Participatory Software Design Processes in a Basic Science Research Setting: Planning of a Web Site Redesign for a Research Laboratory

by

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CERTIFICATE OF APPROVAL

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With this thesis I conclude my Master's degree studies here at OHSU. To me, it not only symbolizes a conclusion (at least for now) to my unique and dynamic formal educational path but also a personal achievement with opportunities and against challenges I have faced in the past 6.5 years since moving to Portland and the States.

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ABSTRACT

Bioinformatics (computational) tools can aid researchers in analyzing and understanding the vast amount of genetic, proteomic and similar data relevant to their research. One such tool are gene-centric web sites, ran by academic research laboratories. Development of bioinformatics tools (stand-alone applications, web sites, databases, etc.) is most often very challenging. It is has been recognized that communication between researchers and software designers is sometimes difficult due to their differing backgrounds and communication styles.

This study produced requirements and conceptual description of a web site bringing together information about Wilson's disease gene and gene products. In addition, the web site was proposed as a tool for efficient collaboration within this research laboratory. Features were described to satisfy information needs of all audience groups, as prioritized by the design group. The structure of this web site and its needs could potentially be used as a starting design template for other laboratories to organize and furnish information to researchers via the internet.

This study also described the process of participatory software design as it was applied in development of a software tool for in an academic research laboratory. It described the design experience in terms of themes, design voices, and social arenas within which the software design discussion takes place. The results showed how the social aspects of the design process influence the discussion and products of the group work. One of the most interesting results is

that established communication culture in the laboratory has an apparent effect on the discussion dynamics within the design group. . While the laboratory members (also design group members) are used to collaborative group discussions, the dynamics of the group communication also reflected the important role the PI has within the research laboratory. This trait enabled the group discussion to move toward consensus and decisions at a steady pace and would suggest that participatory software design could be a viable approach to software design in academic research laboratories.

A. INTRODUCTION

It is widely believed in the software development community that user involvement and input are very important for the production of a successful and accepted piece of software (*2-4*). A participatory approach to software design solicits input from users and it makes the users active members of the design team. Understanding the process of participatory software design can aid in planning a software design project and in managing the participatory communication and design activities.

The purpose of this study was to describe and characterize the participatory software design process as it was experienced during the initial stages of a web site redesign for a basic science laboratory. Specifically, research approach involved full participation of the research laboratory's members during requirements specification and the redesigning/enhancing an existing web site. The requirements and conceptual descriptions of the web site were collaboratively produced and are included in the Appendix.

In addition, the study describes the broader social dimensions of this participatory software design experience. Transcripts of the design group meetings were analyzed within the coding frames used by Sjoberg and Timpka (*1*). This coding frame classifies the content of the dialogue along the three dimensions: "voices" employed in the group's communication, and "organizational" and "social" arenas within which this dialogue takes place. An evaluation of the relationships between the design voices and the participation of the group members in the design discussions clarified how different voices are used by individual participants to reach decisions and participate in decision-making.

One of the most interesting observations is that established communication culture in the laboratory has an apparent effect on the discussion dynamics within the design group. While the laboratory members (also design group members) are used to collaborative group discussions, the dynamics of the group communication also reflected the important role the PI has within the research laboratory. This reflects the biggest difference between the design groups in clinical and research settings and made the participatory software design group communication more efficient.

B. BACKGROUND AND SIGNIFICANCE

B.1. Bioinformatics tools and gene-centric web sites

The completion of the Human Genome Project and the development of new data-intensive research technologies such as microarray chips have increased the demand for organized storage, management and analysis of biological data. This is a rather daunting task, because biological science produces data in a multitude of various formats: DNA and protein sequences, images of blots or microarray chip experiments, protein structure files, etc.. This diversity of data formats and the enormous amount of information make it very challenging for researchers to analyze, compare and interpret the data. Bioinformatics (computational) tools can aid in this process and have become an important part of basic science laboratory research.

Gene-centric web sites bring together knowledge available for a particular gene and gene products. They are especially useful for researchers studying that particular gene or gene family. There are thousands of human genes that are associated with genetic diseases, and each such genetic disease would benefit likely from a gene-centric information portal. This study will produce requirements and conceptual design documents for a web site bringing together information about Wilson's disease gene and gene products. The structure of this web site and its requirements/specification could potentially be used as a starting design template for other laboratories to organize and furnish information to the researchers via the internet.

Development of bioinformatics tools (standalone applications, web sites, databases, etc) is most often very challenging. On one hand, the system must accommodate the diverse data formats and volumes of information. Even more importantly, it is has been recognized that communication between researchers and software designers is sometimes difficult (*5, 6*). Software designers and biologists come from very different educational backgrounds with differing communication cultures and vocabularies. There are many strategies that can be employed in attempting to bring the computer scientists and biologists closer together on a software development project. This study attempted to understand the participatory approach to software design and whether such an approach could be used to efficiently develop bioinformatics tools in a research laboratory setting.

B.2. The Lutsenko Laboratory web site

The web site[1] that was the subject of redesign efforts in this study belongs to the laboratory of Dr. Svetlana Lutsenko, a faculty member in the Department of Biochemistry and Molecular Biology at the Oregon Health & Science University (OHSU). The Lutsenko laboratory investigates Wilson's Disease, a genetic disorder that is fatal unless detected and treated. The genetic defect in the Wilson's Disease Protein (ATP7B) causes excessive copper accumulation in various tissues and organs, and can lead to serious illness due to copper poisoning. The excess copper causes changes in the liver and brain resulting in

[1] www.ohsu.edu/biochem/lutsenko

hepatitis, or psychiatric, or neurological symptoms. The symptoms usually appear in late adolescence. The disease affects about one in thirty thousand people world-wide. The Lutsenko laboratory has been successfully studying the molecular mechanisms that regulate copper concentration in normal and diseased human cells.

The laboratory's web site contains the conventional parts of any research laboratory's home page, such as information about the personnel, research interests, publications. In addition, this web site also has some parts and functionalities which could be developed further to furnish information to the lab members, their collaborators, and the broader scientific community.

One of these sections is the laboratory intranet, which consists of password-protected web pages. Here, the laboratory staff posts information that is intended for internal use such as pre-publication research data and spreadsheets to keep track of the lab's protein and plasmid inventory. This part of the web site could be developed further to facilitate the workflow, productivity, and collaboration within the laboratory and with the collaborating labs outside the University.

The web site also has the potential to become an information hub for the laboratories involved in a Program Project Grant (PPG) for which Dr. Lutsenko is the program director. Within the framework of the PPG, four laboratories are collaboratively investigating metal ion transport within human cells.

Another information-rich part of the web site with potentially great utility to the lab and broader research community is the summary of public information known about the ATP7B gene, gene product, and Wilson's disease. Although the web site has not been promoted since its "Go-Live" (public posting of the web site) in the summer of 2003, Dr. Lutsenko has already received commendations on the utility of the web site. It is the most up-to date web resource related to the ATP7B and its mutations that result in Wilson's disease. The laboratory has a great opportunity to expand the web site to include even more detailed information, and also add resources about the broader protein family of ion transporters to which ATP7B belongs. Such information would have to be logically organized for the needs of a researcher, and also complemented by an array of common bioinformatics tools to automate sequence and structure analysis.

B.3. Software design as a technical and social process

It is important to understand the practice and tasks of software production. This knowledge is essential for successful management of this process. A systematic approach to designing a software can enhance the utility, usability, and production efficiency of the final product (*3, 5-11*). The information technology literature has described the characteristics and interdependencies of the stages of the software development process by modeling various Software Life Cycles. All these models incorporate a variety of concepts into software development, such as software requirements analysis, design, coding, testing, and maintenance (*12*). The design component of the engineering process is especially important for the successful deployment of the software and acceptance of the tool by its intended users (*1, 10, 13-15*).

From a software development perspective, the essence of software design is to build applications that meet the requirements (or goals) of its users (*13*). A software application, no matter how much technically superior it is, can fail if it does not meet the users' needs[2]. This makes "good" software design an essential phase in the process of building a successful, high-quality application. The information technology researchers have thus attempted to understand the stakeholders and improve the processes and outputs of the software design process. This has impacted the manner in which software design activities are understood and incorporated into the software engineering cycle.

The most traditional of software life cycle models is the "waterfall" model, where the design of the system happens at a fixed point – after specification and before implementation (*16*). However, it has been largely acknowledged that the software design relies on an often-difficult communication between the users and the designers who must take imperfect information from users to build an approximate model of an application (*1, 13, 14, 17*). The information that users give is usually imperfect because it is difficult to articulate, at any one point in time, all aspects of the problem the application should solve. Therefore, more recent software life cycle models, such as the spiral, the object-oriented, and the pervasive usability (which will be applied in this study) models, adopt a more

[2] It has been explained that users might not utilize the software as is expected because an insufficiently elaborated design either produces an artifact unsuited to the user's needs or does not take into account the situation or the environment in which it will be used (*7, 15*).

flexible, iterative approach to software production. Here, various activities pertaining to the application's "design" are more distributed throughout the development process and not concentrated into one block of time (*12, 16*). These models also follow the current (expanded) understanding of "design" as a concept, i.e., that a software system is a result of social exchange in a design group, and that design should be performed in working contact with users (*1*).

These newer methodological approaches to the management of software production now involve user input in diverse formats and at various stages of software development. Software designers can therefore more efficiently capture the expectations and functionality that the users have of the system under development, and thus improve the software's usability[3]. Concurrently, the degree to which designers involve users into software development varies greatly: including users as passive subjects to be observed by designers, users as active users without power, and users as active empowered partners in software design. While involving users in analysis and evaluation of software is widely-accepted, most examples from the literature on the information systems development literature and practice still put the technical software design team at the helm of the design process, usability testing and analysis, and solicitation of user input (*7, 14*).

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[3] The most popular of the so-called "usability activities" to improve the users' acceptance and use of the software include usability testing, prototyping, and heuristic evaluation (*7*).

B.4. Participatory Software Design

Despite this prevailing software engineering practice, it has been shown that the most efficient design methods for producing user-centered information systems (with high degree of usability) involve active user participation (*1, 7, 18, 19*). One of these software engineering methods is called "participatory software design". Here, users are active co-designers of the software system throughout the entire software development process. This method improves and speeds up the gathering of useful requirements and their incorporation into the software system (*1, 7*). In addition, its techniques, such as iterative component discussion, low-tech prototyping, storyboard prototyping and mockups, reduce the costs associated with the process of repeated prototype refinement.

Participatory software design acknowledges that, in addition to technical and problem-solving aspects, the design process also consists of the mutual learning and communication elements. It assumes that group work and rational discussion are essential for design and development because it is from them that mutual understanding, consensus, and agreement among stakeholders emerge (*4*). For example, when users describe their tasks, they identify data elements and communication functions that a system must support. After repeated discussions with various groups of users, the multiple system perspectives can be integrated into a composite information strategy that can later be implemented using a wide range of system engineering tools (*1*). Moreover, software designers can learn first-hand about the end-users' perspective of work and tasks.

This design strategy has been used both for in-house and commercial system development (*1*). In health/medical informatics, participatory software design paradigm has been employed in projects as diverse as building web-based collaboration tools for health care professionals (*1, 20-23*), developing a clinical-trial eligibility screening tool (*13*), and requirements gathering for a community health research training program (*17*). These studies generally describe specific projects on technology development and software/technology use in clinical practice and health care systems. The studies typically employ qualitative research methods and data gathering techniques to discuss and evaluate the data.

Investigations of the process of the participatory software design process are less common. While this approach to software design has been used in practice for quite some time, there have not been many attempts to formally describe its dynamics and characteristics. However, one such report identified the design objectives, processes, and ideologies expressed during participatory design of information systems in health care (*1*). While this study contributed towards the development of a clinical health information system in a specific primary care clinic, it also identified general themes, "voices" employed in communication, and social arenas within which the information systems design dialogue took place. In this case, the design themes were discussed with the voices of participatory design, clinical practice and engineering within the arenas of organization, workplace and society (*1, 21, 24*). This separation of design themes along the dimensions of voice[4] (Participatory, Practice, Engineering) and social arenas (Organization, Workplace, Society) was also used for the coding framework in the content analysis methodology in this study.

Describing participatory software design Sjoberg and Timpka (*1*) gave the major emphasis to a clinical-practical point of view. The design decisions were also closely related to societal-level participants and institutions (trade unions, national health care system and regulations, and similar). One interesting observation was that many times the social power of external organizations was used to influence the design of the system (*1*). For example, information about external computing resources that was only known to the technicians was used as leverage in the discussion of the design. In such a situation, an external factor overpowered the principle of equality in participatory design discussions. The authors thus recommended practical actions that would facilitate mutual communication and understanding among clinicians and technical designers and equalize access to information and discussions among the participants in the design team. One example of such a measure was organization of regular design meetings, guided by an agenda and following meeting rules for a "democratic dialogue" (*1, 21*).

It has also been suggested that it is necessary to pay attention to how participation is facilitated in the design process; in participatory approach to software design, the design group members are supposed to have an equal control over information and decisions (*1*). It was found that most often the

[4] an approach to communication that advocates or represents someone's policy or purpose

instructions for the design process are written for the professional software designers while few guidelines are available for direct use by the other participants (*1*). The authors thus recommended that special design instructions be prepared for non-professional designers in the group or that they be taught about the technicalities of the design process in some other way. This could enable the group members to relate practical-clinical questions to the design and increase the manner in which they influence the software development process.

B.5. Action Research

Research methodology used in this project was action research where the predominant research motivation is creating a positive social change (*25*). Its purpose is to solve real-world problems while contributing to new knowledge through reflections on the experiences (*17*). Participatory action research brings together theory and practice in a spiraling of steps, each of which is composed of some type of problem diagnosis, action intervention, and evaluation/reflective learning (*26*).

The researcher's functions are somewhat different from the traditional research roles of an objective observer or an external consultant. In action research, the researcher is an active part of the group, contributing expertise as needed (*26, 27*). This research approach therefore puts considerably more weight to participant's personal and professional values than the more traditional research methods; it also encompasses a much broader combination of technological, social, economic and political aspects of the interactions among the researcher and other participants of the project (*26*).

Most action research begins out of the intent to change or improve a situation. Outcomes of such projects are the processes themselves, as they develop; a project's purpose is to take systematic action in an effort to solve specific identified problems, to employ strategies that will enable all participants to collectively reflect on their problems, to formulate accounts and explanations of the participants' situation, and to collectively develop plans that may resolve the identified problems (*26*).

Often, an intellectual framework is included to guide the problem-solving process and extraction of lessons (*17, 25, 28*). The actions by the design group in this study were guided by the principles of a software development cycle tailored to web site design: the Pervasive Usability Process model incorporates iterative evaluation into all stages of design (*10*). The workflow of this software development approach is presented in Figure 1. The model is drawn as a linear sequence of activities, which reflects the reality that the project moved forward on a sequential schedule. It also helped the designer in facilitation of the group's discussions along a practical web production path. To implement the participatory software design paradigm used in this study, the model was amended by giving users an active role as full participants in all phases of development, including evaluation.

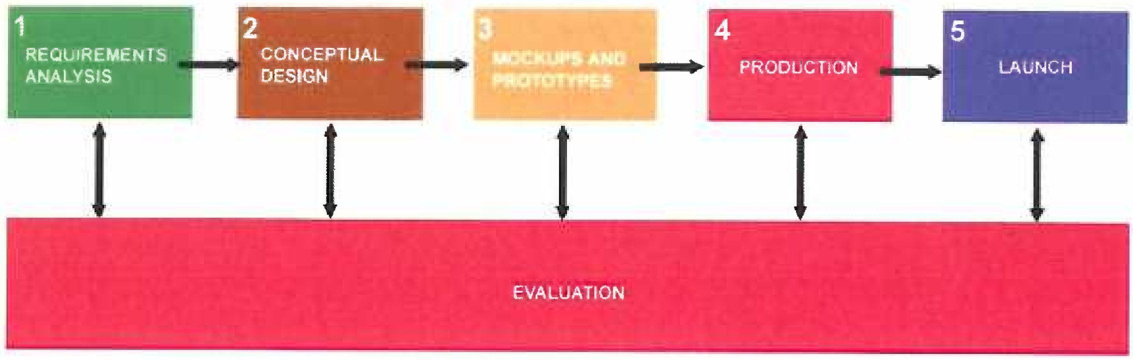

Figure 1: The Pervasive Usability Process (*10*). Evaluation is part of what makes the usability pervasive in this model; usability is also fully integrated into every stage of the process. While the model is drawn in a linear sequence, it is reasonable to expect some feedback among the web design stages. Moreover, the process handles multiple activities in parallel; for example, layout, content development, and technical proof-of-concept designs need to be explored simultaneously, albeit they might have differing time tables.

In this study, the iterative cycles of participatory action research lead the participants from evaluation of the existing web site, through the requirements analysis and conceptual design of the redesigned web site. They also provided a solid basis for further site development and identification of basic themes that will ultimately guide the evaluation of the success of the web site's redesign.

C. RESEARCH DESIGN AND METHODS

This study applied action research methodology to guide a process of participatory redesign of a web site for a basic science research laboratory. Qualitative data gathering and analysis included such methods as interviewing and content analysis, aided the group's discussion of the web site's redesign.

In this project, the activities involved a redesign of a web site were tailored to the requirements and needs of one basic science research laboratory and its members. It thus seemed appropriate to follow the principles of participatory software design and involve all eight users into the evaluation and redefinition of the laboratory web site. Participatory software design captured the specifics of this particular collaboration environment and incorporated them into the design specification. Moreover, since this study involved one designer[5] solely responsible for work on the software, this process enabled a more efficient incorporation of the software designer's perspective into the design specification. Since human and material resources for this study were limited, this approach also efficiently focused and organized the designer's efforts and materials toward the desired results.

Lastly, an effort was made to understand design objectives, processes, and ideologies as they are expressed in the initial stages of a web design project in a basic research setting. An analysis the group's discussion across "themes", "voices", "organizational" and "social arenas", similar to the above-mentioned

[5] The researcher in this study was also the sole software/technical designer in the design group. Following the principles of action research methodology, the researcher is an equal member of the action research group. The narrative thus interchangeably uses labels of "researcher" and "designer" to refer to the author of this project.

study from the primary-care setting (*1, 21, 24*), was be performed to describe the non-technical aspects of the web design experience. Relationships among various design voices (Participatory, Practice, Engineering) were described and their influence on the practice of participatory design process was investigated. The two dimensions of this approach to classification of the discussion themes are represented in Figure 2 .

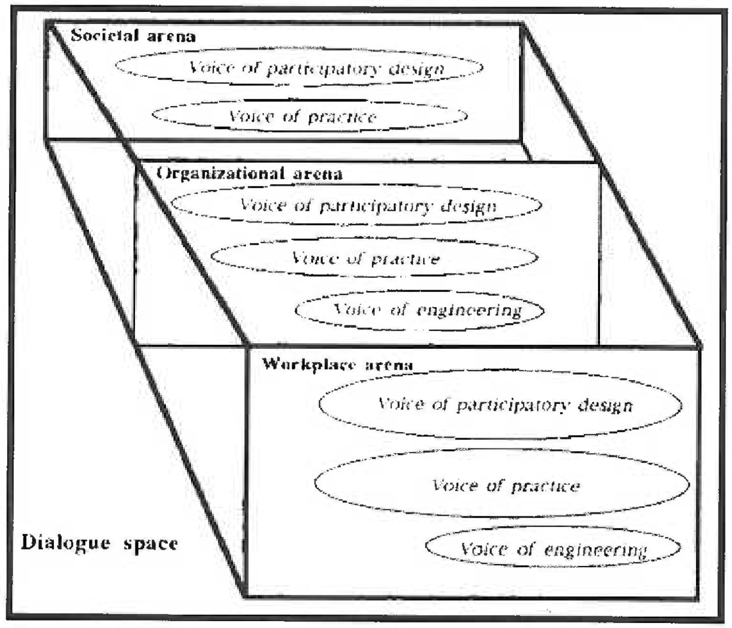

Figure 2: Dialogue space for analysis of group discussions (*1*). The topics are discussed in three arenas and with three voice within each arena. Note that there is no Voice of Engineering in Societal Arena, since no relevant constraints or requirements for the design project need to be discussed from this broadest, national and societal perspective.

For the purposes of this study:

- software = written programs or procedures or rules and associated documentation pertaining to the operation (*29*) of the participating research laboratory's web site and that are stored on the university's servers and/or local laboratory computers

- participatory software design = a team of people who represent the major stakeholders in a product design work together to create designs that reflect the way users will actually use the product in their own work (*30*). In this case, 8 laboratory members and the designer will work together.

C.1. Sample/setting

The web design group for this study consisted of nine members: the web designer and eight members of one research lab at OHSU: the laboratory PI, two Postdoctoral Fellows, one Senior Research Associate, three graduate students, and a Research Assistant. IRB approval and a formal participant consent statement were obtained prior to the commencement of the study (please see Appendices H.1. and H.2.). In accordance with the consent forms, the digital recordings and their transcripts will be destroyed upon completion of the research project. Therefore, full transcripts of the interviews and meetings could not be appended to this thesis.

The lab is directed by the Principal Investigator, but the research group holds weekly meetings where they share and discuss research results. Lab members had already expressed enthusiasm for participation in the redesign of their web site. Inclusion of all laboratory personnel in the web design development process ensured as complete consideration of problems and their solutions as possible. All lab members are familiar with the current web site, actively use its current functions and regularly supply information that needs to be updated.

Sjoberg and Timpka (*1, 21, 24*) emphasize that their studies of participatory design of information systems had their foundations in the societal and workplace settings, where equal opportunity rules are used in the design discussion. Since the group for this study consisted of members of a laboratory who are used to share opinions and discussing them in laboratory meetings and seminars, it was easier to facilitate and achieve equal participation in the discussion by all members of the group. Moreover, our group was within the size recommended by Sjoberg and Timpka (*1*). It was also expected that our design group would have a set and stable membership. Indeed, except for a longer absence by one of the Postdoctoral Fellows, all group members were present for all correspondence and interactions regarding the redesign of the lab web site.

The designer has been volunteering on various bioinformatics projects for this laboratory for the past two years and is thus familiar with the lab's research objectives. A comfortable working relationship had thus already been established between the designer and the lab members which was expected to help facilitate productive discussion and collaboration within the group. In addition, the egalitarian participation principles were presented to the lab members at a brief study start-up meeting. Sjoberg and Timpka have also suggested that the non-technical participants must be better informed about the guidelines for the design process in order to empower all group members to participate in discussion as equals (*1*). The participants of this study learned about the process and documents related to the information systems design (requirements, conceptual design) through the discussions in the group meetings, cooperative discussion and finalization of the design documents.

The designer contributed expertise and experience in web design and its process, programming, computer systems and knowledge of the web environment at the university. The designer also served as the main administrator and organizer of the study activities. The laboratory members added their vision for what their laboratory web site should entail, their knowledge of the functionalities of various informatics systems, and input regarding the specifics of their research environment and research area.

The study site (place of interaction) was primarily the laboratory and the adjacent PI's office. All lab personnel have their own desks and work benches within this space. Interviews and meetings were conducted either in the PI's office, the laboratory, or the conference room next-door.

C.2. Research Action Plan[6]

The process contained an iterative succession of research question/problem identification, data collection, data analysis and interpretation, and results sharing with the participants (Figure 3). These activities followed the web design process framed within the Pervasive Usability Process of web site design (Figure 1 and (*10*)). A diary of action research processes and activities was kept by the designer and self-reflective entries were written down frequently

[6] The data analysis strategies for the research steps and data collection techniques were guided by (*26, 31-34*).

in order to enable the researcher to reflect on group input and efficiently approach group work.

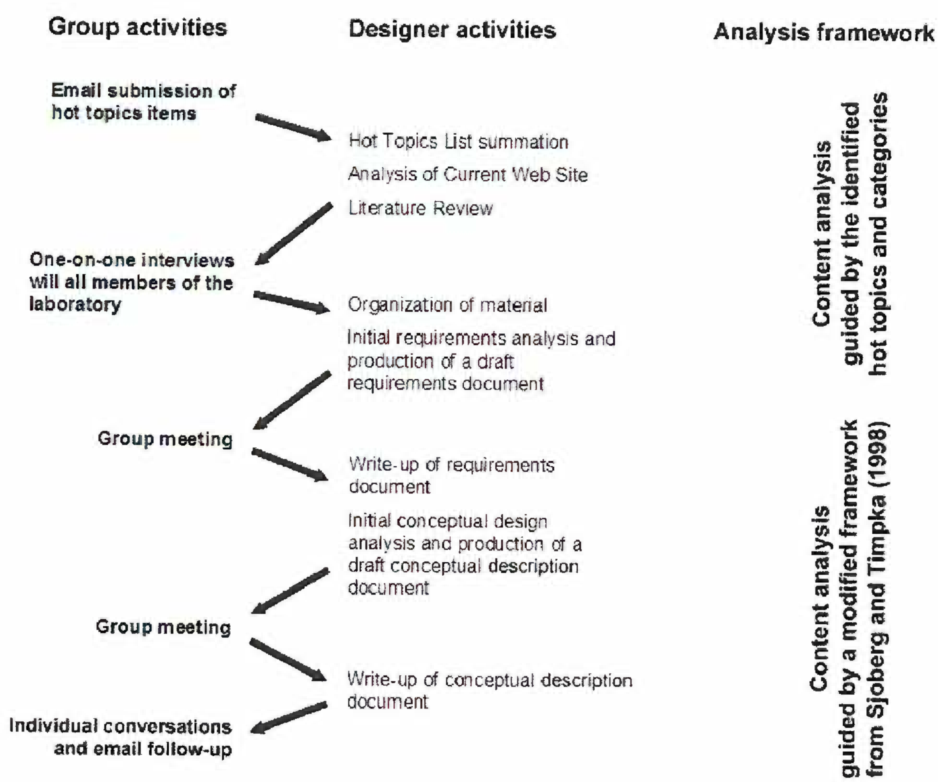

Figure 3: Action Plan for the proposed study. The group's input and discussion guided the designer's write-up of documents, preparation of materials for group meetings, and additional research into technical or theoretical topics. The initial analysis of material was guided by the identified hot topics list, and the group discussions were analyzed with a framework from Sjoberg and Timpka (*1*), modified for the research setting.

In addition to the planned sequence of design activities described below and represented in Figure 3, it was anticipated that impromptu discussions about the study would invariably occur since the lab members and the designer see each other on a daily basis in a professional capacity. The designer included notes about any such discussion into the research diary and incorporated them into the group discussions, when relevant.

In action research, a research question is usually generated collectively as the first research step (*26*). In this study, the basic research space had been determined ahead of time with preliminary discussions: the design group collaborated on determining the features of the new redesigned web site for the participating basic science laboratory. Detailed research questions and goals of the redesign surfaced through the initial formation of the hot topics list and the collaborative discussion of the laboratory's needs and requirements for the new web site.

The succession of research activities was as follows:

C.2.a. Generation of a "hot topics" list.

The group was asked to contribute in writing (paper or email) their ideas about potential web site changes and additions, or about the exceptionally useful features of the current web site. The group was asked to comment on the web site's current and desired visual identity, existing and missing content, and tools/functions that the web site should have or shed. Participation in this step was not mandatory, but it was strongly encouraged since it provided a head start on the various topics that are most relevant to the web site's users.

The designer went through the list of suggestions and made sure all were relevant to the purpose of the study. They were then sorted based on their category (visual identity, content, functionality), and summarized in a hot topics list.

C.2.b. Analysis of current web site

The designer produced a summary of the current organization, available functions, and visual identity of the lab's web site. The evaluation was organized according to established criteria for web design best practices (*35*). In addition, the identified hot topics items were compared to the current characteristics of the web site.

C.2.c. Literature review based on the identified hot topics list

Literature review was performed as needed, based on any new suggestions or to address questions raised by the group's suggestions.

C.2.d. One-on-one interviews with participants

The designer conducted interviews with all 8 lab members. The interviews were semi-structured, guided by the hot topics categories. This method of gathering information provided enough structure and relevant information in the interview records to allow for comparisons, while giving the freedom to explore general views or opinions in more detail. Probing questions were based on the hot topics list, relevant ideas identified from literature review, and on the assessment of the current web site. The interview guiding questions were assembled and reviewed for clarity by a fellow student.

Each interview lasted about 15-40 minutes and took place in the laboratory. A computer connected to the internet was available so that the interviewee was able to discuss and show the lab's current web site or examples of features/functions the site should have.

All interviews were recorded on digital audio media and verbatim transcribed by the designer. The responses were read and coded for various previously-proposed hot topics or new ones, identified in the interviews[7]. A coding framework based on the previously-identified hot topic categories was used for content analysis. This not only guided content analysis but also reduced analyst bias in analysis and coding.

The answers were sorted into the identified hot topic categories and presented in a summary table. Attention was also given to any potential disagreements among the interviewees' opinions. The coding and categorization was checked by an independent graduate student.

A summary capturing the essence of each broader hot topic categories was written and prepared for the initial requirements analysis (see Appendix H.3.).

C.2.e. Initial requirements analysis

This was performed by the designer in preparation for the meeting where the initial summary requirements analysis was then presented for discussion.

[7] Principles of content analysis were taken from Berg (*33*) and Titscher *et al.* (*32*).

A draft document included the target audience and target platforms, user goals, business goals, technical requirements, and similar elements of requirements evaluation. The evaluation also summarized the current web site, any similar web sites of interest, and alternative non web-based solutions to the identified problems.

C.2.f. Group meeting, prioritization of results and discussion

A meeting of all participants was held in order to share the designer's rough summary analysis of the gathered data, and to discuss the gathered information. The discussion was expected to draw out more than a mere explanation of already gathered information; as expected (*25*), it provided further context to the data and gave participants a chance to reflect on what they have themselves discussed among themselves.

From the action research perspective, the interview data and other notes were examined in relation to the potential improvement/addition to the lab web site. The designer facilitated the discussion and made notes.

The discussion was recorded on digital audio media and transcribed verbatim by the designer. The transcripts were used to characterize the communication in this participatory software design process; the discussion was analyzed with content analysis methodology (*32, 33*) within the coding frame used by Sjoberg and Timpka (*1, 21*), modified to fit the basic science research setting. The hot topics that had been previously discussed and identified, were the themes discussed with various design voices and within different social arenas(Organization, Workplace, Society). Any new suggestions for hot topics were also incorporated into the framework. Thus, the design themes were coded and sorted along the dimensions of voice (Participatory, Practice, Engineering) and social arenas. The adoption of coding framework for content analysis thus not only guided content analysis but also reduced analyst bias.

This approach was used to analyze the discussion that took place during group meetings. Classifications of the transcripts into the predefined coding framework were confirmed independently by a fellow graduate student.

C.2.g. Requirements analysis and requirements document write-up

This was completed by the designer, who produced a formalized document based on the discussion from the group's meeting (see Appendix H.3.).

C.2.h. Conceptual description of the web site

This was completed by the designer in preparation for the next meeting. The functionality of the product was drafted. The design was sketched out in an abstract level of specification without a specific layout or implementation scheme. Structure of the web site was drafted conceptually, as deemed most appropriate for the project at the time.

C.2.i. Presentation of requirements document to the lab, conceptual design discussion

A meeting of all participants was held in order to share the designer's rough summary of the gathered data, and to clarify the gathered information. Again, the discussion was expected to draw out more than a mere explanation of already gathered information.

From the action research perspective, the data and other notes were examined in relation to the potential improvement/addition to the lab web site. The designer facilitated the discussion and took notes.

The discussion was recorded on digital audio media and verbatim transcribed by the designer. Again, the verbatim transcripts were used to characterize the communication in this participatory software design process, as described previously.

C.2.j. Conceptual description documents write-up

This was performed by the designer, who produced a formalized document based on the discussion from the group's meeting.

C.2.k. Presentation of conceptual descriptions to lab, discussion

The conceptual design document was given for review to each group member for verbal/written feedback. Suggestions were used to refine the final conceptual design document.

D. RESULTS

D.1. Web Site Elements

Through the iterative problem identification/data gathering/evaluation process described in the previous chapter, the participants moved through the initial phases of web site design. The design team learned about the formal software design process, produced a requirements document for the redesigned web site and conceptually defined its functions, tasks and/or workflow. The study was designed to end at this stage of the design process[8].

Topics of interest that emerged through correspondence, one-on-one and group discussions were as follows (also see Appendix H.3. and H.4. for the Hot Topics Detail, the Requirements and the conceptual description write-up). These topics were evaluated and prioritized through the group discussions that were based, as planned, on the group's interests, discussion of current web site and contrast with a comparable lab web site[9], and technical/resource feasibility.

Current structure and functionality of the web site

Currently the web site is hosted on the university servers and uses database-driven technology (specifically, ColdFusion and Microsoft SQL Server infrastructure) to present information. The site is graphically simple, with a consistent button-style navigation on the left side of the page, geared towards

[8] Time permitting, the web site redesign project will continue in collaboration among the designer and lab members and an improved web site will be posted on the internet once completed.

[9] The design group suggested one web site belonging to a collaborator's academic research laboratory as an example of an appealing and useful laboratory web site.

relaying information, and contains more text than graphical images. The design conforms to basic web design standards, such as consistent header, footer information, navigation, contact information, uniform color and graphic design elements.

The site's main sections currently are: Lab Interests, People, Publications, ATP7B (Wilson's Disease Protein) Information, Copper Chaperones, Program Project Grant information page, Useful Links, and Tools. In addition, a password-protected section of the site ("laboratory intranet") contains PDF reprints of the lab's publications, unpublished data, and an inventory of the lab's available primers and protein constructs. Lab members access this information by logging into the web site with a unique username and password. This also gives access to a simple system for updating basic information on the web site (about lab members, publications, and useful links) independently of the web master. As reported by the lab members, they all use the web site for various information-seeking activities at least 3-4 times a week and are satisfied with the organization and quality of information on the web site. The least used feature on the web site is the system for updating the basic information.

The web site's audience are primarily the lab members, while other user groups include other researchers and collaborators, potential postdoctoral fellows and potential/current students, lay audience/clinicians/patients, funding agencies and grant reviewers (for more detailed discussion of user groups see Appendix H.4). During discussion, the group set the primary focus of the lab web site towards lab members, collaborators and other researchers, which guided the evaluation of the requirements and suggestions for the web site.

While evaluating and planning the web site, the group set the requirements topics in the following areas: adding new and enhancing existing tools on the web site; content additions and enhancements; and visual identity and visual features of the site (see Appendices H.3. and H.4.). The group also reviewed, evaluated and contrasted informative content of the only research laboratory web site that had emerged as an example of a "good" web research laboratory web site, and, consequently, discussed possible changes and additions to their own web site.

Adding new and enhancing existing tools (Functionality)

Review of current functional features of the web site concluded that all existing tools and features are useful and used by the lab members or other users and, therefore, none should be dropped during redesign. On the other hand, some enhancements were suggested, such as increasing compatibility of a molecular viewing applet across a wider variety of browsers and computer platforms (PC/Macintosh/Linux).

The group also brainstormed and evaluated suggestions for additional features for the web site. An essential requirement set by the group was making the web site more easily editable by all lab members to ease lab maintenance and additions of information and files. This implied the need for an implementation solution that would recognize different levels of users (visitor, lab member, collaborator, administrator) and consequently give/restrict access to information, data and shared files based on preset rights for the user categories. The users liked the simple "laboratory intranet" web pages.

Other features that were noted and evaluated as essential were a file repository (upload and sharing) with access restricted to lab members, and an efficient implementation of a web site search function within all posted information and shared files. Development of a new tool for listing the lab's primers and a visual representation of hybridization sites was set as a requirement, as well as addition of a few more links to useful third-party freeware bioinformatic tools.

Enhancements, Additions, Suggestions About Site Content (Informative Value)

The group discussed additions to the informative value of the web site and the most numerous suggestions and requirements pertain to this topic of discussion. Because the lab members and possible collaborators were determined to be the users to whom this web site will be geared, the suggestions sought to add informational value specifically for these two groups. Broadly, the group wished to add a more comprehensive breakdown of various aspects of the lab projects, with most important references of the field. Moreover, the group also requested additions to the list of third-party freeware bioinformatics tools and reference web sites, and some more common practical information and useful analysis results of the Wilson's Disease nucleotide and protein sequences. A suggestion stemming from the focus group discussion was also a new reference page where results of an automatic daily Medline literature search with predefined keywords would be posted, along with archives of daily results for a specific period of time.

Special attention was given to suggestions pertaining to lab management and research collaboration within the laboratory. A new section for posting lab events, meeting schedule, and similar, was proposed. Lastly, the group defined various files that they would wish to share via a new file-sharing repository in their intranet part of the site.

Some additions were also suggested to cater to the needs of other user groups, even though the priority of these additions was labeled as "optional" or "desired in the short-term". Suggestions ranged from obtaining permission from publishers to make PDF reprints freely available to anyone, starting a "learning center" with resources and lecture notes for the PI's current graduate lectures, presenting key discoveries in the field of the lab's research with their clinical relevance (geared more towards clinicians and patients, and funding agencies). In addition, the group suggested reorganization and redesign of the individual lab member's pages to include projects of current and former lab members, seminar posters and similar, which would promote laboratory member's academic achievements more openly.

Visual identity and visual features

Opinions regarding the visual presentation of the web site differed the most within the group. Some group members felt the layout and color scheme were satisfactory and sufficient while others suggested changes in colors or layout to “soften up the look and feel of the page”. No clear consensus was reached regarding the visual layout suggestions and the PI was turned to for final decision regarding the issue. It was decided that a thorough overhaul of the visual identity was not needed but that minor additions and changes would be evaluated later, at the stage of prototype evaluation. The group’s recommendations included developing a laboratory logo, and incorporating more scientific figures/illustrations and personnel photos into the web site’s pages.

D.2. Design Process

In addition to the software-related documents, the researcher also describe the broader social dimensions of this participatory software design experience. Similar to the Sjoberg and Timpka study (*1, 21*), an analysis of the group meeting recordings and of the produced design documents was used to identify “voices” employed in communication, and social arenas within which the information systems design dialogue took place (Figure 2). Per the requirements by the IRB reviewers, audio recordings and transcripts of the meetings used for this analysis are to be kept confidential and will be destroyed upon completion of the study. Therefore, full transcripts of the interviews and meetings could not be appended to this thesis.

Discussion themes

The design group meetings were based on seven discussion themes:

1. research practice
2. technical system design
3. hot topic category 1: Enhancements and Additions to Site Content
4. hot topic category 2: Adding new and enhancing existing tools
5. hot topic category 3: Visual identity and visual features
6. cooperation within laboratory
7. the redesign project (management and logistics)

Specific topics ranged from abstract issues such as presentation of the laboratory web page to collaborators and other researchers, possible impressions of the web page by potential post docs and students, to more specific subjects like steps in protein cloning or primer design.

Discussion arenas

Design discussions took place in three arenas, which show how the design process was related to the social environment:

1. workplace arena (references to colleagues, organizational changes within the university's technical group, and the design group itself)
2. organizational arena (references to the department administration and other parts of the university, especially ITG[10] and WebAdmin[11])

[10] Information Technology Group, the university's IT department

3. societal arena (references to research area of copper transport research, funding agencies, describing local, national and international conference levels)

Most discussion topics regarding the desired and required features of the web site fit into the workplace arena:

> Excerpt (workplace arena):
> *Research Assistant:* Then from the practical point of view we should probably have a central repository of all the primers...
> *Research Associate:* ...primers, with the numbers...
> *Post Doc:* ...and freezer boxes...
> *PI:* We really need to do that...

> Excerpt (workplace arena):
> *Research Associate:* I think if we could build the whole database of all plasmids we have in the lab, and we have sequences of all the primers, that would make it easy to do an alignment search through the whole plasmids and find out what plasmid and where exactly it binds. ...That would be really helpful.

while the production and resource constrains for the project mostly came from both the workplace and organizational environment:

> Excerpt (workplace arena):
> *PI*: I think we should move this into a sub-button [on navigation bar], because right now we are definitely interested in continuing this research but we don't have enough information yet to make it a separate category.

> Excerpt (workplace arena):
> *Research Associate:* I think that's a bit of a separate issue, I mean, organizing the freezer, and I don't think it's a part of the web design project.

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[11] Web Administration team, coordinating the use, development and maintenance efforts of the university's web servers

Excerpt (organizational arena):
Designer: ...because the university has put a lot of rules on the web designers, the way that they just operate the web infrastructure, I don't have direct access to the databases...

Societal arena was the least-represented context for the discussions:

Excerpt (societal arena):
Post Doc 1: Something that would get the general public more interested might be good, since we are kind of dependent on the general public for money, in a roundabout way.

Discussion Voices

Discussion themes (within these three arenas) were analyzed within the framework of three voices as described by Sjoberg and Timpka ((*1, 21*); see Figure 2 for reference). These were identified by the differing ways they were used during meetings (approach to storytelling and approach to power):

1. Voice of Participatory Design (coordination, consensus, and comparative stories)
2. Voice of Practice (work and challenge stories from research experience)
3. Voice of Engineering (technology explanations, theoretic anecdotes)

Voice of Participatory Design was used by everyone to coordinate discussion and move the conversation toward group consensus. The group members talked about suggestions and evaluated alternative solutions. This was the most often used voice and moved flexibly through all three discussion arenas as it facilitated group decision-making (for more examples of this voice see Appendix H.5.):

> Example (voice of participatory design, workplace arena):
> *Grad Student 1:* Lay people are looking mostly for medical stuff, and there's already web sites out there that have medical information.
> *Research Assistant:* Right, maybe we could just have a link or two to some of the best medical information web sites.

As the group coordinated discussion and moved through various decisions, it became apparent that the PI used the Voice of Participatory Design in a facilitator and tie-breaker capacity. The group did not reach many instances in discussion where opinions were just too different to reach a decision. However, when the group opinions were split, or the budget or laboratory resources were discussed, the made a strong facilitating statement or made a final decision that solved disagreeing opinions. In a couple situations, group members even physically turned to her, making eye contact with her and giving her a chance to speak and share her opinion on the controversial matter. This happened only once or twice, but it clearly showed that all design group members recognized the PI's final decision authority regarding the lab. For example, opinions about the standards and requirements for the visual appearance of the web site were the most diverse and the group reached a consensus through compromises and a few decisions made by the PI. Other examples:

Example (coordination):
PI: We really should do this and I encourage everybody to help with information because you know the coding that's what [Designer] will be responsible for but we cannot make her responsible for collecting information so that should come from us.

Example (coordination):
PI: Again, I think people should identify what they think are useful links and contribute...

Excerpt (consensus):
PI: In some way I would like to have this main category (button) but in reality somebody has to fill this category with information.
Designer: So later on you could always add it whenever you'd want... when you'd have time to write more.
PI: Right. That's what I'm thinking.

Voice of Practice was applied by all group members equally and was used to communicate working procedures and practices and support design suggestions with examples from their research practice (for more examples of this voice see Appendix H.5.):

Example (work stories from research experience):
Research Associate: Remember we used to have access to Vector NTI and that was very nice and it's a very good program. But then we lost it and we have never been able to restore this access because they changed servers. So now most people in the lab use the free bioinformatics links... which is far away from Vector NTI.
Designer: I use the Stanford Servers every time I make alignments. Decypher Server. It's never down.

Example (challenge stories):
Designer: However because the university has put a lot of rules on the web designers, the way that they just operate the web infrastructure, I don't have direct access to the databases and it's really frustrating sometimes when I make changes that I need to sometimes wait 2 or 3 days before I can work with it.

Voice of Engineering was mostly employed by the designer who used it in a more consultant capacity (for more examples of this voice see Appendix H.5.). The designer provided the needed technical input into the discussion to help evaluate the ideas and suggestions from the perspective of feasibility, priority and required resources:

> Example (technology explanations):
> *Designer:* ... technology which is called database-driven web sites. Which means that you have a skeleton of the pages on the server but the content is actually really stored in a database... and this is one of the reasons why... this feature does exist but not many of you have used it... you can log in to your web site and you yourselves under your username can actually change certain things that I gave you access to.

E. Discussion

The products of this study were two-fold. The "Action" part of the action research project identified the required and desired features of the redesigned web site and produced the web site design documents. This part of the project was successfully concluded with the publication of the design documents and their distribution among the interested parties (see Appendix for details). The "Research" part of the research project produced data to characterize the participatory design process in the research laboratory setting. This part of the research project is especially novel because previously the participatory software design process has not been studied in an academic research laboratory setting and has not addressed the development of bioinformatic tools.

E.1. Web Site Elements

The discussion regarding the web site redesign and features was guided heavily by the needs and interests of user groups which were identified and ranked by importance by the design group. The site's purpose was defined as primarily a source of information for the lab and other researchers in the field of Cu transport research. The most broadly discussed topics were suggestions about improving the informational value of the web site for the lab members – either through various reference materials and data repositories or through addition of new bioinformatic analysis tools. The laboratory PI and other lab members wish to make the web site into a primary reference point for themselves and other scientists in their research area.

However, one of the laboratory's limitations for producing such a site were available technical expertise and human resources. While the laboratory brings together personnel with biochemical, biophysical and molecular biological expertise, and thus focuses on research and successfully competes for grant funding, it is dependent on their Department to provide technical and web design help. Such dependency of research groups on shared part-time technical, web-design and bioinformatic help is common in basic science research. This guided the group's decisions about which features were essential/optional/desired in the long term, when available resources for implementation were also considered and weighed. For example, it influenced the essential requirement that the web site have a user-friendly web-site-editing capability which would decrease the lab's dependency on a non-lab member web master.

Moreover, more attention was given to the planning and suggestions to improve the depth and quality of summaries of the lab's projects, research interests and useful analyses regarding the Wilson's disease protein and other copper-transport-related proteins. In contrast, it was decided that links to existing tools for bioinformatic analysis on the web were sufficient, and that limited resources should not be used for incorporating those into the web site as stand-alone tools and maintaining them afterwards. This reflects the nature of basic science research and bioinformatic analysis, where scientists choose from a myriad of freeware, open-source tools. Pooling individuals' bookmarks was sufficient as lab members would continue to use them independently and information sharing was prioritized over seamless integration of these tools into the web site. Similarly, the quality and comprehensiveness of the scientific information offered of the web site outweighed in priority most suggestions for visual redesign of the web site.

The PI of this research laboratory stood out from other scientific users of the web site (other lab members and collaborating researchers) as the one with the most diverse needs for the information and tools on the web site. This reflects various responsibilities the PI carries, from research, to teaching, grant writing, grant reviewing, coordinating research projects with collaborators, and lab management. The PI is the only identified user who has an interest and a stake in each functional and contextual part of the web site. All laboratory's activities lead back to the PI, who was then, effectively, one of the most important scientific audience members and members of the design group.

In general, the proposed categories for the web site contained more common elements (such as information about the lab members, publications, collaborative efforts within a Program Project Grant, and basic information about the lab's research interests), and those more specific to a gene-centric web site hosted by an academic research lab. A section of the web site was planned and organized so that it would pool existing laboratory and external information about the genes of interest. The section with useful web links was expanded to encompass research resources and references to funding opportunities and collaborators. More emphasis was also given to the requirements describing the laboratory's protected "intranet pages" and information that the lab would like to share internally. Lastly, in accordance with the lab's requirement to more actively participate in editing and updating the web site, an administrative section of the web site was also discussed. Conceptual description of the web site's structure is briefly sketched out in Appendix H.5.

As previously mentioned, the produced documents could be potentially very useful for other similar gene-centric web site design projects. They will thus be freely shared with the study participants, OHSU's Information Technology Group and other interested laboratories.

E.2. Design Process

It was anticipated that a comparative evaluation of the relationships among design voices and of the group members' participation might shed light on how different voices are used by individual participants in discussions to participate/gain leverage in decision-making. Firstly, the conversation about the web site revolved mostly within the workplace and organizational arenas, which shows the design group's priorities and goals for the web site. Most of requirements and constraints were drawn from their workplace and the immediate departmental and university environment. This seems consistent with the priorities the group set for the web site, which should primarily serve the needs of the lab members and their immediate collaborators.

Interestingly, this research project's meeting discussions encompassed seven discussion themes - the four previously identified during a design of a clinical software tool (*1*) (research practice, technical system design, cooperation within laboratory, the redesign project itself), and adding the three hot topics categories specific for this web redesign project (new features, content, visual identity). This suggests that the participatory software design process itself revolves along similar lines and topics regardless of the project setting (clinical vs. research). One could therefore more confidently conclude that the process itself is an appropriate method to direct the design of software systems in both of these settings.

Voice of Engineering was mostly employed by the designer who used it in a more consultant capacity. This might be a consequence of the fact that the designer was the only member of the group who had formal technical training and thus took over the role of an educator regarding some aspects of web design and web site implementation. In contrast to bigger software design projects where the expertise of group members is more diverse, the design group reflected the specifics of a project for an average-size research group, which normally does not include a full-time bioinformatics specialist. The design group therefore relied more heavily on the designer to explain technical concepts and help with evaluation of alternative technical solutions. This result confirmed a previous study, where voice of engineering was also given mainly a consultative position in the design project that was set in a health care (clinical) setting (*1*). Moreover, the fact that group members have experience using the existing web site and are quite computer literate, required less educational efforts on the part of the designer to level the knowledge and discussion field among all users. A group of basic scientists of different ages and computer user experience might have required more education efforts on the part of the designer.

As previously mentioned, Voice of Participatory Design was used by everyone, most often and moved flexibly through all three discussion arenas, facilitating group decision-making. It also seemed to have a similar function as previously characterized(*1*), finding that the Voice of Participatory Design appeared as an adhesive in the dialogue and was used by the design group to balance the other two voices. This is not surprising, since the Voice of Participatory Design facilitates consensus building. Moreover, Voice of Practice was applied by all group members equally and was used to communicate working procedures and practices and support design suggestions with examples from their research practice. This reflects the collaborative nature of the lab members' work and the lab's work atmosphere.

Opinions were shared without noticeable hesitation and regardless of job position in the lab. In addition, the group moved through discussion, evaluation and decision-making without significant delays or conflict and successfully fulfilled their working goals. Consequently, one can suggest that participatory software design principles fit well into the communication culture of the basic science researchers and is a productive method for framing the work of a software design team.

There was, however, a unique characteristic that was observed regarding the interactions within this design team. While the group followed the principles of participatory decision-making, it also acknowledged the PI's role as the ultimate referee and decision maker. In the research laboratory (and, consequently, within the design group), the authority of the PI was felt and the group turned to her for final tie-breaker resolution of conflicting opinions. As previously mentioned, her authority was called regarding any factors constraining the implementation of the redesigned web site (time, budget, and other resources). Such tiebreaker role spontaneously assigned to the PI consequently facilitated an even smoother flow of discussion and therefore complemented the participatory software design methods. This contrasts to any design group that can be formed in a clinical setting, where, due to the nature of organizational relationships, the power relationships are not as clearly assigned. Sjoberg and Timpka (*1*) suggest in their research that a conflict resolution and referee mechanism should be agreed upon and in place before the design group begins with their work. One can conclude that the culture of the basic science research laboratories already assigns highest authority to the PI. A similar conclusion has also been found previously in a study assessing bioinformatic tasks and workflow within an academic research laboratory (*36*). Again, it seems that a specific characteristic of the research setting and culture makes participatory software design a potentially productive method for a software design project.

E.3. Limitations of the research project

There are two limitations that need to be considered with respect to this study. First, it was limited by time and scope to the initial steps of the web site redesign process. The characterization of the group interactions therefore were based on only two group meetings. A more detailed analysis of the voices, their relationships to consensus and power, and of the discussion arenas would have been possible had the study followed the design group further along the phases of the software usability process (showed in Figure 1). This research, however, sought to determine whether participatory software design was at all a feasible approach to web site design in a research setting and the results, as discussed, indicate that it potentially can be, warranting further research.

Second, the requirements identification and proposed solutions reflect the availability of resources and production constraints related to this web redesign project in this research laboratory. The basic themes and the content/functional categories identified in this thesis project reflect a basic science research environment, and can thus help direct other web design projects for research lab web pages. However, the actual proposed solutions and the implementation choices will differ from a laboratory to laboratory based on the available resources, the PI's personal preferences (to a certain extent) and the organizational/workplace constraints that the particular laboratory faces. Since studies of the feasibility and characteristics of the participatory software design process in health care and research setting are less common, such research would bring important insight into this form of collaborative software design approach and group collaboration.

E.4. Future Research

The conclusions of this study could be further researched along the dimensions of the usability web design process itself and the diversification of the various research groups that could form participatory design groups. This project's design group will continue its work and collaborations in its desire to produce an improved, redesigned home page for this research laboratory. The study could be improved and research conclusions further explored if the study was expanded scope- and/or time-wise and would follow communication for the duration of the whole usability web design process (as described in Figure 1). This would show how the participatory approaches to software design are useful in other stages of web design, especially in the "mockups/prototyping" design phase which traditionally (*3, 7, 10*) requires user input and evaluation to be successful.

In addition, since there still are variations in the resources, size and specific lab characteristics across research laboratories in basic science, further projects applying and evaluating participatory software design in a research setting would contribute to the evaluation of participatory software design methods. They would also further illuminate the functional and conceptual specifications related to development of gene-centric web sites for research laboratories.

F. Conclusion

This study has (i) produced requirements and conceptual descriptions for a gene-centric web site, and (ii) described and characterized the participatory software design process as it was experienced during the initial stages of a basic science laboratory's web site redesign. All group members contributed to the web site redesign process.

The produced documents could be potentially very useful for other similar gene-centric web site design projects. The requirements, functional specifications and conceptual description of the web site are included in the Appendix. They will be freely shared with the study participants, OHSU's Information Technology Group and other interested laboratories.

Following the principles embedded in action research, the results of this study were/will continue to be shared freely with the participants. The design itself of this research study includes continuous sharing of information with all participants. Hardcopies of the software design documents and of the final thesis write-up will be given to the laboratory's PI. The laboratory members will also have full access to the development versions of the web site on the staging server. Lastly, it is anticipated that all study participants will continue to collaborate with the designer, as the design project continues through prototyping and eventually reaches the go-live of the new redesigned web site.

In addition, the study also attempted to characterize the participatory software design process experience in terms of themes, design voices, and social arenas within which the software design discussion takes place. As anticipated, the study showed how social aspects of the design process influence the discussion and products of the group work. The most interesting observations here were the influence of the research laboratory communication culture apparently has on the dynamics within the design group. While the laboratory members (design group members) are used to collaborative group discussions, the dynamics of the group communication also reflected the important role the PI has within the research laboratory. This reflects the biggest difference between the design groups in clinical and research settings and made the participatory software design group communication more efficient.

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H. APPENDICES
H.1. IRB RESEARCH STUDY CONSENT FORM

IRB# 8326

Protocol Approval Date: 8/23/04

OREGON HEALTH & SCIENCE UNIVERSITY

Consent Form

TITLE: **Participatory software design processes in a basic science research setting: Planning of a web site redesign for a research laboratory**

PRINCIPAL INVESTIGATOR: Christopher Dubay, Ph.D. (503) 494-2116

CO-INVESTIGATORS: Tina Purnat, B.A. (503) 494-8632

PURPOSE:

You have been invited to be in this research study because you are a member of the Dr. Svetlana Lutsenko's laboratory.

You have already consented to participate in a research study because you agreed to participate in the software design group evaluating the Lutsenko Lab web page. During this research project you will be audiotaped. The purpose of form is to obtain your permission to use the audiotapes (in digital format) for research publications.

If you agree to join and do not withdraw later, you will be in this study for up to 4 months.

PROCEDURES:

You will be audiotaped during a one-on-one interview and three subsequent group meetings. The group discussion will focus on the current Lutsenko lab web site and features you think should be omitted or included to improve it. Transcripts of all three meetings will be used for analysis of the characteristics of the group communication and decision-making, and will be reviewed by the group once completed.

BENEFITS:

You will not personally benefit from being in this study. However, by serving as a study participant, you may help us learn how to benefit the Lutsenko laboratory and biomedical researchers in the future.

ALTERNATIVES:

You may choose not to be in this study.

CONFIDENTIALITY:

We will not use your name or your identity for publication or publicity purposes.

The digital audio files and transcription text files will be kept on a password-protected laptop, and will be erased once the study is completed. Any paper records of the transcripts will be shredded and disposed as confidential materials. Only the Principal Investigator and his staff will listen to the recordings for the purpose of transcription.

COSTS:

You will incur no costs by participating in this study.

LIABILITY:

The Oregon Health & Science University is subject to the Oregon Tort Claims Act (ORS 30.260 through 30.300). If you suffer any injury and damage from this research project through the fault of the University, its officers or employees, you have the right to bring legal action against the University to recover the damage done to you subject to the limitations and conditions of the Oregon Tort Claims Act. You have not waived your legal rights by signing this form. For clarification on this subject, or if you have further questions, please call the OHSU Research Integrity Office at (503) 494-7887.

PARTICIPATION:

Tina Purnat (503) 494-8632 has offered to answer any questions you may have about this study. If you have any questions regarding your rights as a research subject, you may contact the OHSU Research Integrity Office at (503) 494-7887.

You do not have to join this or any research study. If you do join, and later change your mind, you may quit at any time. If you refuse to join or withdraw early from the study, there will be no penalty or loss of any benefits to which you are otherwise entitled.

You will be given a copy of the signed consent form.

SIGNATURES:

Your signature below indicates that you have read this entire form and that you agree to be in this study.

____

Study participant *Date*

____

Study PI/person obtaining consent *Date*

H.2. IRB Digital Media Consent Form

IRB# 8326

Protocol Approval Date: 8/23/04

OREGON HEALTH & SCIENCE UNIVERSITY

Media Consent Form

TITLE: Participatory software design processes in a basic science research setting: Planning of a web site redesign for a research laboratory

PRINCIPAL INVESTIGATOR: Christopher Dubay, Ph.D. (503) 494-2116

CO-INVESTIGATOR(S): Tina Purnat, B.A. (503) 494-8632

PURPOSE:

You have already consented to participate in a research study involving the software design group evaluating the Lutsenko Lab web page. During this research project you will be audiotaped. The purpose of form is to obtain your permission to use the audiotapes (in digital format) for research publications.

PROCEDURES:

You will be audiotaped during a one-on-one interview and three subsequent group meetings. The group discussion will focus on the current Lutsenko lab web site and features you think should be omitted or included to improve it. Transcripts of all three meetings will be used for analysis of the characteristics of the group communication and decision-making, and will be reviewed by the group once completed.

RISKS AND DISCOMFORTS:

Because this will be a group project in which the materials from the interviews and group meetings will be used by the group to collectively make decisions (and the transcripts will only be accessble to the group members), no anonymization of transcribed data will be performed. The audio and text files will be kept on a password-protected laptop owned by the PI, and will be erased once the study is completed. Any paper records of the transcripts will be shredded and disposed as confidential materials.

BENEFITS:

You will not personally benefit from participating in this study. However, by serving as a subject, you may contribute new information which may benefit the Lutsenko laboratory and biomedical researchers in the future.

ALTERNATIVES:

You may choose not to participate in the study at all.

CONFIDENTIALITY:

The digital audio files and transcription text files will be kept on a password-protected laptop, and will be erased once the study is completed. Any paper records of the transcripts will be shredded and disposed as confidential materials. Only the Principal Investigator and his staff will listen to the recordings for the purpose of transcription.

COSTS:

You will not be charged for the use of the audiotapes nor will you be paid for allowing us to use them.

LIABILITY:

The Oregon Health & Science University is subject to the Oregon Tort Claims Act (ORS 30.260 through 30.300). If you suffer any injury and damage from this research project through the fault of the University, its officers or employees, you have the right to bring legal action against the University to recover the damage done to you subject to the limitations and conditions of the Oregon Tort Claims Act. You have not waived your legal rights by signing this form. For clarification on this subject, or if you have further questions, please call the OHSU Research Integrity Office at 503-494-7887.

PARTICIPATION:

Tina Purnat, (503) 494-8632, has offered to answer any other questions you may have about this study. If you have any questions regarding your rights as a research subject, you may contact the OHSU Research Integrity Office at (503) 494-7887.

You do not have to join this or any research study. If you do join, and later change your mind, you may quit at any time. If you refuse to join or withdraw early from the study, there will be no penalty or loss of any benefits to which you are otherwise entitled.

SIGNATURES:

Your signature below indicates that you have read the foregoing and agree to permit this use of your photographs, videotapes, or audiotapes. You will receive a copy of this consent form.

____

Study participant *Date*

____

Study PI/person obtaining consent *Date*

H.3. Identified Hot Topics and Suggestions

Topic Area 1: Functionality – New and existing tools

- add search feature – to search across shared information
- make web site editable but lab members for site maintenance
- make it more compatible with Mozilla, Safari and Explorer on Mac
- implement an easy way of uploading and managing files for sharing
- fix/add PDF viewing on the page itself to be compatible cross-platforms
- add a list of primers with a link/map to where the primers hybridize
- add an alignment program that is user-friendly (protein and DNA alignments)
- add a tool that presents primers and maps where one can use it in the AA sequence
- tool for conversion of AA sequence into nucleotide

Topic Area 2: Content

2.1. researcher/lab related

- add links to freeware online tools for manipulation of protein and DNA sequences
- add useful links to info about immunofluorescence, electron microscopy information
- ATP7B alignment might be more useful to add smaller groupings of sequences in alignments (mammalian, prokaryotic, etc)
- add nuclear sequence of the protein

- add pubcrawler or something similar– automatic search of medline for new articles, evolving page with new research papers from medline, daily, furnish general search terms, all could submit buzz words
- catalog of genetic, clinical, structure/function information on WNDP and Cu chaperones, add references to lab for other people's work
- add a brain or kidney area to the web site;
- share gene array data

2.2. for lay/non-lab audience

- "learning center" – to post Lutsenko lectures and teaching materials/links
- could PDFs of publications be freely shared?
- add more personalized information to lab members' info pages (photo, research projects, education, email, interests), projects for current and past members, Bjorkman lab also has images of seminar posters
- make more personable addons – quotes from people, thoughts on topic or on science, photos
- revise research directions
- acknowledgement of funding sources
- data from key discoveries, paper figures
- Bjorkman laboratory web site also has: lab responsibilities, living here - shuttles, movies, weather, housing etc, maps and driving directions

2.3. lab management /sharing (intra/extranet)

- "lab events" – information about group meetings, science conferences, thesis defenses, etc
- protocols (some could be public)
- main important figures, repository of PPT slides
- share endnote libraries
- share produced models (PDF files)
- inventory of plasmids, expressed protein constructs

Topic 3: Visual identity and visual features

- several people said they liked the visual identity, that it is simple in navigation and is not distracted by loud colors or features
- add a logo or some image on the main page (Cu transport schematic or protein structure)
- change color scheme (greys or blues)
- soften up the lines, the page is too plain- looking
- maybe add a 2-D photo as a background of the page to soften up the visual display
- update lab photo
- update footer, present interactive features better

H.4. Requirements and Conceptual Description of the Lutsenko Lab Web Site

1. Audience

The user groups for this web site, with somewhat unique demands are:

- PI
- lab members
- collaborators/other researchers in the field
- prospective students
- lay audience/clinicians/patients
- granting agencies/grant reviewers/grant managers

The most important audience for the web site are all lab members and the lab's collaborators along with other researchers in the field. They set the tone for the presentation and organization of the web site.

Although lay audience/clinicians/patients already visit the site and email the PI with clinical questions, this group of users has more specific clinical information demands which can be the least satisfied with a research-information-oriented web site.

2. User goals

This web site is primarily research-scientific in nature.

- users expect clear and easy navigation through the information
- graphic identity is less important than quality of data presented

It provides information about a disease and a disease gene and should aid in analysis of information posted.

- PI wants to present the lab's research and projects related to the disease and gene, along with references; most important third-party references about the relevant research areas and links to outside resources; possible protected sharing of information with collaborators, if necessary; presentation of teaching aids, lectures and relevant other teaching material and a space for interaction with current students
- lab members want easy access to organized information about their particular research area of interest, along with useful links to most often used bioinformatic tools; clearly present their research interests and role on projects; post basic CV information on the web
- collaborators/other researchers in the field want organized and relevant information about the gene and disease, with simple access to the lab's and outside information and bioinformatic resources
- prospective students and lab members want information about the lab, the lab's research goals, projects and accomplishments, and a sense of the lab's work and collaborative atmosphere

- lay audience/clinicians/patients want more clinically-relevant information, how the lab's research is geared towards the development of therapeutics
- granting agencies/grant reviewers/grant managers want an overview of the lab's research directions, a sense of scientific rigor and productivity of the PI and the lab

It makes available tools to aid in some basic lab management and information sharing among lab members. This is an expectation and a need specifically relevant to the PI and other lab members:

- they want a means to easily exchange files of various formats for scientific presentations, papers, talks, data
- they want a means of sharing basic lab-management related information such as schedule of meetings and lab presentations, plasmid and protein construct libraries
- they want a simple, secure way of sharing research data of various projects, either in progress or not yet published

It presents basic information about the lab, current and former lab members and their role on the project.

3. Business goals

The value of this web site can be assessed based on the consistent use of the web site by the lab members, the lab reputation and valuation by other researchers and the rest of the public.

The redesign, additions and revision of the web site will make the web site more in-tune with the needs and expectations of the laboratory members and other potential users.

4. Usability objectives

The lab members are likely to use the web site for reference every day. Other groups of users will possibly come to the site less frequently. Based on this, the following required usability objectives were set:

Category	Specific Objectives
Learning time/task time	• Users will be able to use this site the first time without any training. • First-time users will be able to find their topic of interest within two minutes of visiting the site; expert users (5 or more visits) will be able to find a topic within 30 seconds.
Number of errors	• Users will not visit more than three incorrect pages (on average) in completing a task. • Users will make no fatal errors at least 99 percent of the time (such as entering an incorrect plasmid name or

Category	Specific Objectives
	sequence information).
Subjective impressions	• On a scale of 1 (really appealing) to 7 (really unappealing), users will rate the site at least a 2.5.
Accomplished tasks	• At least 75 percent of lab members who start an information search will complete the task. • At least 95 percent of users who complete their credit card information will complete a purchase.
Revisits	• At least 50 percent of registered users will return to the site at least once per week.
Navigation	• The site will provide clear navigation which will be indicated with at least two different notations of location within the site. • The user should be able to get to any page within three clicks.

5. DESIGN CONSTRAINTS

Design team:

All technical and graphic design work will be performed by the designer/author of this thesis.

All design decisions, prototype evaluation and similar, will be coordinated and discussed within the software design group, as defined in this thesis.

Budget:

The budget and budgetary decisions for this project are dependent on the PI. The requirements summarized in this document were proposed, evaluated and prioritized taking into account the lab's basic budget priorities. Further design decisions and their impact on the project cost will be discussed with the PI, as needed.

Most of the expenses will be associated with acquiring server space and domain name. Coding and design effort will be volunteered by the designer.

Rough timeline:

The web site redesign and all required features can be developed and ready for the design group review 4-6 weeks after the beginning of coding and procurement of proper server space.

Target platforms and their technical limitations:

All features and tools on the web site have to function in Microsoft Internet Explorer and Mozilla Firefox for PC, and Microsoft Internet Explorer 5.0+, Safari and Mozilla Firefox on Macintosh. There is more leeway in cross-platform compatibility of the visual design elements.

Hardware and system software:

The web site requires a server offering the latest stable versions of PHP, Unix, and SQL. Alternative hosting solutions are the university web servers or a commercial server. The design group has decided to implement the redesigned web site on a commercial server, with its own domain name for the web site.

These requirements are sufficient for implementation of the Mambo Server content management software (www.mamboserver.com, www.mamboforge.net). This is an open-source system which enables implementation of all requirements set by the design group except for the plasmid database and plasmid mapping tool.

A basic project constraint/priority matrix is as follows:

Dimension (1-low priority; 2-medium; 3-high)	*driver* strongly aligned with project success	*constraint* within which one must operate	*degree of freedom* you can adjust within some stated bounds
Schedule			visual redesign and essential updates/addons should be implemented by mid-summer 2005, others by order of importance
Features		All essential features should be fully implemented	
Quality		Most lab members must express liking and acceptance of the web site	
Staff	design team includes the whole lab, while the implementation and coding will be performed primarily by one person		
Cost		Solutions and associated cost should follow Svetlana's instructions	

6. STRUCTURAL/FUNCTIONAL SPECIFICATIONS

6.1. USER GROUPS

The web site must provide the capability to form the following hierarchical user access groups with different access authorities to the web site.

6.2.1. Lab members

- This group must be able to add, modify, and delete all content and graphics to the web site.
- This group must be able to add, modify, and delete all digital media files to the web site.
- This group must have access to the private part of the web site ("intranet").
- This group must be able to search within protected and public pages and digital files across the web site.
- Membership in this group must require registration and activation of the user account by an existing lab member.
- This user group must have authority to confirm, modify and delete content and files added to the web site by collaborators user group.
- Users should be able to choose and change their own password.

6.2.2. Collaborators

- This group must be able to add content and graphics to the web site.
- This group must be able to add digital media files to the web site.
- This group must have access to the private part of the web site ("intranet").
- This group must be able to search within protected and public pages and digital files across the web site.
- Membership in this group must require registration and activation of the user account by an existing lab member.
- Users should be able to choose and change their own password.

6.2.3. Anonymous users

- This user group does not require registration and includes all visitors to the web site that do not have a user account.
- This user group must see only the public part of the web site, including content pages and digital files.

6.2. INTRANET

- The intranet must be accessible and editable only to the lab members, and also accessible to the collaborators user group.
- By logging into the web site, user groups "lab members" and "collaborators" should seamlessly access both public and private parts of the web site.
- This section of the web site must contain the following content: laboratory protocols, laboratory events calendar and announcements, inventory of plasmids and expressed protein constructs.

6.3. ADMINISTRATIVE INTERFACE

The site must have an administrative interface and delegate the ability to update the site content to the lab member user group. It must give this user group the ability to add, modify, and delete content on the site and digital files in the file repository.

- The admin interface must provide a basic level of content approval for registered laboratory members.
- It must provide WYSIWYG content editor support.
- Editing authority and tools should be attached to each content item and seamlessly integrated into the content of the web site.

6.4. GENERAL SITE CONTENT AND FUNCTIONAL REQUIREMENTS

6.4.1. Each page must contain the following elements:

- Contact information, with the mailing and shipping address for the laboratory, and the PI's email address. Email addresses must be coded into pages in a manner that prevents harvesting by spam bots.
- Each page must have a clear link to the PI's bio (personnel) page.
- The header with a basic OHSU black navigation bar, a search input box, and a clear tab-style indicator of the location of the page within the site hierarchy.
- The footer with "Last updated by" and an acknowledgement of any grant support directly funding the web site.
- A navigation menu on the left, with clear, distinct navigation buttons leading to various sections of the web site.

6.4.2. The web site must have a search box feature.

- The web site must be fully searchable across all content and digital media files.
- Users should be able to search by phrase for content and files and media file type for files
- Anonymous users must not see search hits from private content or files on the web site.

6.4.3. The web site must have a system for upload and management of media files (images, documents).

- The system must allow upload of the following types of files: jpg, gif, tiff, PDF, ppt, enl, PDB, doc, rtf. Users within the Lab members group should also be able to upload unspecified types of files.
- Each file in the media database must be titled, classified by type of file, description text, public/private access. Lab members should be able to add their own types of descriptor and classification fields for the files.
- The file database must be searchable by above descriptors.

6.4.4. The web site must have a calendar of events.

- The calendar system must enable the "lab members" user group to add, modify and delete events and important dates in the system.
- The events must be able to be kept private and viewable only by lab members and collaborators.
- The events should have the option to be classified as public and be viewable by general public.
- The calendar should present the events in a customary calendar grid.
- The calendar should allow users to upload, and delete file attachments within the body of the event descriptions.
- The calendar could offer an email reminder feature for events a lab member chooses.

6.4.5. The web site should provide monthly basic visitor statistics.
The statistics should be available only to the "lab members" user group.

6.4.6. General visual elements
Visual redesign was determined to be mostly optional and not an essential part of the redesign.
Optional:

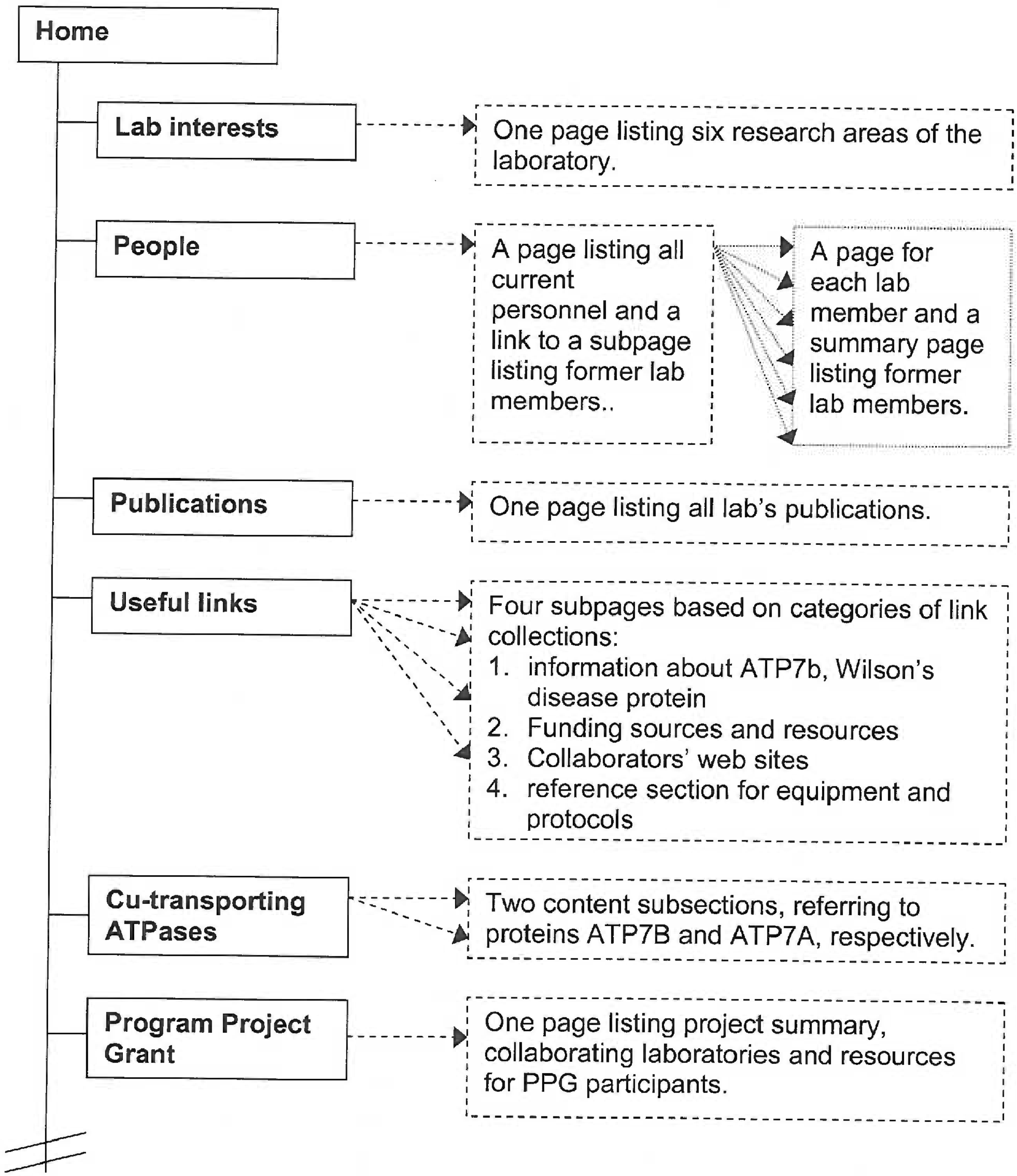
- The site should have a recognizable logo on the home page and its elements across other levels of the site.
- The site graphic elements should contain more soft lines to smooth out the look.
- The interactive features in illustrations and graphics should be presented in a more obvious and user-friendly way.

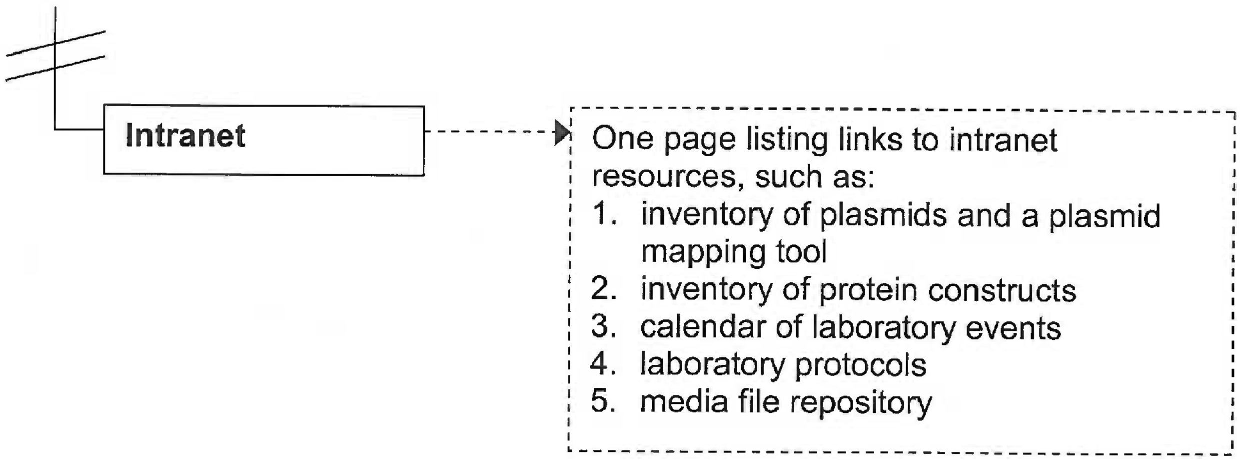
Not essential:

- The site could have a photo or 2D figure transparently embedded into the background of pages to soften up the visual display.
- The site could add/change color scheme into greys or blues.

6.4.7. **The site must be updated at least once every two weeks** for content and checked for broken links. Photographs and figures should be updated every 9-12 months, or as needed.

6.5. CONTENT AND SITE STRUCTURE DESCRIPTIONS





6.6.1. Lab interests

- One summary page introducing 6 research projects in the laboratory:
  1. Structure and Function of Wilson's disease Protein, a copper-transporting P_1-type ATPase ATP7B
  2. Regulation of copper homeostasis through protein trafficking and kinase-mediated phosphorylation
  3. Metallochaperone Atox1, copper transfer mechanism
  4. Understanding Wilson's disease pathology
  5. Copper homeostasis in the brain
  6. Cu chaperones (Atox1, Cox 17, COS)
- Each project description must contain references, relevant figures, and could also reference funding sources for the project.

6.6.2. People

The section listing people associated with the laboratory should list present and a link to a list of former members. Present members should have links to individual personal pages.

- The current lab member pages must list the person's name, education, title, email address, and relevant publications from this laboratory.
- The current lab member pages could list (and should be dependent on input and maintenance by individual lab members) personal research interests and projects, personal information, photo.
- In addition to above specification, the PI information page must also have a section listing the PIs lecture notes and slides and any useful links intended for the students taking her classes.
- The page listing former lab members should list the following information about each person: name, degree, current position, current email.

6.6.3. Publications

- All publications produced by this laboratory must be listed on this page, in full citation mode. A link to the PubMed record and to a PDF reprint must also be available.
- The PDF reprints should be restricted to intranet users until permissions from publishers to post them publicly is obtained.

6.6.4. Useful links

- Four categories of subpages and link collections:
  1. Information about ATP7b, Wilson's disease protein
  2. Funding sources and resources
  3. Collaborators' web sites
  4. Reference section for equipment and protocols
- Each link record must have a long title, short text description, link category classification, and a URL

6.6.5. Copper-transporting ATPases

Two content subsections, referring to proteins ATP7B and ATP7A, respectively. Each section should include information available for the particular gene/protein, including information about metal binding sites, transmembrane segments, crystal structures, alignments, mutations, and links to external resources about the gene.

6.3.6. Program Project Grant

- One page must list project summary, links to collaborating laboratories and resources for PPG participants (such as equipment use schedule)

6.3.7. Intranet

One page listing links to intranet resources, such as:

1. inventory of plasmids and a plasmid mapping tool
2. inventory of protein constructs
3. calendar of laboratory events
4. laboratory protocols
5. media file repository

H.5. DIALOGUE SPACE FOR THE DESIGN GROUP

Workplace arena (references to the laboratory, colleagues, organizational changes within the university's technical group, and the design group itself)	
Voice of Participatory Design (coordination, consensus, and comparative stories)	*Excerpt 1 (coordination):* PI: Well, I think in the long run, that would require a lot of investment, in terms of time and money… and, well, [Designer] effort, too… and I think ideally one would want to have a web site which is not just for internal use but other people could use it too for information. So I think that what ever information we have, it's nice to have it in such a way that it's in an accessible form. *Excerpt 2 (coordination):* PI: We really should do this and I encourage everybody to help with information because you know the coding that's what [Designer] will be responsible for but we cannot make her responsible for collecting information so that should come from us. *Excerpt 3 (coordination):* PI: Again, I think people should identify what they think are useful links and contribute… *Excerpt 4 (consensus):* Grad Student 1: Lay people are looking mostly for medical stuff, and there's already web sites out there that have medical information. Research Assistant: Right, maybe we could just have a link or two to some of the best medical information web sites. *Excerpt 5 (consensus):* Designer: …I am a big proponent of giving control over content to you so we could probably make it so that later on, if someone has a primer could just go in and type it into the system. Research Associate: We could have an online repository where you could type in the name and the sequence and add it automatically to the database. Post Doc: …and location. We need location. Research Associate: I think that's a bit of a separate issue, I mean, organizing the freezer, and I don't

	think it's a part of the web design project. Research Assistant: But we need to record location of the primer in the database. *Excerpt 6 (consensus):* PI: I think we should move this into a sub-button [on navigation bar], because right now we are definitely interested in continuing this research but we don't have enough information yet to make it a separate category. While with ATP7B and A the lab identifies, so we have lots of information on them. Designer: We could. this actually wouldn't be that hard either, but for the public you could have the link off of your project summaries, and if you do want to deposit any information, we can have it available for the lab members only... PI: In some way I would like to have this main category (button) but in reality somebody has to fill this category with information. Designer: So later on you could always add it whenever you'd want... when you'd have time to write more. PI: Right. That's what I'm thinking. *Excerpt 7 (comparative stories):* Graduate Student 1: I use the web site for strictly functional purposes... I don't like it when web sites are squashy, have too fancy things that distract you from what you need the web site for. When I use it I'm using it strictly for trying to figure something out, so I like it the way it is. The way it is right now it's very functional... I don't know how other people use it but that's how I use it. Research Assistant: I think for me it works fine and it's easy to get around but we're scientists... I think our perspective is a little bit different, we're used to dealing with dry bland information, but on the other hand there's people who like to get visually stimulated, and it really help when you have a web site with photos... You don't have a popular web site without photos, nice color schemes and links that are not just highlighted blue, and with something like an actual logo...

Voice of Practice (work and challenge stories from research experience)	*Excerpt 8 (challenge stories from research experience):* Graduate Student 1: Most of the primers do not label where they are and what exactly the sequence is…. Where the ends are and so it's difficult to figure out where it is unless it specifically says it's from nucleotide this to this. Unless you make all of your own and not borrow anyone else's, it's difficult. *Excerpt 9 (work stories from research experience):* Research Assistant: Then from the practical point of view we should probably have a central repository of all the primers… Research Associate: …primers, with the numbers… Post Doc: …and freezer boxes… PI: We really need to do that… Research Assistant: …and XY coordinates of each primer so we would know where the primer is. Post Doc: We should at least be able to narrow it down to a box… PI: I wouldn't be surprised if we have primers which are overlapping in nucleotides, so we really need to do this. *Excerpt 10 (work stories from research experience):* Research Associate: Remember we used to have access to Vector NTI and that was very nice and it's a very good program. But then we lost it and we have never been able to restore this access because they changed servers. So now most people in the lab use the free bioinformatics links… which is far away from Vector NTI. Designer: I use the Stanford Servers every time I make alignments. Decypher Servers. It's never down.
Voice of Engineering (technology explanations, theoretic anecdotes)	*Excerpt 11 (technology explanations):* Designer: … technology which is called database-driven web sites. Which means that you have a skeleton of the pages on the server but the content is actually really stored in a database… and this is one of the reasons why… this feature does exist but not many of you have used it… you can log in to your web site and you yourselves under your username can actually change certain things that I gave you access to.

	Excerpt 12 (technology explanations): Designer: The good thing about PHP is that there are actually a lot of open-source systems that work really well, already written for it. *Excerpt 13 (technology explanations)::* Research Associate: I think if we could build the whole database of all plasmids we have in the lab, and we have sequences of all the primers, that would make it easy to do an alignment search through the whole plasmids and find out what plasmid and where exactly it binds. ...That would be really helpful.

Organizational arena (references to the department administration and other parts of the university, especially the IT and Web departments)	
Voice of Participatory Design (coordination, consensus, and comparative stories)	*Excerpt 14 (comparative stories):* Designer: I personally think that the university servers aren't catering to what you need for this and that one of the alternatives is to go to a commercial server. And just for a $120 a year (PI: Get a commercial server.) you could get it going. *Excerpt 15 (comparative stories):* PI: In a way, I suspect, just nobody uses it and we might just not know… [the university] must have some kind of an alignment program like Vector NTI… Designer: They do. They have GCG… PI: GCG is pretty old. Designer: its color coding of the sequence… they have two alignment programs in GCG... I think Pretty is the one that uses probably 20 colors and when you get the alignment it's really pretty (laugh)… and the second one, I forget what it's called but there's no color coding, you just get you know, stars and colons to mark conserved and similar residues… PI: It sounds like if we could get our connection to the Vector NTI server revived, that could be an option, right? Research Associate: Yes. Well, we could also buy it and set it up on just one computer. We could not set up all computers on the lab but… still. This would solve all of these problems because I think Vector NTI has all the features we need… alignments, restriction digestion… But if you could get the [university's] option more incorporated into the web site… Designer: The problem is that if you want to use the GCG web interface... it's called SeqWeb… then you do have to log into it in order to use it so… I mean they are paying for the license so…. PI: What's downstairs? What program? Research Associate: Vector NTI.
Voice of Practice (work and challenge stories from research experience)	*Excerpt 16 (challenge stories):* Designer: This is the problem with university servers and this is why I've been very unhappy and why it's been going so slow…. It's because the university has constraints on what type of systems you can use to implement what we want – which is called database-

	driven web sites. ... However because the university has put a lot of rules on the web designers, the way that they just operate the web infrastructure, I don't have direct access to the databases and it's really frustrating sometimes when I make changes that I need to sometimes wait 2 or 3 days before I can work with it. *Excerpt 17 (work stories):* Graduate Student 1: I have files needed for [the university] radiation safety, things like maps I've made of the lab that you need to use to do the Radiation Survey, and I've also made a new form onto which you have to make all calculations, just plug in a few numbers... We could share that across the lab.
Voice of Engineering (technology explanations, theoretic anecdotes)	*Excerpt 18 (technology explanations):* Designer: And, they use a database-driven technology called ColdFusion, which is actually fine... it's something that you need to buy, kind of like an operating system for the servers... which is fine, but if you go to a commercial server, what they usually use is Linux for the operating system of the server, which is free, and then they also then support PHP, which is also free and it's equivalent to ColdFusion for which OHSU pays a ton of money for and that's why they are so stringently protecting the servers.

Societal arena (references to research labs and the area of copper transport research, funding agencies, describing local, national and international agencies, collaborations, conferences)	
Voice of Participatory Design (coordination, consensus, and comparative stories)	*Excerpt 19 (comparative stories):* Post Doc 1: Something that would get the general public more interested might be good, since we are kind of dependent on the general public for money, in a roundabout way. So people should see that there is... that there's many ways it's possible to... that there's many reasons to apply basic science. To make a connection about how this basic research links up with the clinical aspects. To me there should be something, at least links to the more clinical sites. Designer: That might be kind of like the BMB in the news section of the Departmental web site.
Voice of Practice (work and challenge stories from research experience)	*Excerpt 20 (challenge stories from research experience):* PI: It needs to work both on Mac and PC... the problem is that academic institutions... Research Associate: Yes, it's mostly Macs... PI: ...right now if you look at the metal binding site, it may look pretty on a PC but it looks horrible on Mac. *Excerpt 21 (work stories from research experience):* Designer: There was also a suggestion to add PDFs of papers so that everyone regardless of whether they are logged into the web site or not, could view them. Generally, that is OK, except that we would have to get permission due to copyright from all the journals... which I guess can be done is [the PI] writes an email and states that she wants to share them on the web site. Usually they give it to you. PI: You know I don't mind doing it. Just because I think it's actually nice... I like it when there is an option for people to just go and take a look... I just need to get organized and do it.