RESEARCH STATEMENT

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My research interests broadly align with the areas of Digital Libraries and Human Information Interaction. I focus on the human-centered design and evaluation of application-specific software that assists individuals and groups in creating, using, and managing digital collections. To ensure the utility and usability of collection interfaces I study users’ work practices and interaction styles. Informed by the results of these studies, I build Hypermedia and Ubiquitous Information Systems for Information Visualization and devise Information Retrieval techniques to help users locate relevant data from large repositories. My collaborative, inter-disciplinary research also contributes to areas such as Educational Technology and Digital Humanities. To achieve my research objectives, I address the following questions:

- **Interfaces and systems**: How do we design information systems that aid users in achieving their goals? How could we harness novel information appliances to improve quality of life? How do we plan and execute user studies to assess the usefulness of these systems and their user interfaces?

- **User practices**: How do individuals and groups create, manage, and use information to accomplish their objectives? How are advances in hardware and software technology transforming current practices?

- **Information characteristics**: How to represent information best to enable its use by diverse audiences? How does the display and encoding of information affect its perception and its use? What attributes of information artifacts do users consider significant?

The issues of system interfaces, user practices, and information characteristics are intricately intertwined. Design of useful and usable software requires an understanding of user practices, constraints, and skills. Conversely, new software modifies existing work practices. In particular, creating software for heterogeneous mobile and desktop environments presents additional challenges due to the differences in device characteristics, interaction mechanisms and modalities, and constraints imposed on the users.

One of my primary objectives is to develop a strong, collaborative research program supported by external funding. To realize this objective, I will draw upon my prior experience in defining, executing, and managing inter-disciplinary research projects. Over the last few years I have collaborated and consulted with researchers in education, physiology, art history, Hispanic studies, sociology, disability services, visualization science, environmental perception, and, of course, computer science.

Academic research presents opportunities to shape the future through contributions to theory, systems, and education. I will strive to develop students into capable, independent, and ethical researchers. I would like to broaden my research perspective by actively involving young and minority investigators in cutting-edge research. I have developed the skills that will contribute to achieving this vision through long-term involvement and leadership in research, organizations, mentoring, and diversity initiatives.

**Interfaces and Systems**

In an information-centered society such as ours, we use information systems to enhance the quality of our personal and professional lives. We pay our bills online, check weather forecasts before traveling, and communicate with friends scattered across the globe. At work, we manage meeting schedules, email colleagues, analyze results of experiments, and teach classes at a distance. The design of successful systems is informed by user characteristics and preferences. These systems leverage existing practices and harness user skills to support and enhance users’ performance. Over the course of my graduate career, I have planned and conducted several end user evaluations and have analyzed user responses to obtain qualitative as well as quantitative results.

**Work to date**: My dissertation work, titled Multi-device Integrated Dynamic Activity Spaces (MIDAS), has focused on the creation of an infrastructure and human-centered policies for generating flexible, reconfigurable, coordinated information presentations across multiple, heterogeneous information devices. An ever-increasing set of mobile devices—such as PDAs, MP3 players, and digital cameras—are
now network-capable. While these devices make viable candidates for accessing information from digital collections, small form factors and limited processing power restrict the presentation quality. MIDAS enables the co-use of multiple mobile devices in conjunction with traditional computing devices—such as notebook computers, desktop computers, printers—or large-screen appliances, such as televisions and wall-size displays, in order to improve the quality of information presentations. MIDAS operationalizes flexible, multi-modal, display-agnostic presentations by decoupling the structure of hypertext documents from their content and the content from its rendering. In doing so, it enables users to transcend the limitations of individual devices, routing information elements to devices that can present them best. As new devices become available or current devices unavailable, MIDAS reapplies its policies and optimizes the presentation for the new set of devices.

As a part of the Walden’s Paths project team, I have developed and evaluated software tools for the creation, use, and management of Web-based meta-documents (documents that refer to other documents) called paths. Paths are topical collections for educational or personal use. They collate information from different Web sites without affecting the original structure of either the sites or the individual pages. I have explored issues in supporting special-purpose features, such as information filtering techniques for locating relevant paths from large path repositories and multi-lingual interfaces to promote cross-cultural and international use of Walden’s Paths. As Web pages included in the paths reside at their original locations they may change, migrate, or disappear in an unpredictable manner, thus threatening the integrity of paths. I have participated in the design of algorithms that estimate the degree as well as the nature of these changes and interfaces that report these results and their implications.

**Future work:** The MIDAS infrastructure enables further research in several directions. It is an attractive vehicle for providing ubiquitous access to digital libraries. While MIDAS is capable of presenting information on several devices simultaneously, the limits on human cognition for assimilating and applying information from multiple devices are yet unexplored. An understanding of these limitations will help augment the information presentation policies. MIDAS is also capable of serving as a framework for collaborative computing where users combine their devices to achieve common goals. Its support for diverse modalities also makes MIDAS an attractive basis for designing accessible systems for users with disabilities while minimizing the authoring overhead.

**User Practices**

Well-designed information systems embody our knowledge of human practices and aid us in achieving real-world objectives. They improve, and sometimes transcend, traditional practices to reduce users’ cognitive load by providing users with relevant information at the appropriate time. The reshaping of educational practices due to technological advances exemplifies this effect.

**Work to date:** As a member of the Walden’s Paths project team I have investigated the teacher practices in creating distributed educational Web page collections, called paths. As a part of my master’s thesis, I designed a path authoring tool for K-12 teachers based upon observations of their work practices. I evaluated the system interface of this tool with five middle school teachers. I found that teachers browsed the Web comfortably and located relevant pages for their paths competently, while managing multiple applications simultaneously: the Web browser and the authoring tool for creating the path structure.

During a summer internship at IBM’s T.J. Watson Research Center, I investigated the role of technology in facilitating the formation of short-term, but critical, support networks for summer interns. The interns used an intranet Web site as a digital supplement to familiarize themselves with other interns and to communicate with them. I organized focus groups, invited feedback via targeted questionnaires, and analyzed the Web site access logs to study how the interns’ use of this resource aided their integration into their new work environment. Interns actively followed up with people they had met at events and wanted to know more about their colleagues. Observations revealed that the nature of the dialog, both online and offline, changed over the course of the summer. Early interaction was formal, centering on work, travel, and health issues. As the interns got to know each other, the interaction became playful and
the Web site, a place to unwind. This research highlighted the significance of personal information sharing in the quick formation of online and offline communities.

**Future work:** In collaboration with a Hispanic studies researcher, I am investigating the use of large image collections for insights into Picasso’s art and life. Interviews and observations of school and college instructors of art, art history, art education, and art survey classes provided us a view of how they use images in their classrooms. This input has informed the design of a software interface for expressing and visualizing relationships between Picasso’s artworks. Studying the use of this system in research and education will guide its continuing development and foster new practices in the humanities.

Users of the MIDAS infrastructure will interact with multiple devices simultaneously, in the pursuit of a single, coherent task. Studying the use of MIDAS in different domains, such as education, humanities, and the sciences, will be useful for generating task-specific interaction patterns for different devices.

**Information Characteristics**

“A picture is worth a thousand words”. While this maxim may be empirically flawed, it accurately expresses the differences in the properties of information representations. Text, images, audio, and video all inform and influence our understanding of the world in different ways. Avid readers often complain that movie adaptations of books do not live up to the expectations built up by the book. Even if we disregard the business decisions involved in the screen adaptation of books, the fundamental difference between these media is also responsible for the difference in the human experience. Understanding the characterizing features of information representations enables the choice of the right representations to support users in successfully performing their tasks.

**Work to date:** MIDAS’ information presentation policies are guided by the results of user studies that explored user perception of the attributes of digital photographs. Users expressed the change they perceived as an image was scaled or de-colorized. Preliminary results indicate that users perceive the colors in images to be more critical than its size. Images of natural vistas and man-made structures can be scaled to a greater degree than images of people and textual symbols.

Working with Bat physiology researchers, I have designed methods for evaluating the skills acquired by novice researchers. While new researchers train by watching videos of bat blood flows, we determined that still images can replace videos for evaluating fundamental research skills. This discovery is critical for training and evaluating remote researchers. I also investigated how image layout affected users’ performance on specific tasks using thumbnail, scrolling, and montage layouts. Results indicate that image layouts affect user performance and, as expected, novices performed significantly worse than experts. Furthermore, novices use different strategies than do experts. Investigation of the characteristics of image layouts and their mapping to those of users’ tasks is useful for assisting users in other domains perform similar tasks.

**Future work:** Understanding expert strategies enables us to train novice researchers in these strategies, with a goal of speeding their “time to maturity” as researchers. Users had difficulty estimating the diameter of blood vessels, highlighting the need for additional support in size estimation tasks. We are now exploring mechanisms for conveying the real-world dimensions of objects depicted in image collections in several domains. Estimation of actual size of objects visible in photographs is also essential in analyzing aerial photos taken for geological surveys. Similarly, radar images and data used to train meteorologists require viewers to estimate the proportions of features displayed.

In the context of MIDAS, automatic or semi-automatic transformation between representations is an attractive approach for presenting information elements on diverse devices. Such transformation at viewing time will reduce the effort in authoring MIDAS contents, paving the way for semi-automatic enrichment and expansion of information collections. For example, extracting the text from a PDF file will enable a system to summarize this file for display on a PDA, while adding this summary to the information repository. Furthermore, a text-to-speech converter could read the text to a visually impaired user or to someone using a cell phone that has limited display space.