," and disclaimers about how they were "really rough." Some designers seemed to be somewhat ashamed of their

sketches, or perhaps they had misgivings about showing them to a relative stranger. According to several designers, anything presented to a client must look "professional," which means at a minimum a color printout or photocopy of a high-resolution mock up, and usually it means a mock-up presented on a computer.

Several designers reported that they "used to sketch more." While it wasn't clear exactly what was behind this reduction in sketching, one designer said that he began working with Illustrator and Photoshop earlier and earlier in projects because he knew he would have to produce something to present to the client very early on. Knowing this, it was easier to work in an electronic medium from the start. Several other designers agreed that early deadlines drove them to switch from paper to electronic media earlier in the project than they might have liked.

Another designer reported that she switched to working with computer-based tools when she thought she would be making incremental variations to a single general idea. She said:

> *The beginning of each step I'll do on paper. As soon as I feel like I'm going to be starting any design revisions, then I'll move to [an electronic tool]… because it's easier to make changes to these things.*

Some other uses of paper were observed besides personal sketching to work out ideas. Several designers reported using paper and pencil when meeting with other designers. Spontaneous ideas and revisions were captured on paper in these settings. Paper was generally preferred to whiteboards because of its portability: after the meeting one can easily take it with them back to the desk. Designers would also give printouts of electronic sketches to colleagues for comments and they would be returned to them with handwritten annotations (see Figure 8).

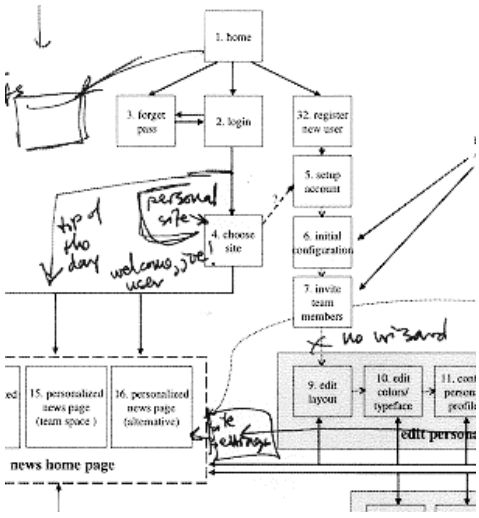

Figure 8: Another use for paper. Documents are printed, given to other team members, and annotated.

Computer-Based Tools

The applications used by the designer of the CAD tutorial were also regularly used by other designers, especially among the individuals with graphic design backgrounds. These designers relied heavily on some combination of Photoshop, Illustrator, and Director for much of their work.

The user interface designers on the other hand did not use the same set of tools. One of the UI designers did not use any graphics programs at all: her diagrams were all on paper and most of her computer-based work involved writing reports using a word processor. Another UI designer made heavy use of Visio for making diagrams. She also used paper sketches to some extent and did a lot of word processing.

All of the designers, especially the more experienced designers, tended to be heavily invested in the tools they used. They admitted to using their preferred tools for tasks that might have been more easily accomplished with another tool. One designer did all of her diagrams, including site maps and schematics, using Microsoft Word's drawing utilities. Another designer said he used Director's paint function for all his graphics needs, even though he knew that Photoshop would be better for some of the things he did. He simply did not have time to learn a new program. Similarly, the UI designer who used Visio for diagramming also used Visio for making page schematics, which she acknowledged might be easier to make, or at least more attractive, if they were made using a program with more graphics capability. Again, the potential gain from using a new program did not outweigh the inconvenience of having to learn it.

DESIRABLE FEATURES FOR NEW DESIGN TOOLS

The motivation for this study was to guide the design of tools to support web design. In particular, we were interested in how informal tools might fit into the design process. In this section we focus on some areas where the need for improved tools was most apparent and suggest features for future tools to address those areas.

Use an Informal User Interface

We found support for our hypothesis that an informal interface would be useful to designers. Since all of the designers sketch at least some of the time, and some designers sketch quite a lot, a sketch-based web design tool would fit naturally into many designers' work practices. Many designers reported regretfully that they were converting to electronic media earlier in the design process than they had in the past. A tool that provides some of the advantages of an electronic medium (e.g., ease of incremental modification) but preserves the ability to sketch may encourage designers to continue to sketch farther into the process. Other research has suggested that prolonging sketching, and therefore the ambiguous representations that are produced by sketching, will result in a broader exploration of the design space [2].

Informal interfaces leverage modes of interaction that are already familiar to users. This means that a good informal interface should be relatively easy to learn and use. As described in the above discussion about computer-based tools, ease of learning and use will be critical to the acceptance of any new design tool.

Support Multiple Representations

This study found that designers use multiple representations throughout the course of the design process. These representations depict the site at different levels of detail. A design tool should support a similar range of representations. Such a tool would be an improvement over the current state of the art, in which different representations are created using separate, poorly integrated tools. Several designers expressed a wish that the different representations could be tied together in a unified framework so that consistency and coherent project management strategies could be more easily maintained.

Focus on Early Design Phases

Through this study, we were able to focus our understanding of where in the process an informal tool would fit best, and which specific aspects of design it would best support. We found it most appropriate to focus on the design exploration phase, and on information and navigation design. Later phases place a greater emphasis on graphic design, require greater precision, and would not benefit greatly from a tool with an informal interface. Existing tools such as Photoshop, Illustrator, and Dreamweaver do a much better job of supporting the activities of later design phases (e.g., graphic design and prototyping) than those of early phases. A tool that focuses on early-phase information and navigation design should concentrate on supporting the production of the artifacts that are most relevant to those activities, e.g., site maps, storyboards, and schematics.

Integrate with Other Tools

While an informal tool may not explicitly support later design phases, it should support transitions into them. One way to do this is through integration with other tools and representations. Since the need to present polished design ideas to clients early in the process is one of the factors driving an early conversion to formal representations, a sketch-based tool should support the integration of sketches with more formal representations produced in other tools such as Photoshop or Illustrator. It should also strive to integrate well with other types of applications that designers use regularly, such as presentation and word processing software.

Manage History and Variations

Designers expressed a desire to have a unified way to manage different *variations* of design ideas. Variations play a key role during the design exploration phase, and it would behoove an effective design tool to help support their creation and management.

In order to keep track of project milestones and variations, designers are forced to invent ad-hoc methods of their own, usually involving saving multiple versions of files and using complex, cryptic file names to encode the relevance of each version. Several designers were interested in having a tool that would help them keep track of project histories so that they could refer back to decisions made early in the process and better understand the context under which these decisions were made.

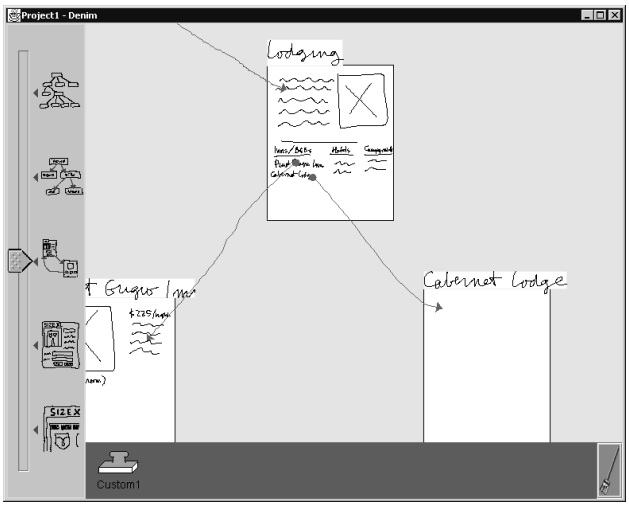

Figure 9: DENIM, shown here in "Storyboard View," allows designers to design web sites by sketching and integrates site map, storyboard, and individual page representations through zooming.

DENIM: AN INFORMAL WEB SITE DESIGN TOOL

Based on the results of this study, we developed DENIM, a sketch-based tool supporting information and navigation design of web sites. We only present a brief overview of DENIM here, but a more complete description of the system and initial feedback from designers who used the system is presented in [12].

DENIM (see Figure 9) supports sketching input, allows design at different refinement levels, and unifies the levels through zooming. In particular, DENIM supports visualizations matching the *site map*, *storyboard*, and *schematic* representations described in this paper. DENIM also allows designers to interact with their site designs through a "run mode," which displays the sketched pages in a limited functionality "browser" that allows the user to navigate the site by clicking active regions of the sketches and linking to other pages within the site.

The current version of DENIM is focused on addressing the first three implications mentioned above. It uses an informal interface, supports multiple representations, and focuses on the early phases of design. At present, DENIM

does not integrate with other tools or more formal representations, nor does it manage design histories and variations. We plan to address these issues in future development of DENIM.

CONCLUSION

We have described a study of web design practice consisting of interviews with eleven professional designers and the collection and observation of work artifacts. The results of the study, including observations of common design processes and types of intermediate artifacts are also described. It was observed that designers use multiple representations of web sites during the design process, and that each representation is tailored to focus on different aspects of the design. Designers often sketch on paper early in the design process in order to quickly explore design ideas and to keep from focusing on low-level details too early in the process.

Based on our observations of design practice, we have outlined features for informal computer-based tools to support early-phase web design practice and briefly introduced an application that incorporates some of those features. We believe that such a tool will fit more comfortably into the design process followed by designers and give us an opportunity to test the principles of informal interfaces in a domain where the benefits can be clearly seen.

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