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AN INTERDISCIPLINARY APPROACH TO WEB DESIGN

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***Abstract*:** The theory of interdisciplinary studies can be understood to apply to the creation, not just the study, of a complex system; in this case, to the creation of a Web site. We examine the aspects of a Web site that make it complex, and the disciplines used in its creation. After interpreting the steps in Web site design as steps in the interdisciplinary process, we critique specific Web sites and show how they could be improved through a more fully interdisciplinary Web design process. We conclude with recommendations for making more interdisciplinary both the education of Web designers and their organization into Web design teams.

In "A Theory of Interdisciplinary Studies," William Newell (2001) proposes a unified approach to interdisciplinarity that is applicable to the humanities, social sciences, and natural sciences. We extend the theory even further to the professions by taking the position that interdisciplinarity is properly understood to include not only the study, but also the creation, of a complex system. A cross-functional team that creates a new product (business), designs a treatment program (medicine), addresses a community or societal problem (public administration), produces an artistic work (fine and performing arts), solves a technical problem (engineering), or effects a family intervention (social work) can be engaged in interdisciplinarity. Thus, while the focus of this article is on Web design, we see it as representative of a whole class of interdisciplinary activities.

A Web Site as a Complex System

A functioning Web site, following Newell (2001), can usefully be understood as a quasi-stable complex system with nonlinear relationships among its components. In these terms, the main challenge of Web design is to construct a complex system that produces the desired overall pattern of user experience. We argue that creators construct a Web site most successfully by following an interdisciplinary process while viewing the Web site as a complex system.

Our definition of a complex system is drawn from Newell (2001): "A complex system is composed of components actively connected through predominantly nonlinear relationships" (p. 9). The components of any type of system (simple, complicated, or complex) interact to form an overall pattern of behavior. That pattern of behavior is more than (and different from) the sum of its component parts and gives the complex system its distinctive identity. For discussion of forms of complexity, systems in general, kinds of systems, complex systems in general, and types of complex systems, see Newell (2001).

The components of a Web site are its clusters or pieces of visual and written information. Their relationships include the way those pieces of information are arranged on a page, linked to information on other pages or in databases, and organized in site functions. Together, those components and relationships form the elements of a complex, interconnected system. The overall pattern is the distinctive "feel" of a Web site, whose aspects include how it looks (presentation), the ease with which it is navigated (structure), and its functionality (behavior). The nonlinearity of the relationships among components means that small changes in a single component or relationship can have a large impact on the perception of other components or relationships, and thus on the overall pattern of user experience. For example, changing the text beneath an image of a car to read, "Click for more details," rather than, "More details below," affects the user's perception of the function of that image on the page. Before the change, the image may only be a visual accent to the page and assumes a top-to-bottom relationship of information, but after the change, the image may be perceived as a link to further information that can be brought to the forefront immediately, possibly a close-up image of the car or a set of specifications for the vehicle. This perception may lead the user to expect other images on the site to do the same, changing the way the user navigates and views the site.

Web sites need to have some stability so that frequent users can navigate

them easily, yet they can only be quasi-stable in that they need to evolve over time. Web sites evolve in response to changes in client or user needs, changing regulatory policy/law, content, technology, social context, and the contributing design disciplines. If a company found it was attracting many visually impaired customers to its Web site, it might need to make its Web site more accessible to these users through a text-to-speech browser or by supplementing longer text documents with audio files. As the content on a Web site changes, the visual and written components will naturally change, as will their interrelationships. When new technologies develop for the Web, they will occasionally bring with them the need for new design insights. Macromedia's Flash technology, for example, changed the face of the Web by greatly expanding the ability to produce animations, motion graphics, and rich interactive experiences. The addition of motion and animation created a need to develop techniques to incorporate them into graphics and text. Changes in social context also alter the components of a Web site. Today, the icon for a house on a Web site alerts users that they can click on that link to go to the designated home page. The icon is usually a square with a triangle roof and maybe a hint of a door. As the Web expands to include cultures in which a home is not appropriately symbolized by four walls and a slanted roof, the icon for home may have to change. Finally, the disciplines that contribute to Web site design – programming, graphic design, writing, information architecture, usability, and what we are calling (after Tufte 1990) visual information design – are like other disciplines in that they evolve as they encounter new issues, new technology, and new demands.

Our premise that Web site creation can be conceptualized as a complex system differs from some theorists. Jeffrey Veen (2001) takes the position that Web sites are composed of presentation, structure, and behavior. If we think of a Web site as a complex system, however, it becomes more appropriate to think of presentation, structure, and behavior as aspects of the pattern produced rather than elements of the Web site itself. Veen describes presentation as "how [the organization of content] is presented visually to users" (p. 17). But in terms of complex systems, presentation is more appropriately understood as the effect created by the components of a site – imagery, text, and sound – and their relationships. Veen writes that structure is "how something is organized and optimized for ease of use and understanding" (p. 17). From the perspective of the complex system, however, structure is the overall pattern of relationships among the components of a Web site; it is not concerned with the information content of the components themselves. Finally, Veen holds that behavior is how

"users…interact with the product and the product's resulting behavior" (p. 17). In contrast, the view from the complex system perspective holds that behavior refers to the user's experience in interacting with the elements of the complex system (i.e., components and their relationships). Examples of behavior, in this view, might be the text response given when a phone number search is made or the color a link turns when it is clicked.

Disciplines that Study Elements and Aspects of the Web Design System

The complex nature of a Web site requires developers from different disciplines to acknowledge the various elements of the system and the various aspects of the pattern it produces. Specifically, the elements of the system are typically produced by writers (written components), 'visual information designers' as we call them (visual components), and programmers (relationships). The aspects of the system's pattern are developed by graphic designers (presentation), usability experts (behavior), and information architects (structure). Since the field of Web design is still taking shape, the focus of some of these disciplines is still being negotiated; it is unclear, for example, whether links within the written text are the primary responsibility of writers, information architects, or programmers. Indeed, there is not even a recognized label for people who create images, diagrams, maps, and other visual material (our term is visual information designers).

We start by examining the disciplines that relate to the elements of a Web site. Regarding the written component, Jeffrey Zeldman (1999) shows that there are "two tiers of writing that go into every site: the much-neglected navigational text [called] Guide Copy…and the primary content itself":

> A lot of writing on the Web falls under the heading of navigational text, or "guide copy," by which I mean the words that guide you through the site. There's an art to this kind of writing. It's neither journalism nor advertising, though having a background in either (or both) may help. No other medium requires this kind of writing.

Bonime and Pohlmann (1976) point out that some of the rules or methods of writing that apply in other media will not work or must be rethought when it comes to interactive media such as the Web because of hyperlinking, non-linearity, and the addition of multimedia (pp. 76-77). For example, writers for print material, such as magazines or books, assume that at the end of a page the reader must turn the page to continue, while writers for Web sites may not assume a next or previous page. If an online document is divided

into several pages, the writer encounters an array of options, such as "Next" and "Previous" links at the bottom of the page, or a listing of linked page numbers: "1, 2, 3, 4, 5," or a linked table of contents at the beginning of a document. Web writers must determine how best to craft text for their purposes and audience.

By "visual information design," we refer to the creation of visual components, namely images such as "charts, diagrams, graphs, tables, guides, instructions, directories, and maps" (Tufte, 1990 p. 9). What makes this discipline different from graphic design is its focus on the creation of visual components themselves rather than on their interrelationships. Tufte recognizes the significance of the discipline of visual information, as he writes, "our investigation yields general principles that have specific visual consequences, governing the design, editing, analysis, and critique of data representations" (p. 9).

Programming implements relationships among components instead of creating their written or visual information. Programmers create documents which provide a structure for content that is then displayed in a Web browser. They also create programs, scripts, or applications that take information inputs and construct new relationships among them. Programming is concerned with the relationships between informational components; for example, a search function takes information from a user, compares it to written information components on the site, and links the user to relevant information. Programming creates relationships between those pieces of information by organizing them in documents, by linking documents through hyperlinks, or through functions created to locate content, such as a search function.

Next we turn to those disciplines that relate to the aspects of a Web site as the overall pattern experienced by a user. Regarding presentation, "the graphic designer combines graphic materials – words, pictures, and other graphic elements – to construct a visual communications *gestalt*" (Meggs, 1989, p. 1), meaning "a configuration or structure with properties not derivable from the sum of its individual parts" (Meggs, p. 1). The graphic designer treats words and images as objects in space that can be arranged to provide meaning and context that would not be found if those parts were separated or configured differently. In addition, graphic design not only transmits pieces of information, but also evokes emotions and conveys aesthetic values.

Usability experts are concerned with the behavior of a site as experienced by the user. They promote "ease of use" by modifying informational

components and relationships within the Web site. They often remove unnecessary components and relationships to simplify a Web site. Jakob Nielson (2000), the most well known usability expert, writes, "there are essentially two basic approaches to design: the artistic ideal of expressing yourself and the engineering ideal of solving a problem for a customer. This book is firmly on the side of engineering" (p. 11). Steve Krug (2000) writes that if ease-of-use is most important, the best thing to do is to allow intuition to guide a user's experience instead of forcing the user to think about the Web site's structure (p. 11).

The discipline of information architecture has been borrowed from other fields to fill a gap in Web design by focusing almost entirely on structure. According to Eric Reiss (2000), "'information architecture' deals with the arrangement of browser-based information (more specifically, the internal relationships between individual Web pages) so visitors can do whatever they came to do with as little effort (and confusion) as possible" (p. 2). It involves "defining and arranging information…in a sensible manner" (p. 3). Information architects organize the content of entire sites by integrating information through grouping, building hierarchies, and forming relationships. Reiss observes that

> [I]ndividual 'information architects' often perform radically different tasks depending on their specific job and educational experience. For example, experts with a background in library science frequently deal with issues that benefit from their extensive knowledge of indexing and cataloging techniques. On the other hand, someone with a computer science background is more likely to focus on the design and integration of databases. Nevertheless, both are information architects (p. 2).

Thinking of a Web site as a complex system helps clarify what writers, visual information designers, and programmers have in common (i.e., they produce elements of the system), and how they differ from graphic designers, usability experts, and information architects (who develop aspects of the system's pattern of behavior, i.e., the "feel" of the Web site).

Current Approaches to the Process of Web Design

Some within these individual disciplines may feel they have the single correct approach to Web design; most others will recognize their limitations and not try to make decisions they are unqualified to make. Our assessment,

however, is that each discipline brings a valuable but limited understanding to the design process, often in the form of rules and guidelines that provide a methodology for those who work in these disciplines. What a disciplinary approach lacks is a view of the Web site as a whole. It tends to leave graphic designers (who deal mainly with the presentation aspects of the Web site) with an understanding of the visual design of a page, but perhaps not that page's relationships to other pages on the site. It provides programmers (who deal mainly with the relational elements of a Web site) with an understanding of the input and output relationships between informational components, but provides a limited basis for understanding how to create that information. Visit the Web site of a technical writer (e.g. http://www.scottrell.com/) and you may find a site that looks very much like a technical document. Visit the Web site of a programmer (e.g. http://sweetcode.org/), and you may find a site that is organized like a database. This narrowness of perspective may be perfectly acceptable for personal home pages, but not for the commercial development of most Web sites.

Seen from a complex systems perspective, a disciplinary approach works on one element of the Web site complex system or addresses one aspect of the pattern of user experience generated by that system. It acts as if all other elements or aspects are of secondary importance, as are connections to them. Because a disciplinary approach doesn't understand the overall impact of relationships among elements and aspects, it cannot appreciate the complex system as a whole nor its overall behavioral pattern. Eric Lerner (personal communication, July 10, 2002), a Project Manager at Macromedia, observes, "Typically...graphic designers are (unsurprisingly) design minded, and lack...critical thinking skills."

An adisciplinary approach addresses the shortcomings of the disciplinary approach by offering a formulaic, one-size-fits-all solution to the task of Web site design, as exemplified in Lisa Lopuck's (2001) *Web Design for Dummies*. In contrast to the disciplinary approach, it sees the site as a whole, integrating its elements at the cost of ignoring their distinctive characteristics. Granted, this approach may work for novices and those with limited knowledge needing to produce a Web site quickly. The result, however, is often a vanilla-flavored user experience, with aspects of presentation, behavior, and structure that are integrated but unresponsive to the site's distinctive purpose.

An adisciplinary approach understands the Web site as a system, albeit a simple one (that is, a relatively small system dominated by linear relationships), but it lacks a complete or detailed view of its elements. It

makes rudimentary generalizations about elements or aspects that are not modifiable for the particular system. Thus, the resulting Web site may be weakened by its inability to respond to the unique requirements of the specific site being developed. An adisciplinary approach may be useful as a starting point for the beginning Web designer who has no formal training in applicable disciplines, but like the disciplinary approach, it is inadequate for professional Web design.

The current state-of-the-art in Web design takes what we call a multidisciplinary approach. This is essentially a team approach to Web design where each member of the team has expertise in a different discipline. The strength of this approach lies in using individual elements of a Web site (written components, visual components, and their relationships) to enhance its distinctive aspects (presentation, structure, and behavior). Teams typically include members whose disciplinary expertise lies in elements of the Web site (writing, visual information design, and programming) as well as those whose expertise lies in aspects of the Web site (graphic design, information architecture, and usability). The multidisciplinary approach responds to the shortcomings of the disciplinary approach by recognizing the limitation of individual disciplines, and the shortcomings of the adisciplinary approach by recognizing the value of disciplines.

In general, a multidisciplinary Web design process starts with a project leader who serves as liaison to the client and who assembles a team that establishes the goals for the presentation, structure, and behavior of the site. The team would probably consist of several disciplinary experts as well as the client who will be involved in the construction of the site. Based on the established goals, the team conceptualizes the large-scale components and their relationships. Then information architects, graphic designers, and programmers each develop more detailed specifications and sketch out the presentational, structural, and behavioral aspects of the site. These are checked by usability experts and passed on to writers, visual information designers, and programmers who construct the elements of the site – written information, visual information, and their interrelationships. The resulting alpha draft is checked by some members of the team and then presented to the client. Further revisions are identified by the client and executed by appropriate team members, creating one or more beta drafts, until a final version is accepted by the client (Lerner 7/10/02).

The actual design process used by a multidisciplinary team varies from company to company. One firm that perhaps represents the multidisciplinary approach at its best is hesketh.com, a Raleigh, NC-based company formed in

1995 that specializes in business Web sites. In an interview with Rick Cecil (personal communication, September 14, 2003), a Developer and Project Manager at hesketh.com, we found that the site's typical development team consists of roles very similar to those laid out in our hypothetical multidisciplinary team, although the terms used for these roles often differed. For example, an account manager – like our project leader – is in charge of "project management, client management, risk management, [and] change management." The visual designer and creative director at hesketh.com perform the roles of visual information design and graphic design, being responsible for the visual components and their relationships, respectively. The technical lead and developer are responsible for "technical design, [and] programming," mapping well to the programmer's position. The production lead and production specialist at hesketh.com are concerned with both programming and "content integration." These positions map to the responsibilities of both the programmer and the writer. The interaction designer functions much like our usability expert, being responsible for interface design, and a team at hesketh.com also includes an information architect as we do.

The site development process at hesketh.com involves four stages: discovery, elaboration, development, and deployment. Each of these stages maps well to our understanding of the multidisciplinary development process. In the discovery stage, the hesketh.com development team establishes the goals for the site. Cecil explains that the team "observe[s] or interview[s] site users, evaluate[s] competitor sites, and conduct[s] needs analysis to determine the type of site the client and their customers need/want." The discovery phase establishes the goals for the presentation, structure, and behavior of the site. The team begins conceptualization of the large-scale components and relationships in the elaboration stage by "prototyping the site." It "design[s] the site structure, page layouts, and site components" as well as "finalize[s] technical requirements." In the development stage the hesketh.com team will "deliver an alpha and beta for client review and testing." Cecil explains that there are generally up to "three rounds of revisions for each deliverable." Here, the members of the team develop the concepts from the previous stage into drafts of the entire site and begin a process of review and revision. The site development process ends with deployment: "transferring the site to the client, and training them on how to maintain it." This stage is reached when a final version of the site has been accepted by the client (Cecil 9/14/03).

The multidisciplinary approach has an inherent limitation, however, that

reduces the chances of producing optimal Web sites. Because the people constructing each element or aspect of a Web site are narrowly trained in a single discipline, they make design decisions that take into consideration only the aspect or element for which they are responsible. What they tend to neglect are the consequences of those decisions for the other aspects or elements and the people constructing them; i.e., the interactions between elements or aspects of the Web site (Lerner 7/10/02). Since much of the design process is linear – each expert makes her or his contribution and then hands it off to the next expert – the result is that people working early in the process make decisions that can adversely affect the options for those entering later in the process, and they in turn may make decisions that compromise some of the work done earlier. The industry jargon for this is "Throw it over the cube wall" as in "I'll code my part, throw it over the wall to you, you can design it, and throw it over the wall to X, etc." (Lerner 7/10/02).

While these problems are partially ameliorated through the iterative process of review and revision, they remain inherent in a multidisciplinary approach and cannot be fully overcome in the context of that approach. For one thing, team decisions are affected by group dynamics as well as by the objective merits of each argument. This becomes especially problematic when members of the team have a narrowly disciplinary perspective. The discipline whose advocate is most eloquent, persistent, loud, or powerful is likely to be over-emphasized. But even good team decisions must still be implemented by individuals, so problems with narrowly conceived decisions that affect the work of others re-emerge with each iteration. Moreover, review and revision cost money, so there is pressure on the team to keep down the number of iterations. Thus, a design that is good but less than ideal from one discipline's perspective may be accepted by the expert from that discipline because the time, effort, and interpersonal costs required to change it are not worthwhile. The result is that a multidisciplinary process may produce Web designs that are more expensive and of poorer quality than if their designers were interdisciplinarily trained and organized. The difference in price or quality may be small, but in a competitive market, it can determine whether a firm thrives or goes out of business.

In complex systems terms, the focus of the multidisciplinary process on individual elements and aspects is likely to produce suboptimal Web designs because it cannot take full advantage of the potential contributions of individual disciplines, nor can it tightly integrate them to form a Web site. It implicitly presumes that a Web site is merely a simple system with loose connections among elements, and fails to recognize the strength of the

nonlinear nature of those connections, so it cannot address the complexity of the system. We believe that only an interdisciplinary approach can deal with the full complexity of Web design.

An Interdisciplinary Web Design Process

Like the multidisciplinary approach, an interdisciplinary approach to Web design may utilize a team of experts. The differences lie in the training and organization of the members of the team. Ideally, interdisciplinary Web designers would have primary expertise in one of the disciplines, but they would also have sufficient training in each of the other disciplines to appreciate their perspectives and take them into account as they construct their element or aspect of the Web site. They would see their portion of the Web site in the context of the site as a whole. A major consequence of interdisciplinary training for Web designers is that the need for multiple reviews and revisions is reduced. While clients will always need a chance for review, even when their initial goals are met by the draft site, there is less need under the interdisciplinary approach for internal reviews to integrate the work of the various experts because they have already taken each other's perspectives into consideration.

An interdisciplinary approach ideally overcomes the inadequacies of the other approaches. Unlike a disciplinary approach, it yields Web sites that balance presentation, structure, and behavior because it pays attention to the site as a whole as well as to its elements. In contrast to the adisciplinary approach, the interdisciplinary approach constructs Web sites whose overall aspects are responsive to the distinctive characteristics of its elements because its designers are trained in the contributing disciplines. And it produces higher quality, less expensive sites than come out of a multidisciplinary approach because its team members are interdisciplinarily trained, and fewer design iterations are required. To understand how interdisciplinary Web designers draw on the perspectives of different disciplines and integrate their insights in the design, we need to look closely at the interdisciplinary process.

Newell's (2001) theoretical work sets out an interdisciplinary process grounded in the nature of complex systems. While this process has been developed for the study of existing complex systems, we argue that it can be adapted to guide the process of interdisciplinary Web design. Following Newell, we believe this interdisciplinary process is divided into two parts: "drawing on disciplinary perspectives" and "integrating their insights through construction of a more comprehensive perspective" (Newell, p. 9). Each

part has several steps, the sequence of which is logical but not necessarily followed in practice. To illustrate each step, we will use a fictitious scenario where an outdoor sports company wants to create a dating service Web site for outdoor enthusiasts.

The first six steps comprise Part One, "Drawing on Disciplinary Perspectives." The first step in this interdisciplinary process is to define the problem. The client determines the goals of the Web site and serves as an active member of the team, educating and being educated by other team members. The problem facing the Web designers is to integrate the client's goals along with the team's specialties to construct a site that meets those goals. Since the goals are translated directly into characteristics of the aspects of the site – its presentation, structure, and behavior – the problem becomes how to construct elements (written information, visual information, and their interrelationships) that can be combined to produce those characteristics. Using our example, the web development team must identify the overall problem (How do we build a commercial dating service Web site that will meet the needs of outdoor enthusiasts?) as well as specific problems (What kind of visual layout will be most attractive and useful to this specific audience? How will we keep the dating service from being misused by unruly members?). The second step is to determine relevant disciplines. In general, this step is taken by the Web design professional, who determines what disciplines are necessary to the development process, but a team leader could conceivably add or remove perspectives, depending on the specific project.

More importantly, interdisciplinary *construction* of a complex system differs from the interdisciplinary *study* of a complex system in that the disciplines required include those focused on the aspects of its pattern of behavior as well as on the elements of the system. Thus, Web design typically requires information architects, graphic designers, and usability experts as well as writers, visual information designers, and programmers. In our example, because much of the dating service involves the creation of a connection and communication tool, the team might find it advantageous to add an extra programmer. They might also find it useful to hire a marketing expert specializing in marketing to outdoor enthusiasts to help make decisions about visual layout and overall image or branding.

The third step is to educate designers in the "concepts, theories, [and] methods of each discipline" (Newell, p. 9). Ultimately, this step must be taken by educational institutions, but until then firms might be well served by providing in-house training in other disciplines or by having team

members occasionally change roles. In our example, it will be important that programmers have a good understanding of usability because this is directly involved in the way they gather information from new members and build useful matchmaking results.

The fourth step is to gather relevant disciplinary knowledge and search for new knowledge. In part, this step is taken by hiring experts in different disciplines as the firm expands, since the profession will develop new knowledge as practitioners recognize the need for it. For our example, the usability expert might seek out new information concerning the experience the outdoor enthusiast demographic has with computers and the Web, guiding future decisions about the complexity of the site's design and functions.

For the fifth step, the problem must be studied from the perspective of each discipline. In the context of a team approach to design, that means each expert focuses on a particular element or aspect of the site in the context of the emerging site as a whole. For our example, this means the information architect must pay attention to how dating service members will try to use the site (usability) and how the site will be visually laid out on the page (graphic design) so that she can organize the site's content (member profiles, communication tools, information about service, etc.) with those other elements in mind.

The sixth step, generating disciplinary insights, means making a decision about the particular aspect or element while paying attention to its implications for other aspects or elements. This means the information architect from our example must decide if an excerpt from members' written profiles should be included with the initial brief results returned from the matchmaking search by considering both the site layout being developed and what future members will expect and want as they browse possible matches.

The next six steps make up Part Two, "Integrating Disciplinary Insights Through Construction of a More Comprehensive Perspective." The seventh step is to identify conflicts in disciplinary insights. Whereas in the study of an existing complex system, conflicts between disciplines are grounded in different assumptions about the nature of the system, in the researchers' knowledge of that system, and in the values attached to those differences, in the creation of a new complex system, the conflicts between disciplines largely reflect value differences in what that system should be. Thus, conflicting contributions of different Web design disciplines reflect differences in their values (e.g., aesthetics v. usability, written v. visual information) and consequently in their focus. A team leader or member who wants to understand the source of conflict in contributions needs to have

an appreciation for the vocabulary, values, and goals of each discipline as well as those of the client. The information architect from our example, in deciding what to include in match results, may find that potential members will want profile excerpts returned as a part of matchmaking results, but that the site layout being developed does not provide enough visual space for this. The graphic designer has limited the visual space in an effort to reduce the need to scroll through numerous screens. The information architect has discovered a conflict between usability and graphic design.

In the eighth step, the conflicts that have been identified need to be evaluated. For Web design, the criteria for evaluation are the ultimate goals for the Web site set by the client. In our example, the information architect must weigh the conflicting values and contributions of graphic design and usability in light of the ultimate goals of the dating service Web site. Is it more important to minimize the page length or to include the profile excerpts? The information architect may find that the layout can be modified relatively easily, with little or no negative effect on the overall design and aesthetics. Or she may find that the benefits gained by including profile excerpts in match results do not warrant a visual design change that would affect the layout of the entire site. Better yet, is there a win-win solution? In this case, a good web designer will look for a solution that will add profile excerpts as well as maintain the current layout.

The ninth step is to resolve conflicts. Here the design challenge is to determine what balance of values best achieves those goals. After the information architect has weighed the possibilities, she must make the best decision for the goals of the dating service Web site. Conflicts between value considerations can be resolved in a few different ways: preserving as much of the differing sides as possible, exerting authority, or agreeing to disagree. Each may be useful at different points in the process.

The tenth step is to create common ground. In the context of Web design, this involves the use of both/and thinking to find solutions that meet more than one set of value considerations. In our example, the information architect finds that by having profile excerpts appear when the mouse pointer is moved over the pictures returned with matches, the conflict is resolved and the overall site aesthetics and brand have not been compromised and may, in fact, be enhanced.

In the study, as opposed to the creation, of a complex system, the eleventh step is to construct a new understanding of the problem. The implementation of this step and even its location in the process may differ for the creation of a complex system such as a Web site; indeed, it may vary from one Web

designer to another. As with writers, composers, and artists, some Web designers clarify their understanding through the act of creation while others work better if they understand before they start creating. In either case, the goal is to envision the Web site as a totality, a complex whole. In our example, the graphic designers will determine what changes to the visual layout are necessary to accommodate the addition of profile excerpts while upholding the values and contributions of both graphic design and usability.

The twelfth step is to produce a model that "captures the new understanding" (Newell, p. 9). This step is actually building the Web site. Again, this step may precede or follow the construction of a new understanding. For our example, the graphic designers will now make the necessary changes to the visual layout.

Finally, the thirteenth step is to test the model. In the case of Web design, this involves the presentation of an alpha and then a beta model to the client, and perhaps eventually the performance of use studies. In our example, both the client and team members will test the site to make sure the conflict between the site layout and space for profile excerpts has been resolved successfully. By adopting an interdisciplinary approach to Web site design, the team should produce a site with better presentation, structure, and behavior – in short, a better "feel" – and do it more cheaply and quickly. The success of the interdisciplinary approach comes because programmers, visual information designers, and writers take into account the other elements of the Web site (as well as the aspects produced by graphic designers, usability experts, and information architects) as they develop their own elements. They are mindful of the interplay between their elements and the overall Web site as a complex whole.

Critiques of Web Sites

Many sites on the Web today lack proper integration of disciplinary insights. These integration problems may not be obvious to everyone – even to the designers and creators of the site. But most average users sense when something is "off." They may not know what it is, but they usually know the difference between a clean, attractive site and a cluttered, uncomfortable site. Users will experience a site as easy or difficult to use and pleasing or unpleasant to the eye. These feelings will often determine whether they return or not.

Creating an integrated Web site comes from breaking down that site into individual problems of creation or relation of information components,

choosing the best possible solution from a finite number of possibilities (keeping in mind the goals of the whole site) and then bringing each of those components and their relationships back together until the whole site has been designed.

It may seem as if trial-and-error is the only way to build successful sites: design the site, test it, find out what doesn't work, try something different, test it again until it works. Our understanding of the interdisciplinary process suggests that the nature of the trials and the way we evaluate errors can be fruitfully approached using interdisciplinary methods. However, designers must not rely on trial-and-error alone. A good designer will be able to anticipate difficulties through a deeper understanding of the needs and goals of the Web site, and an understanding of the integration process.

The next two sections analyze real Web sites to show how this integration process works, point out aspects of the site that fail to integrate properly, and show why the lack of proper integration reduces the effectiveness of the sites. Then, we propose how the design problems could have been avoided by using the interdisciplinary process modeled previously.

One thing to note, however, is that most sites are constantly evolving. They can change information components and relationships often because Web site modifications are relatively cheap. This means that for many sites, the process of trial-and-error is employed on a regular basis. So, over time, a site may evolve into a much more effective means of communicating information for desired experiences. This also means that by the time these examples are read, it is possible, and even likely, that they no longer exist. For this study, we include screenshots illustrating problems at the beginning of the corresponding section. The images are deliberately blurred to keep the focus on the structure of the site and not on the images nor the text. In all cases, the date of capture was February 28, 2002. Even if the sites change, these pages remain valid as illustrations of the principles we are discussing.

Travelocity.com

Travelocity.com is a site for making travel reservations: booking flights, hotel accommodations, and cruises. The site is divided into seven main areas: Guides & Advice, Flights, Lodging, Cars/Rail, Vacations, Cruises, and Deals/Rewards. One way that many sites distinguish between their different content areas is to suggest visually that each area is a folder in a filing cabinet. Visually, visitors see several tabs with names on them (see Figures 1 and 2). Visitors click the tab and are taken to that folder – suggesting that

they are actually opening the folder and reading its contents. This visual cue is also used on Amazon.com, one of the largest online booksellers. Figures 1 and 2 show that the seven main content areas are also located in a horizontal bar across the top of the page, just below the head graphic and welcome. Included with the content areas are the tabs labeled “Home” and “My Stuff.” “Home” is the main page through which the site is visited, and “My Stuff” is a customized page for users with an account on the Web site. In Figure 1 on the home page, the word “Home” is on a darker tab, while the other words are not. When visitors click on the other word links on the bar, they are taken to a page where that word link is now on the darker tab, shown in Figure 2. This is a slight variation of the tab-folder visual analogy, since the other words are not on tabs along with the current page’s tab. This does not present a problem, however, since many users are familiar with this visual element and use it easily.

Figure 1: Travelocity.com Home Page.

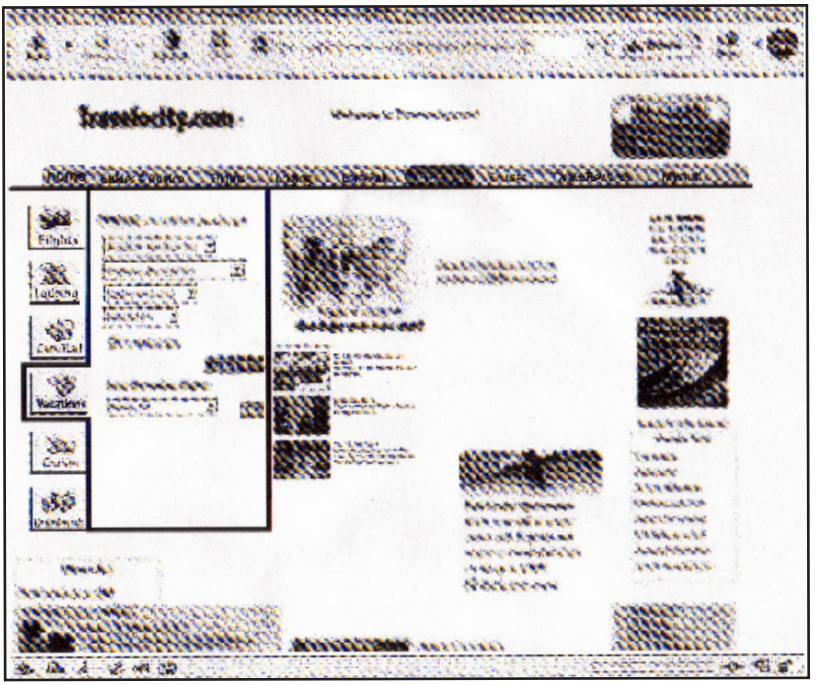

Figure 2. Travelocity.com Vacations Page.

Yet there is a second set of tabs on the left-hand side, connected to the horizontal bar (outlined with a dotted line in Figure 3). This vertical set of tabs reads: "Flights," "Lodging," "Cars/Rail," "Vacations," "Cruises," and "Deals." Connected to these tabs is a box with a form to search for flights. One guesses that by pressing the other tabs, one will be presented with another search form to find one of the other types of reservations. Instead, when clicking on these tabs, one is taken to the content areas found on the horizontal bar, and then the search form is switched to search for the current type of reservation.

There are several things about this second set of tabs that work against the site. First, the vertical tabs (outlined with a solid line in Figure 3) are confusing because they all are tabs, whereas for the horizontal bar (outlined with a dotted line in Figure 3), only the current page is on a tab. The vertical tabs that are not selected are gray (outlined with a dashed line in Figure 3), which signifies that they are in the background – another common visual cue.

The horizontal bar, however, does not use the gray to signal inactivity and thus creates a conflict between the two sets of tabs. If one has grayed-out tabs and the other has no tabs, which one directs the visitor to other content areas on the site? Seeing these two tab bars, one might expect that the horizontal bar would take you to different sites – since the visual cue is more clearly represented in the vertical bar and is more subtle in the horizontal bar.

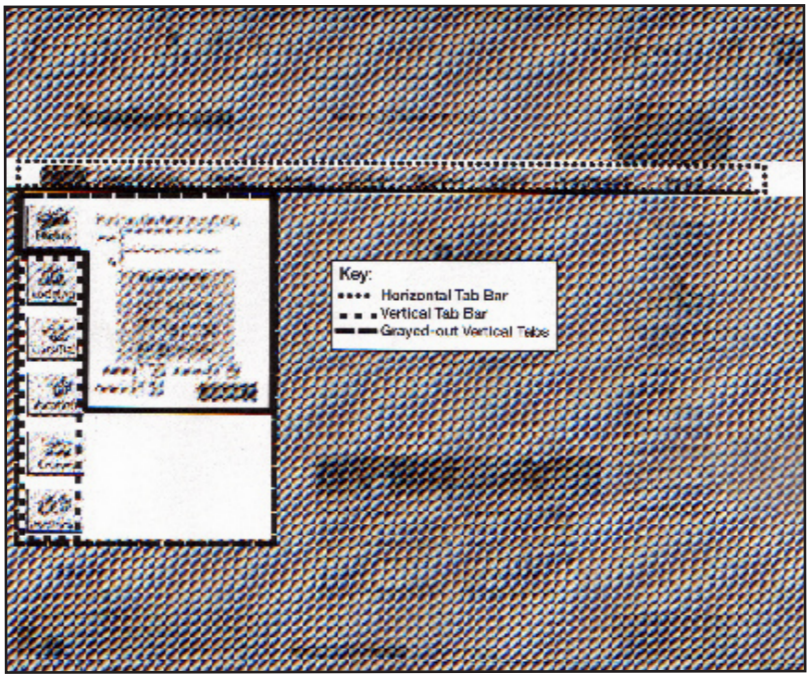

Figure 3. Travelocity.com Home Page with highlighted sections.

The second problem is that the vertical bar suggests that clicking on the other tabs should change only that search form, not transport one to a different content area of the site. This is because the horizontal bar is at the top and stretches across the entire page, signifying that it encompasses the entire contents of the page. The vertical tab bar only encompasses the search box. By choosing a different tab, one expects that the content encompassed by that tab will change, not everything on the entire page. This element of the Web site is counterintuitive and contradicts one of the tenets of usability,

which is to refrain from making users think and allow intuition to guide them (Krugg, 2000, p. 11).

What makes sense about having this vertical tab bar and search box is that it clearly points out the most important part of the site. Visitors know immediately that by clicking the other tabs, they would be able to search for any of the types of reservations. However, the way the vertical tab bar is designed and the way it functions, by taking the user to a different part of the site, confuses the users (even if only momentarily) and detracts from the effectiveness of the Web site.

This is a problem of integration because it involves drawing on several different ideas and tying them together in a way that is not dominated by any one of those ideas. The idea of using tabs to signify different content areas comes from hand filing systems and was borrowed by the disciplines of usability and graphic design. The idea of using tabs to change different content areas and to encompass the different search functions for the site comes from programming and an understanding of characteristics of the Web.

In an interview with Chris Lauer (personal communication, September 12, 2003), a developer at Travelocity.com, we learned that updates and changes to the functionality of Travelocity.com used the same general multidisciplinary process as the design and development of an original Web site. Lauer explained that "changes to functionality are normally brought to our management from the business owner of the product." These changes are then brought to the information architect, who organizes the information and passes it off to the designer. The designer creates mockups for review by the team and business owner. Once changes have been approved, the designer "creates development-ready html [code], and hands off to the project manager/development team. The designer then works with development to make sure the look and feel of the final product are correct."

In the process of integrating design changes at Travelocity.com, someone failed to realize that using the tabs for two different purposes would conflict with the site's continuity and confuse users. The site's designers used the concept of the visual analogy of "tabs" to suggest that a tab encompasses a certain area of content on the site; and, when users select another tab, only the content encompassed within that tab will be shown. The user may well expect that the visual analogy will hold true for every tab found within the site.

Chris Lauer explained that the vertical tab bar was designed to be the

primary navigation for the front pages and that the horizontal bar was not a part of the initial design. But, after launching the site with only the vertical tab bar for navigation, Lauer explained that, "a few in upper management expressed concern that users wouldn't get navigating through our travel reservations from the widget [vertical tab bar], so the header [horizontal tab bar] was put back on."

Although this may have been an important concern, the horizontal tab bar element, added as an afterthought, led to a double standard in the site's design and did not benefit its goals. Instead of going back to the original intentions of the tabs, the designers put the horizontal tab bar into place without thinking through the full ramifications of making this change. The implementation of this element was a failure to integrate insights from the usability perspective and to realize that this violated the rules set up for the use of the visual analogy. Integration did not take place ultimately because individual insights were not combined to achieve the best result.

If designers of the Travelocity.com Web site had been following an interdisciplinary process, this problem might well have been avoided. When deciding to add this element of the site, the designers would "[study] the problem from the perspective of each discipline," "[generate] disciplinary insights into the problem," and then "[identify] conflicts in insights" (Newell, 2001, p. 9). This conflict could have been caught when the element was studied from the perspective of each discipline – specifically from usability and graphic design. By looking at the addition of this element from a usability perspective, the discrepancy between the two tab bars might have been seen and the problem addressed. The designers could have changed the unselected words in the horizontal bar to gray tabs and the programmers could have had the vertical tabs change only the search box and not transfer visitors to another content area. Another option would have been for the designers to remove the vertical tabs altogether, and provide a title graphic above the current search form. Either option would have solved all conflicts and would have made the site easier to use.

One thing to note, however, is that just because elements of a Web site are successful, does not mean that the site designers used the best process to arrive at them. The Travelocity.com designers could have caught the discrepancy by chance and fixed it. They could have been simply lucky. Luck cannot be counted on, however, whereas reliance on an interdisciplinary process maximizes the likelihood of finding and correcting such errors during the design process – or, better yet, avoiding such errors in the first place.

CDNOW.com

CDNOW.com, acquired by Amazon.com, was one of the leading sellers of CDs, videos, and DVDs online. The site catered to a wide variety of people with a wide variety of tastes. The company needed to make it easy for people to find the music and movies they wanted to buy or find new music and movies that they might like to buy (the difference between searching and browsing). The site designers also wanted to offer information of various sorts on the home page. They included a large spread on a storewide sale halfway down the page, news articles about music and movies and, along the top, a collection of links to "Music," "Video/DVD," "Gift Center," and "MYCDNOW." The important features of the site were in a line down the left side of the page: the search box, the shop index, and the browse index. These features of the site were how the majority of users were to be able to navigate the Web site – either by searching for a specific artist or title, or by browsing categories, choosing a category, and then browsing artists or titles.

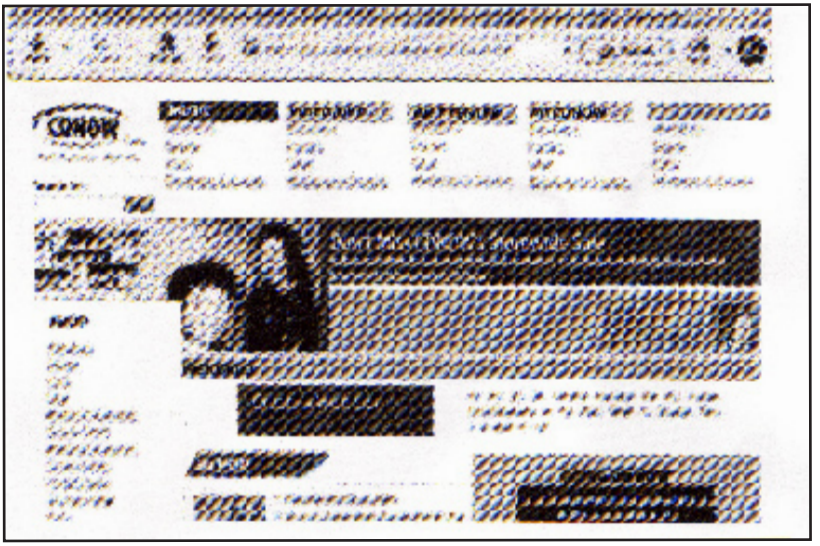

Figure 4. CDNOW.com Home Page (upper section).

Figure 5. CDNOW.com Home Page (lower section).

There were two glaring problems with this site's home page (see Figures 4 and 5). They have to do with a conflict between the written and visual information on the page and how that information is arranged. The first problem is that the site failed to balance visual elements and direct the viewer's attention to the most important elements. When visitors looked at the page for the first time, they would most likely be confused about how to find what they were looking for. In Figure 4, the first thing that draws attention is the graphic with Alanis Morissette in it. The eye is then drawn to the words, "Don't Miss CDNOW's Storewide Sale" beside the graphic. This is initially confusing, because this announcement is the biggest visual element on the page, and yet it is not even a permanent feature – it merely advertises a sale. It does not give any further direction. From here, the eye is pulled in different directions because nothing leads to what is the next important element. Most likely visitors will look up, trying to get their bearings by viewing the heading of the site. They see a small CDNOW logo and search box under it and then several boxes of lists across the page giving a variety of links. But these links conflict with the list going down the left side of the page. Which is more important? Is

the site divided into separate categories by the links along the top or along the left? Looking down instead, visitors see the welcome, almost at the bottom of the main viewing area. Scrolling down further (see Figure 5), there are several boxes close together, but they are titled in different ways. The "In Pop," "In Rock," and "In Video/DVD" boxes go together, but the "Going on Now" and "Heavy Hitters" boxes don't seem to correspond. Eventually, visitors can figure out the site's structure and purpose by scanning the page, clicking on a few links to see what elements of the page carry over to other parts of the site. (In this case, the top logo, search box, and boxes of lists stay as elements on every page.) The problem is that, even though people would eventually figure out how to navigate the site and find the content they are looking for, they lose time trying to understand the site. Jakob Nielson writes that, "Research has shown that reading from computer screens is about 25 percent slower than reading from paper" (2000, p. 101). Since CDNOW.com was an e-commerce site, many of its users came to the site with the goal of making an online purchase. If CDNOW.com made it difficult for users to accomplish tasks quickly, frustrated customers would go elsewhere.

The second problem is related to the layout and confusion of the main page. The "grid system" is a widely accepted concept in graphic design. This system is a way of designing visual elements so that they are aesthetically pleasing, balanced and give viewers an easy way to understand the presentation as a whole. This main page appears to use the grid system, but fails in four places. Figure 6 shows the attempted grid system indicated by the solid lines. The worst offense is in the first vertical line on the left. It comes up along the left-hand index, travels along the line through Harry Potter's head, and then it fails to line up with the space between the CDNOW logo and search box and the "Music" link box. This throws off the balance of the page more than anything else. The second place the grid fails is not quite so bad. The second vertical line, near the middle of the page, comes up correctly between the news boxes. But when it reaches the top of the page, it splits the "Gift Center" box, which, again, throws off the grid. The third and fourth places where the grid fails are in the lower two horizontal lines. A careful examination shows that the bottoms of the "In Pop" and "Heavy Hitters" boxes and the "In Rock" and "In Video/DVD" boxes do not line up. It may seem logical that, since these places depart from the grid only a small amount (10 to 20 pixels), it would make little difference. But it is actually worse for the boxes to be that close and not exact, rather than to be further apart. If they were further apart, then visitors would be less likely to expect a grid design.

Figure 6. CDNOW.com Home Page (full spread) with grid system imposed.

Ultimately, graphic design was left out of the CDNOW.com production process, and decisions were made without consulting or valuing insights from the graphic design perspective. Mike Griffin (personal communication, October 8, 9, 2003), a former developer at CDNOW.com, explains that site development for CDNOW.com was divided into four User Experience teams: personalization, core site, promotion, and tools. Each of these teams was responsible for different parts of the site. Because the site was so large, starting in 2001, the CDNOW.com development team began creating and incorporating the use of programs, called "tools," to control frequently changed content areas, such as the "Today at CDNOW," "Going On Now," and "In Rock" boxes on the home page. When new text and graphics were required for these areas, individual project requests were made. Griffin writes, "Visual changes to strictly graphics were for the most part requested by Merchandising and Marketing." A designer then created three mockups, reviewed by Art Directors, then by a Product Manager and then finally forwarded to Merchandising or Marketing personnel.

The problem is that the site's content was divided up, and distinct visual areas of the site were being developed by several different teams. These teams worked on portions of the site, rather than the whole. Since the focus was on these smaller visual components, the overall pattern was neglected. The real flaw is that CDNOW.com "tools" were based on the programming concept of modules: independent parts of a program that can be used or changed without affecting the rest of the program. This concept may be an excellent way to keep a site updated and to control individual content areas, but it does not benefit the overall visual design of a Web site. The interdisciplinary process would have been useful because it inherently considers the whole when developing smaller components of the site. The site's visually disjointed components may well have been repaired by viewing the overall pattern experienced by the user, identifying the conflicts between larger components and then solving them using the discipline of graphic design.

This brings up an important question: do all team members need to be involved to make revisions or additions to a site? The answer lies in what facets of the Web site system the changes affect. In the case of CDNOW.com, the changes being made to content through tools affected larger facets of the site that were not being considered. Disciplinary Web designers may not be capable of knowing the impact of their own changes because they are trained in only one perspective and do not necessarily have a balanced, coherent view of the Web site as a whole. They lack an understanding of the

Web site as a complex system, with its nonlinear relationships, so they may be unreliable when assessing whether a certain change will have a small or large impact on the Web site as a whole. In this case, involvement of all team members is important to determine the effects of changes in one area. On the other hand, the interdisciplinary Web designer who must make individual revisions or additions to a site has an advantage over the disciplinary Web designer, because the interdisciplinary Web designer has been trained to see the Web site from many perspectives and remain conscious of the ways individual parts affect the overall synthesis of the site. The influence of the interdisciplinary approach to the development of effective Web pages has implications for the education of Web page designers.

The Interdisciplinary Education of Web Designers

Is it possible for a student of Web design to gain competence in all the major disciplines involved in Web design? Will that student be prepared for identifying all disciplinary insights necessary for a specific project? Will the focus on integration keep the student from ever really gaining a proper understanding of disciplinary perspectives? These are all important questions to ask of the interdisciplinary approach. The value of the interdisciplinary process to the Web design community depends on the answer to these questions.

We believe students of an interdisciplinary approach to Web design can be adequately schooled in the disciplines as well as in the integration process. Obviously, one could spend a lifetime studying a single discipline, but Web design requires an understanding of more than one discipline. In "The Case for Interdisciplinary Studies," Newell writes, "for such positions, the abilities to understand and critically evaluate the work of experts and to make decisions based on that evaluation seem more important than a specialized knowledge of any one discipline" (1983, p. 6).

Specifically, Web designers require competence in each of the disciplines that contribute to constructing the elements and aspects of a Web site, at least one and perhaps two or even three courses each. Today, those disciplines include visual information design, writing and programming (to address the elements of visual information, written information, and their interrelationships) as well as graphic design, information architecture, and usability (to address the aspects of presentation, structure, and behavior). In addition, Web designers need explicit training in interdisciplinary process. Interdisciplinary studies courses that are self-conscious about process

would aid in meeting this goal, but the differences between studying and creating a complex system are sufficient to make some training desirable in interdisciplinary Web design *per se*. Since individual members of a professional Web development team will still require an area of expertise, it may be useful for the interdisciplinary Web designer to be trained with a specialty in one of the Web design disciplines. Near the end of their study, students would be well advised to take one or two courses in which they work as part of an interdisciplinary Web design team, learning how to integrate disciplines as a team with each member using his or her specialties.

Conclusion

Web sites are one of a wide array of commercial products that can be productively understood as complex systems best developed through an interdisciplinary approach. Web site designers typically work in design teams (referred to more generally as "cross-functional teams") drawn from disciplines such as programming, writing, and visual information design that study elements of the complex system comprising the Web site, as well as from disciplines such as information architecture, usability study, and information architecture that focus on aspects of the behavior of that complex system. The way these team members bring together their expertise can determine the quality and cost of their product. Newell's theory of the interdisciplinary process as the appropriate response to complexity sets the context for an analysis of the Web design process that argues for integration of expertise and for training team members to consider the implications of their own expert decisions for the other elements and aspects of the Web site and thus for the effectiveness of the site as a whole. The ability to go beyond one's own expertise by integrating it with the expertise of others lies at the heart of interdisciplinary Web design. That ability can ultimately make the difference between a Web design firm that is competitive and one that fails, so it is important for design firms to provide on-the-job training in other disciplines and in interdisciplinary integration until educational institutions start training students in interdisciplinary Web design.

As important as the implications of this article are to Web designers and, by extension, to participants in other cross-functional teams, they may be even more important to interdisciplinarians. Discussions of interdisciplinarity typically focus on study not production, on the academy not the corporate world. This article demonstrates that the theory of interdisciplinarity can

be fruitfully extended from the study of an existing complex system to the creation of a complex system. As such, it opens up a way of conceptually connecting the liberal arts and the professions, and connecting the academy and the business world.

Biographical Note: William H. Newell is a professor in the School of Interdisciplinary Studies at Miami University and has been teaching interdisciplinary courses since 1969. He has published two books, written more than thirty articles and chapters, and guest-edited two journals on interdisciplinary studies since 1981. The founding president of the Association for Integrative Studies, he has served as its executive director since 1983. In the last quarter century he has served as an external evaluator, consultant, visiting scholar, and keynoter on interdisciplinary higher education roughly ninety times.

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